

polytechnic
UNIVERSITY

**UNDERGRADUATE AND
GRADUATE CATALOGUE
2007-2009**

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Web: www.poly.edu/admissions
E-mail: admitme@poly.edu

Long Island Graduate Center

105 Maxess Road
Melville, NY 11747
Phone: (631) 755-4300
Fax: (631) 755-4404
E-mail: ligc@poly.edu



Westchester Graduate Center

40 Saw Mill River Road
Hawthorne, NY 10532
Phone: (914) 323-2000
Fax: (914) 323-2010
E-mail: westinfo@west.poly.edu

Manhattan Location
Institute for Technology and Enterprise
55 Broad Street, Suite 13-B
New York, NY 10004
Phone: (212) 547-7030
Fax: (212) 547-7029
E-mail: ite@poly.edu



Visit our website: www.poly.edu

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POLYTECHNIC UNIVERSITY MISSION STATEMENT

To excel as a leading high quality research university engaged in education, discovery and innovation with social, intellectual and economic impact in the New York region, the nation and the world.

PART 1

GENERAL INFORMATION



The Polytechnic University catalogue is an official publication of the University. The catalogue provides information about academic programs and is intended to provide a helpful summary of University policies and procedures, and selected activities and services. Information concerning admission, academic regulations and requirements, student services, academic offerings and a listing of the administrative officers and faculty are included. Every effort has been made to publish a catalogue that is as complete and accurate as possible, but requirements, deadlines, tuition, fees, curricula, courses and staffing are subject to change at any time without advance notice or obligation. Some course descriptions may vary from actual course content due to advancements in the discipline, interests of individual instructors or decisions of the faculty to change the scope and/or content of the course.

ADMINISTRATIVE OFFICES

LEGEND

LC – Dibner/CATT Bldg.
JAB – Jacobs Academic Bldg.
JB – Jacobs Bldg.
ORH – Othmer Residence Hall
RH – Rogers Hall
WH – Wunsch Hall

EXECUTIVE OFFICES

Office of the President

Office: JB 555
Tel: (718) 260-3500
Fax: (718) 260-3641
E-mail: hultin@poly.edu

Office of the Provost

Office: JB555
Tel: (718) 260-3550
Fax: (718) 260-3063
E-mail: ekunhard@poly.edu

Office of the Chancellor

Office: LC 129
Tel: (718) 260-3553
Fax: (718) 260-3662
E-mail: chang@poly.edu

Office of Development and University Relations

Office: JB 458
Tel: (718) 260-3493
Fax: (718) 260-3755
E-mail: duncan@poly.edu

Office of Finance and Administration

Office: JB 555
Tel: (718) 260-3026
Fax: (718) 260-3755
E-mail: westcott@poly.edu

Office of Academic Affairs

Office: JB 555
Tel: (718) 260-3880
Fax: (718) 260-3063
E-mail: rtorsen@poly.edu

Office of Marketing and Communications

Office: JB555
Tel: 718 -260-3968
Fax: (718) 260-3755
E-mail: lestingi@poly.edu

ACADEMIC ADVISEMENT CENTER

www.advisement.poly.edu
Office: JB 356
Tel: (718) 260-3716
Fax: (718) 260-3941
E-mail: advisement@poly.edu
Hours: Monday-Friday, 9AM-6PM

ACADEMIC ASSESSMENT AND INSTITUTIONAL RESEARCH

survey.poly.edu
Office: RH 404A
Tel: (718) 260-3060
Fax: (718) 260-3431
E-mail: mmainier@poly.edu
Hours: Monday-Friday, 9AM-5PM

ACADEMIC SUCCESS

www.poly.edu/specialservices/index1.html
Office: JB 356
Tel: (718) 260-3014
Fax: (718) 260-3136
E-mail: hfung@poly.edu
Hours: Monday-Friday, 9AM-5PM

ADMISSIONS-GRADUATE

www.poly.edu/admissions/graduate
Office: RH 102
Tel: (718) 260-3182
Tel: 914-323-2023 (Westchester)
Fax: (718) 260-3642
E-mail: gradinfo@poly.edu
Hours: Monday - Friday, 9AM-5PM

ADMISSIONS-UNDERGRADUATE

www.poly.edu/admit
Office: WH, 2nd Floor
Tel: 800-POLYTECH or (718) 260-3589
Fax: (718) 260-3446
E-mail: admitme@poly.edu
Hours: Monday-Friday, 9AM-5PM

ALUMNI RELATIONS

www.poly.edu/alumni
Office: JB 452
Tel: 800-FON-POLY or (718) 260-3561
Fax: (718) 260-3114
E-mail: alumni@poly.edu
Hours: Monday-Friday, 9AM-5PM

ATHLETICS

www.poly.edu/athletics
Office: RH 220
Tel: (718) 260-3453
Fax: (718) 260-3474
E-mail: mbrazil@poly.edu
Hours: Monday-Friday, 10AM-7PM
Gymnasium/Fitness Center:
Monday-Friday, 11AM-9:30PM
Saturday-Sunday, 12PM-7PM

BERN DIBNER LIBRARY OF SCIENCE AND TECHNOLOGY

library.poly.edu
LC, 3rd Floor
Tel: (718) 260-3530
Fax: (718) 260-3756
E-mail: library@poly.edu
Hours: Monday-Friday, 9AM-10PM
Saturday-Sunday, 12PM-8PM

CAFETERIA

See Jasper H. Kane Dining Hall

CAREER SERVICES AND COOPERATIVE EDUCATION

www.poly.edu/special/careerservices
Office: JB 359
Tel: (718) 260-3650
Fax: (718) 260-3325
E-mail: careerservices@poly.edu
Hours: Monday-Friday, 9AM-5PM

CENTER FOR YOUTH IN ENGINEERING AND SCIENCE (YES CENTER)

www.poly.edu/yes
Office: WH 117
Tel: (718) 637-5944
Fax: (718) 260-3446
E-mail: bjohnson@poly.edu
Hours: Monday-Friday, 9AM-5PM

CONTRACT AND GRANTS

www.poly.edu/cng

Office: RH 321

Tel: (718) 260-3036

Fax: (718) 260-3063

E-mail: mklidas@poly.edu

Hours: Monday-Friday, 9AM-5PM

COUNSELING CENTER

www.counseling.poly.edu

Office: JB 358

Tel: (718) 260-3456

Tel: (718) 260-3207 (for emergencies)

E-mail: counseling@poly.edu

Hours: Monday-Friday, 9AM-5PM

Walk-in hours: Monday-Friday, 1-2PM

**DAVID PACKARD CENTER
FOR TECHNOLOGY AND
EDUCATIONAL ALLIANCES**

www.poly.edu/edu/packard

Office: RH 321C

Tel: (718) 260-3524

Fax: (718) 260-3733

E-mail: nkrift@poly.edu

Hours: Monday-Friday, 9AM-5PM

DIBNER LIBRARY

See Bern Dibner Library of Science
and Technology

FACILITIES

Office: JB 152

Tel: (718) 260-3020

Fax: (718) 260-3753

E-mail: acarino@poly.edu or

facility@poly.edu

Hours: Monday-Friday, 8AM-5PM

FINANCIAL AID

www.poly.edu/finaid

Office: JB 256

Tel: (718) 260-3300

Fax: (718) 260-3062

E-mail: finaid@poly.edu

Hours: Monday & Thursday, 10AM-6PM

Tuesday & Wednesday, 10AM-5PM

Friday, 10AM-3PM

FINANCIAL OPERATIONS

Office: JB 454

Tel: (718) 260-3869

Fax: (718) 260-3752

E-mail: financialoperations@poly.edu

Hours: Monday-Friday, 9AM-5PM

GENERAL STUDIES PROGRAM

www.gs.poly.edu

Office: JB 354

Tel: (718) 260-3391

E-mail: mparham@poly.edu

Hours: Monday-Friday, 9AM-5PM

GRADUATE CENTER

www.poly.edu/graduate

Office: RH 102

Tel: (718) 260-3182

E-mail: gradcenter@poly.edu

Hours: Monday-Friday, 9AM-5PM

**HIGHER EDUCATION
OPPORTUNITY PROGRAM
(HEOP)**

www.poly.edu/heop

Office: JB 355

Tel: (718) 260-3370

Fax: (718) 260-4135

E-mail: heop@poly.edu

Hours: Monday-Friday, 9AM-5PM

HUMAN RESOURCES

www.poly.edu/hr

Office: JB 258

Tel: (718) 260-3840

Fax: (718) 260-3981

E-mail: askhr@poly.edu

Hours: Monday-Friday, 9AM-5PM

INFORMATION SYSTEMS

insight.poly.edu

Office: RH 337

Tel: (718) 260-3123

Fax: (718) 260-3680

E-mail: help@poly.edu

Hours: Monday-Friday, 9AM-5PM

**INTERNATIONAL STUDENTS
AND SCHOLARS**

www.poly.edu/oiss/homepage.cfm

Office: RH 153

Tel: (718) 260-3445

Fax: (718) 260-3710

E-mail: mgendel@poly.edu

Hours: Monday-Friday, 9AM-5PM

JASPER H. KANE DINING HALL

www.poly.edu/lackman

Lackmann Culinary Services

Office: RH, 1st Floor

Tel: (718) 260-3786

Fax: (718) 875-0309

E-mail: lackmann@poly.edu

Hours: Monday-Sunday, 7:30AM-9:30PM

LONG ISLAND GRADUATE CENTER

www.poly.edu/li

105 Maxess Road, Suite N201, Melville

Tel: (631) 755-4300

Fax: (631) 755-4404

E-mail: ligc@poly.edu

Hours: Monday-Thursday, 9AM-6PM

Friday, 9AM-12PM

MAILROOM

Office: JB 151

Tel: (718) 260-3396

Fax: (718) 260-3136

E-mail: mailroom@poly.edu

Hours: Monday-Friday, 8AM-5PM

MANHATTAN LOCATION

[www.poly.edu/aboutpoly/](http://www.poly.edu/aboutpoly/directionsMnh.cfm)

directionsMnh.cfm

New York Information Technology Center,

55 Broad Street, Suite 13B

Tel: (212) 547-7030

Fax: (212) 547-7029

E-mail: ite@poly.edu

Hours: Monday-Friday, 10AM-6PM

**POLYTECHNIC TUTORING
CENTER**

www.tutoring.poly.edu

Office: JAB 373

Tel: (718) 260-3425

E-mail: tutoring@poly.edu

Hours: Monday-Thursday, 11AM-5PM

Friday, 10AM-3PM

PRINTING SERVICES

Office: JB 150

Tel: (718) 260-3396

Fax: (718) 260-3136

Hours: Monday-Friday, 8AM-5PM

REGISTRAR

www.poly.edu/registrar

Office: JB 256

Tel: (718) 260-3486

Fax: (718) 260-3052

E-mail: registrar@poly.edu

Hours: Monday & Thursday, 10AM-6PM

Tuesday & Wednesday, 10AM-5PM

Friday, 10AM-3PM

RESIDENCE LIFE

www.poly.edu/reslife

Office: ORH 103

Tel: (718) 260-4160

Fax: (718) 260-4195

E-mail: reslife@poly.edu

Hours: Monday-Friday, 9AM-6PM

ADMINISTRATIVE OFFICES

SECURITY

Tel: (718) 260-3727 LC Entrance
Tel: (718) 260-3537 RH Front Entrance
Tel: (718) 260-3213 RH Rear Entrance
Tel: (718) 637-5901 WH Entrance

SPECIAL SERVICES

[www.poly.edu/specialservices/](http://www.poly.edu/specialservices/SpecialServices.html)

[SpecialServices.html](http://www.poly.edu/specialservices/SpecialServices.html)

Office: JB 341
Tel: (718) 260-3560
Fax: (718) 260-3945
E-mail: specserv@poly.edu
Hours: Monday-Friday, 9AM-5PM

STUDENT ACCOUNTS

[www.poly.edu/administration/](http://www.poly.edu/administration/stuaccounts.cfm)

[stuaccounts.cfm](http://www.poly.edu/administration/stuaccounts.cfm)

Office: JB 256
Tel: (718) 260-3700
Fax: (718) 260-3052
Email: stuacct@poly.edu
Hours: Monday & Thursday, 10AM-6PM
Tuesday & Wednesday, 10AM-5PM
Friday, 10AM-3PM

STUDENT AFFAIRS

www.poly.edu/student-affairs

Office: JB 158
Tel: (718) 260-3137
Fax: (718) 260-3924
E-mail: mhutmake@poly.edu
Hours: Monday-Friday, 9AM-5PM

STUDENT DEVELOPMENT

www.poly.edu/student_development

Office: JB 158
Tel: (718) 260-3800
Fax: (718) 260-3197
E-mail: studentdevelopment@poly.edu
Hours: Monday-Friday, 9AM-5PM

STUDENT NOTEBOOK COMPUTER HELP DESK

www.poly.edu/notebook

Office: RH 339
Tel: (718) 260-3368
Fax: (718) 260-3188
E-mail: notebook@poly.edu
Hours: Monday-Friday, 8AM-6PM

UNDERGRADUATE ACADEMICS

www.poly.edu/ugacademics

Office: RH 216
Tel: (718) 260-3718
Fax: (718) 260-3896
E-mail: ugacademics@poly.edu
Hours: Monday-Friday, 9AM-5PM

WEB SERVICES

www.poly.edu/webmaster

323 Rogers Hall
Tel: 718.260.3971
Fax: (718) 260-3756
E-mail: support@webteam.poly.edu
Hours: Monday-Friday, 9AM-5PM

WESTCHESTER GRADUATE CENTER

www.poly.edu/west/

40 Saw Mill River Road, Hawthorne
Tel: (914) 323-2000
Fax: (914) 323-2010
E-mail: westinfo@west.poly.edu
Hours: Monday-Friday, 9AM-5PM

ACADEMIC CALENDAR 2007-2008

FALL 2007

Wed. October 31, 2007
All day Registrar's Office - JB 256
January 2008 graduates-Deadline to apply for graduation is October 31st, 2007.

Tues. November 13, 2007
Last day to withdraw from course with a "W" grade

Wed. - Fri. November 21 to 23, 2007
NO CLASSES - Thanksgiving Recess
Offices closed Thursday and Friday
November 22 and 23

Fri. December 7, 2007
Undergraduate Classes End

Mon. December 10, 2007
Undergraduate Reading Days

Tues. December 11, 2007
Undergraduate Reading Days

Wed. December 12, 2007
Final Exams

Thurs. December 13, 2007
Final Exams

Fri. December 14, 2007
Graduate Classes End

Fri. December 14, 2007
Final Exams

Mon. December 17, 2007
Final Exams

Tues. December 18, 2007
Final Exams

Wed. December 19, 2007
Final Exams

Thurs. December 20, 2007
Final Exams

Fri. December 21, 2007
Final Exams

SPRING 2008

Wed. January 2 to Wed. January 16, 2008
Winter Mini-Session

Mon. January 21, 2008
Martin Luther King Jr's Birthday
NO CLASSES

Tues. January 22, 2008
Classes Begin
First Day of Classes for Undergraduate and Graduate Classes

Mon. February 18, 2008
NO CLASSES - President's Day

Tues. February 19, 2008
Mon. Classes Meet
Make-up Day for President's Day

Mon. March 17 to March 21, 2008
NO CLASSES - Spring Break

Tues. April 8, 2008
Last Day to Withdraw from a Course with a "W" grade

Tues. April 29, 2008
Undergraduate Classes End

Wed. April 30, 2008
Undergraduate Reading Days

Thurs. May 1, 2008
Undergraduate Reading Days

Fri. May 2, 2008
Final Exams

Mon. May 5, 2008
Final Exams

Tues. May 6, 2008
Final Exams

Tues. May 6, 2008
Graduate Classes End

Wed. May 7, 2008
Final Exams

Thurs. May 8, 2008
Final Exams

Fri. May 9, 2008
Final Exams

SUMMER 2008

Mon. May 12, 2008
Summer Mini Session Begins

Fri. May 16, 2008
Graduate Classes Begin for X & Z Sessions

Fri. May 23, 2008
Summer Mini-Session Ends

Mon. May 26, 2008
No Classes - Memorial Day

Thurs. May 29, 2008
Undergraduate Classes Begin for X & Z Sessions

Thurs. June 19, 2008
Last Day to Withdraw from Graduate X Session

Last Day to Withdraw from a Graduate X Session course with a grade of "W"

Wed. June 25, 2008
Last Day to Withdraw from Undergraduate X Session -

Last Day to Withdraw from an Undergraduate X Session Course with a Grade of "W"

Fri. July 4, 2008
No Classes - Independence Day

Mon. July 7, 2008
Graduate Classes end for X Session

Tues. July 8, 2008
Graduate Classes begin for Y Session

Thurs. July 10, 2008
Make-Up Day For Independence Day
Friday Classes Meet; No Thursday Classes

Thurs. July 10, 2008
Undergraduate Classes end for X Session

Fri. Jul 11, 2008
NO CLASSES

Mon. July 14, 2008
Undergraduate Classes Begin for Y Session

Thurs. July 24, 2008
Last Day to Withdraw from Z session with a "W"

Last Day to Withdraw from Z Session with a grade of "W" for both Undergraduate and Graduate Classes

Fri. August 8, 2008
Last Day to Withdraw from Undergraduate Y Session

Last Day to Withdraw from Undergraduate Y Session with a Grade of "W"

Mon. August 11, 2008
Last Day to Withdraw from Graduate Y Session

Last Day to Withdraw from Graduate Y Session with a grade of W

Fri. August 22, 2008
Undergraduate Classes end for Y & Z Sessions

Tues. August 26, 2008
Make-Up Day for July 10th Conversion Day:
Thursday Classes Meet, No Tuesday Classes

Tues. August 26, 2008
Graduate Classes end for Y and Z Sessions

ACADEMIC CALENDAR 2008-2009

FALL 2008

Tues. September 2, 2008
Classes Begin

Mon. October 13, 2008
NO CLASSES - Columbus Day

Tues. October 14, 2008
Monday Classes Meet

Tues. November 11, 2008
Last day to withdraw from course with a
“W” grade

Wed. - Fri. November 26 to 28, 2008
NO CLASSES - Thanksgiving Recess
Offices Closed Thursday and Friday
November 27 and 28

Fri. December 5, 2008
Undergraduate Classes End

Mon. - Tues. December 8 to 9, 2008
Undergraduate Reading Days

Fri. December 12, 2008
Graduate Classes End

Wed. - Thurs. December 10 to 18, 2008
Undergraduate Final Exams

Mon. - Fri. December 15 to 19, 2008
Graduate Final Exams

Mon. - Fri. January 5 to 16, 2008
Winter Mini-Session

SPRING 2009

Tues. January 20, 2009
Classes Begin

Mon. February 16, 2009
NO CLASSES - President’s Day

Tues. February 17, 2009
Monday Classes Meet

Mon. - Fri. March 16 to 20, 2008
NO CLASSES - Spring Break

Mon. April 6, 2009
Last day to withdraw from a course with a
“W” grade

Tues. April 28, 2009
Undergraduate Classes End

Wed. - Thurs. April 29 to April 30, 2009
Undergraduate Reading Days

Tues. May 5, 2009
Graduate Classes End

Friday - Mon. May 1 to 11, 2009
Undergraduate Final Exams

Wed. - Tues. May 6 to May 12, 2009
Graduate Final Exams

SUMMER 2009

Thurs. May 14, 2009
Summer Mini Session Begins

Fri. May 15, 2009
Graduate Classes Begin for X & Z
Sessions

Thurs. May 28, 2009
Summer Mini Session Ends

Mon. May 25, 2009
NO CLASSES - Memorial Day

Fri. May 29, 2009
Undergraduate Classes Begin for X & Z
Sessions

Thurs. June 18, 2009
Last Day to withdraw from Graduate X
Session with a grade of “W”

Thurs. June 25, 2009
Last Day to withdraw from Undergraduate
X Session with a grade of “W”

Fri. July 3, 2009
NO CLASSES - Independence Day

Mon. July 6, 2009
Graduate Classes end for X Session

Tues. July 7, 2009
Graduate Classes Begin for Y Session

Mon. July 13, 2009
Undergraduate Classes Begin for Y Session

Thurs. July 23, 2009
Last Day to Withdraw from Z session
with a grade of “W” for both
Undergraduate and Graduate Classes

Fri. August 7, 2009
Last Day to Withdraw from
Undergraduate Y session with a grade
of “W”

Mon. August 10, 2009
Last Day to Withdraw from Graduate Y
session with a grade of “W”

Fri. August 21, 2009
Undergraduate Classes End for Y and Z
Sessions

Mon. August 24, 2009
Graduate Classes End for Y and Z
Sessions

POLYTECHNIC UNIVERSITY PROFILE

INTRODUCTION

Polytechnic University is the nation's second oldest private engineering university. Today, it is the New York metropolitan area's preeminent resource in science, engineering and technology education and research. A private co-educational institution, Polytechnic has a distinguished history in electrical engineering, polymer chemistry and aerospace and microwave engineering. Currently, it is a leader in telecommunications, information science and technology management. The University has charted a new course that captures ever-evolving global issues and seeks to resolve them through innovation, invention and entrepreneurship.

The student body includes more than 1,500 undergraduates and nearly 1,300 graduate students. Twenty percent of the undergraduate population are women; 9 percent are black, 6 percent Hispanic and 25 percent Asian. Polytechnic is among the leading private universities in the nation in awarding engineering degrees to underrepresented minorities.

Undergraduate programs at Polytechnic prepare students in engineering, science technology education and research equally for immediate entry into the professional practice of their specialties or for continued graduate study at Polytechnic or other leading graduate institutions.

HISTORY

Founded in 1854 as the Brooklyn Collegiate and Polytechnic Institute, the school originally educated young men, ages 9 to 22, and was located on Livingston Street in downtown Brooklyn. In 1889, the collegiate and preparatory departments were separated, with the collegiate division adopting the name Polytechnic Institute of Brooklyn. The preparatory department was renamed and moved off campus in 1901.

The Institute, historically referred to as "Brooklyn Poly," moved its campus to Jay Street in 1957. In 1961, it opened a Long Island campus in Farmingdale as a graduate and research center.

In 1973, Polytechnic merged with the New York University School of Engineering and Science and was renamed the Polytechnic Institute of New York. The Institute began offering undergraduate programs at its Long Island campus in 1974 and, in

1975, opened the Westchester Graduate Center in White Plains. The center later moved to its current location in Hawthorne in 1987.

In 1985, the Institution was granted university status by the New York State Board of Regents and officially renamed Polytechnic University.

The next 15 years saw a period of great activity as the University undertook the creation of MetroTech Center, a 16-acre, \$1-billion university-corporate park, which was built around Polytechnic's existing buildings and renewed an area that once had been a site of urban decay. Polytechnic updated its facilities, renovated its student center building and built a new home for its library and for the Center for Advanced Technology in Telecommunications. It also began offering several management of technology programs in the heart of Manhattan's high-technology and financial district.

During this time, the University launched the Campaign for Polytechnic-*Fulfilling the American Dream* to raise \$275 million to transform itself into one of the nation's premier technological universities. In 1998, Polytechnic received a \$175 million bequest from the estates of Donald F. Othmer, a longtime Polytechnic professor, and his wife, Mildred, the largest single cash gift ever made to a private American university at the time. In 1999, Polytechnic received its second largest contribution from alumnus Joseph J. Jacobs, who gave \$20 million. The campaign successfully concluded on June 30, 2001.

In 2000, Polytechnic began construction on two new buildings on the MetroTech campus: the Joseph J. and Violet J. Jacobs Building, an eight-story academic and athletic facility with state-of-the-art classrooms and laboratories and a full gymnasium; and the 20-story, 400-bed Donald F. and Mildred Topp Othmer Residence Hall, Polytechnic's first on-campus residence hall in Brooklyn. Both buildings opened in summer 2002. In addition, the main academic building, Rogers Hall, underwent a complete renovation to create several new instructional facilities and upgrade instructional equipment in existing facilities. An expanded cafeteria, seating 300, opened in fall 2002, and a new student lounge opened in spring 2003.

The University has also redirected its ed-

ucation programs, phasing out undergraduate programs at the Long Island campus and consolidating them at MetroTech, while still offering graduate programs to the Long Island engineering and technology community. Undergraduate programs on Long Island were discontinued in June 2002 as the University opened the Long Island Graduate Center in Melville, N.Y.

ACADEMIC PROGRAMS

Polytechnic offers the degree Bachelor of Science in 14 disciplines, covering computer science, engineering, the physical sciences, mathematics and liberal arts. The degree Master of Science is offered in 35 disciplinary specialties. The degree Master of Engineering in Interdisciplinary Studies in Engineering is offered with different concentrations, including Wireless Innovation. The degree Doctor of Philosophy is offered in 11 disciplines.

Bachelor of Science programs prepare students for entry-level employment in the various professional disciplines, as well as for study at an advanced level. Master of Science programs are oriented towards professional development in the subject area and can be arranged to provide the core coursework for PhD study. The PhD is the terminal research degree for those seeking careers in industrial or academic research. It requires an independent research dissertation that advances the state-of-the-art in the discipline of study. Details of academic degree requirements and detailed program descriptions are given in Part 3 of this catalogue.

ACADEMIC DEPARTMENTS

Faculty in the University is grouped into academic departments for administrative purposes. Each degree program is planned and administered by the faculty of a department (or in some cases by faculty from two co-operating departments). Instructional laboratories and some research laboratories are managed by academic departments.

Part 2 of this catalogue contains descriptions of the faculty and facilities of the following nine academic departments, as well as identification of the degrees that each department supervises.

- Chemical and Biological Engineering
- Chemical and Biological Sciences
- Civil Engineering

- Computer and Information Science
- Electrical and Computer Engineering
- Financial and Risk Engineering
- Humanities and Social Sciences
- Management
- Mathematics
- Mechanical and Aerospace Engineering
- Physics

RESEARCH PROGRAMS AND CENTERS

Polytechnic University offers major programs in experimental, theoretical and computational research, leading to significant contributions in the advancement of many areas of technology. Members of the Polytechnic faculty have been and continue to be among the world's leaders in such diverse areas as electromagnetics and wave propagation, wireless communications, telecommunications, polymer chemistry and engineering, optics and plasma physics, chemical and electronic imaging, materials science and engineering, transportation and traffic engineering, geotechnical engineering and software engineering and development.

In 2006, Polytechnic University conducted over \$12 million of sponsored research under contracts and grants funded by the federal and state governments and by private industry. Over 75 faculty members were involved in these efforts, which also provided support for over 80 research fellows. Research at Polytechnic is conducted either through academic department structures, or through one of the major interdisciplinary research centers.

Many of these research centers sponsor continuing education efforts in areas related to their research mission.

CENTER FOR ADVANCED TECHNOLOGY IN TELECOMMUNICATIONS (CATT)

The Center for Advanced Technology in Telecommunications (CATT) was created in 1983 as one of New York State's four original Centers for Advanced Technology. The CATT research programs focus on three key areas that are crucial to the needs of businesses today: wireless networks, network security, and network applications. The CATT houses 30 experts, who work in cooperation with telecommunication-provider and telecommunication-user businesses. More information on CATT is available at <http://catt.poly.edu>.

CENTER FOR FINANCE AND TECHNOLOGY (CFT)

The Center for Finance and Technology (CFT), addressing the evolving financial- and technology-enabled-innovation needs of the financial services industry. The CFT is a research hub as well as a laboratory for generating new ideas and tools for the industry. The CFT also undertakes collaborative research projects to provide ideas, methods and tools with scholarly and practical applications. For more information, contact Fred Novomestky at (718) 260-3436 or fnovomes@poly.edu, or visit www.cft.poly.edu.

CENTER FOR TECHNOLOGY IN SUPPLY CHAINS AND MERCHANDISING

The Center for Technology in Supply Chains and Merchandising emphasizes technology in the engineering and management of supply chains, retailing and merchandising.

The center's mission is threefold: to encourage engineering and computer science majors to enter the retail and merchandising industries, to provide advance training to the managers and technical professionals of these industries, and to foster research and the creation of intellectual capital in the development and application of technology and technology management in distribution and retail.

The center's emphasis on the technical side differentiates it from other academic programs that are primarily focused on marketing in the retail and merchandising field. The center draws on Polytechnic's diverse student body and its existing programs in telecommunications, transportation, information systems, technology management and financial engineering.

The center offers internships in the retail and supply-chain industry to undergraduate students, and to high school students who plan to enter Polytechnic and have an interest in the industry. The center also supports a tract in the Management of Technology and Innovation in Retailing (MOTIR) as part of the executive Management of Technology (MOT) Program offered by Polytechnic's Department of Technology Management. For more information, contact George Schillinger at gschilli@poly.edu.

INSTITUTE FOR TECHNOLOGY AND ENTERPRISE (ITE)

The Institute for Technology and Enterprise (ITE) is supported by the Department of Technology Management at Polytechnic

University and located at 55 Broad Street in Manhattan. The ITE is New York City's research and education hub for the management of technology and innovation and modern e-business, telecommunications and networking decision making. Located in the heart of high-technology New York City, the ITE is a focal point and R&D engine for building managerial knowledge and developing learning programs suited particularly to technology-intensive and "hybrid" -i.e., digital and physical-settings. The ITE's emphasis is on the creation of new value through innovation.

The ITE is also a gathering place for a unique, diverse and interdisciplinary community, comprising faculty members from the Department of Technology Management and other Polytechnic departments, industry leaders, and participating professionals in the ITE's executive master's programs. These highly committed professionals and scholars take part in the ITE round tables and workshops in New York City and around the world, and, working together, develop relevant research and learning materials that are used in learning programs and other international events.

For more information, call (718) 260-3610, fax: (212) 547-7029, e-mail ite@poly.edu, or visit www.ite.poly.edu.

NATIONAL SCIENCE FOUNDATION INDUSTRY/ UNIVERSITY COOPERATIVE RESEARCH CENTER FOR BIOCATALYSIS AND BIOPROCESSING OF MACROMOLECULES (NSF-BBM)

The NSF-BBM was established in 2000 to fill a need expressed by industry to provide a mechanism to assess the potential impact that biocatalysis and bioprocessing might have on its future businesses. The NSF-BBM is organized to provide industrial members with critical cutting-edge research on enzyme transformations related to polymer technology. The resulting knowledge base and the resources of the NSF-BBM are made available on a proprietary basis to its members. The objective is to allow industrial members to make informed decisions as to how new developments in biocatalysis and bioprocessing can specifically be directed toward their core-business needs.

For more information on the NSF-BBM, contact Prof. Richard A. Gross at rgross@poly.edu.

OTHMER INSTITUTE FOR INTERDISCIPLINARY STUDIES

The Othmer Institute for Interdisciplinary Studies was launched in 2002 to enhance Polytechnic's position as a significant contributor to a knowledge-based society. The institute was founded with a \$25 million endowment from a bequest from Donald F. Othmer, a longtime Polytechnic professor, and his wife, Mildred. Underlying the creation of the institute is the insight that extraordinary innovations often take place at the intersection of completely different fields. Being relatively small but committed to knowledge creation in the technology arena, Polytechnic is well situated for undertaking interdisciplinary breakthroughs. By sponsoring unique research and educational initiatives, creative outreach efforts and groundbreaking diverse spin-offs, the institute aims to act as a unique catalyst for such progress and as an agent of potentially transformational change at the University. For more information, call (718) 260-3556, fax (718) 260-3896, e-mail oiis@poly.edu, or visit www.othmerinstitute.poly.edu.

HERMAN F. MARK POLYMER RESEARCH INSTITUTE (PRI)

The Herman F. Mark Polymer Research Institute (PRI) was founded in 1943 by Dr. Herman F. Mark, internationally recognized as the "father of polymer science." Today it continues to be a leader in the synthesis, characterization, structure, processing, properties and applications of polymeric materials. In addition to its role in fostering interdisciplinary interest and work in polymers, the PRI sponsors symposia, conferences and professional educational programs.

The institute provides a focal point for the research of over 15 faculty members in chemistry, chemical engineering and physics. The PRI is actively involved with industry in regard to outsourcing, problem solving and education. In addition to the traditional chemical-related areas, the PRI has recently expanded its interests in macromolecular technology to health-related areas. For more information, contact Prof. Yoshi Okamoto at yokamoto@poly.edu.

TRANSPORTATION RESEARCH INSTITUTE (TRI)

Created in 1975, the Transportation Research Institute (TRI) uses research and educational programs to develop and transfer the knowledge base in transportation systems and policy to improve the mobility

and safety of persons, freight and services in metropolitan areas. TRI has conducted various landmark studies on capacity analysis of freeways and signalized intersections and led the development of the 1985 Highway Capacity Manual, which is used throughout the world as a design and analysis standard. TRI oversees the Intelligent Transportation Systems (ITS) research on technical, institutional and private-public issues and on its education and training. Through the Urban ITS Center, TRI assists New York City and New York State's Departments of Transportation in facilitating the deployment of ITS technologies in the New York metropolitan area. Other areas of TRI research include travel demand management, policy studies, transportation models, operational analysis, highway construction materials and pavement management. TRI comprises faculty from civil engineering, computer science, mechanical engineering, chemical engineering, the social sciences and transportation engineering. For more information, contact Prof. John C. Falcocchio at attri@poly.edu or jfalcoc@poly.edu.

URBAN UTILITY CENTER

Polytechnic University, in collaboration with major local, national and international utilities, established the Urban Utility Center to promote public-private partnerships for accelerating the assessment, demonstration and deployment of innovative infrastructure technologies. UUC's primary goal is to promote reliable and cost-effective use of technology in order to address fast growing societal needs for accelerating the rehabilitation of aging infrastructures, improving their performance, and upgrading the quality and safety of the vital public services that they support.

UUC has access to a unique network of public and private strategic partners and expert resources in the US and Europe which has the capacity to 1) coordinate, prioritize and direct R&D efforts across a broad array of interdependent infrastructure industries; 2) identify and evaluate early stage technologies; 3) integrate potential end-users into the development process, including utilities and municipalities; and 4) conduct on-site demonstrations in selected sites of the member utilities. For more information, contact Prof. Ilan Juran at uuc@poly.edu.

WIRELESS INTERNET CENTER FOR ADVANCED TECHNOLOGY (WICAT)

The Wireless Internet Center for Advanced

Technology (WICAT) was founded in 2001, with funding from the New York State Office for Science, Technology and Academic Research, under its Enhanced Center of Advanced Technology Program. WICAT houses researchers from the University's Departments of Management, Electrical and Computer Engineering and Computer and Information Science, as well as Columbia University's Departments of Electrical Engineering and Computer Science. WICAT researchers perform systems-oriented research aimed at making the wireless Internet a reality. For more information, visit <http://wicat.poly.edu>.

BEST INCUBATOR

The mission of the Brooklyn Enterprise on Science and Technology (BEST) is to provide an educational environment to stimulate the establishment and growth of science and technology based start-up and spin-off companies, expand Brooklyn's existing industry base, and attract high-technology industry to the region in order to create jobs and enhance economic development within Brooklyn. BEST seeks to foster entrepreneurial activities by providing low-cost facilities, educational opportunities, and an array of technological and business services to new and emerging companies. BEST provides entrepreneurs and start-ups with hands-on management assistance, access to financing, and exposure to critical business or technical support services as well as shared office services, access to equipment, flexible leases, and expandable space—all under one roof. BEST breeds blossoming firms, helping them to survive and grow during the start-up period when they are most vulnerable.

FACULTY

The heart of Polytechnic is its distinguished teaching and research faculty. There are more than 450 full-time and adjunct faculty; teaching and research fellows; research assistants, associates and scientists; and post-doctoral and special fellows. The number of full-time teaching faculty alone is over 135. The Polytechnic faculty is committed to providing the best possible educational environment in the classroom, in the laboratory, through individual guided studies and projects, through advising and through the strong one-on-one relationships most faculty members develop with their students.

The faculty originates, organizes and approves all curricula taught at the University and also establishes the academic standards for student performance. Class sizes are rel-

atively small, and all faculty members maintain regular office hours for consultation with individual students. Because many faculty members are actively involved in on-campus research, they are easily accessible outside the classroom. All formal academic advising after the first semester is done by the faculty.

The Polytechnic faculty is one of the most distinguished in the world. Polytechnic faculty members were among the founders of the National Academy of Engineering, the Institute for Electrical and Electronics Engineers, the American Institute of Chemical Engineers and the American Society of Engineering Education. The faculty includes members of the National Academy of Engineering and numerous fellows of the various professional disciplinary organizations. Faculty members have authored numerous undergraduate and graduate textbooks used throughout the United States and abroad and edit leading professional journals. They are frequently honored with prestigious awards.

ALUMNI

The POLYTECHNIC ALUMNI, the University's alumni association, provides a range of on-and off-campus educational, social, cultural and other programs for the benefit of alumni. The association is governed by an elected Executive Council and an International Board of Directors. Polytechnic alumni can be found in all 50 states and at least 64 countries.

The POLYTECHNIC ALUMNI supports regional and special-interest chapters established by alumni to provide opportunities for alumni gatherings and to represent Polytechnic in the community. Alumni organize reunions, by class year, discipline or other criteria.

Each year, the POLYTECHNIC ALUMNI recognizes alumni accomplishments through different award programs, including the Distinguished Alumni Award and Dedicated Alumni Award. In addition, it funds annual scholarships for selected students and presents annual awards to outstanding graduating seniors and outstanding athletes from Polytechnic sports teams.

The University provides alumni with the opportunity to audit Polytechnic courses at reduced tuition and use the Bern Dibner Library of Science and Technology. Alumni may open a free Polytechnic e-mail account and have lifetime access to many of the services offered by the Office of Career Services.

Cable, the alumni publication of Polytechnic University, is published quarterly to provide current news and information on the activities of the alumni and Polytechnic. Every five years, the POLYTECHNIC ALUMNI publishes a directory containing pertinent information on all known alumni.

Information regarding the organization's programs can be found in *Cable* or at www.poly.edu/alumni.

The Office of Alumni Relations works with the POLYTECHNIC ALUMNI to organize many of its programs, provides administrative and communication support and assists academic and administrative offices in keeping in touch with the more than 38,000 living alumni.

CAMPUSES

Brooklyn Campus
Six MetroTech Center
Brooklyn, NY 11201
Tel: (718) 260-3600
Fax: (718) 260-3136
E-mail: admitme@poly.edu

Polytechnic's main campus is located in the center of downtown Brooklyn, a vibrant residential and business community. The Brooklyn campus forms the nucleus of MetroTech Center, the largest urban university-corporate park in the United States. Developed in 1982, the 16-acre, \$1-billion complex features a tree-lined commons and pedestrian walkways and is home to several technology-dependent companies that have fostered research and employment relationships with the University.

- **Rogers Hall** is the main academic building and named after the late Harry S. Rogers, Polytechnic's fifth president (1933-57). The building houses faculty and department offices, classrooms, research and teaching laboratories, cafeteria, dining hall, student lounge.

- **Bern Dibner Library of Science and Technology/Center for Advanced Technology in Telecommunications (CATT) Building** opened in 1992 and provides 128,000 square feet of academic space. The building houses several key elements of the University: a state-of-the-art library, named after the late Bern Dibner '21 Hon'59, a Polytechnic alumnus, trustee and benefactor; the prestigious New York State-funded research center, CATT; computer laboratories; and administrative offices for the Departments of Management, Electrical and Computer

Engineering, and Computer and Information Science.

- **Joseph J. and Violet J. Jacobs Building** opened in 2002 and is named after the late Dr. Jacobs '37 '39 '42 H'86, former chairman of the Polytechnic Board of Trustees, and his wife. The eight-story building, the main entrance to the University, contains lecture halls; laboratories for chemistry, biology and environmental engineering; "smart" classrooms wired for the latest Internet and multi-media technologies. The building also includes a full multi-purpose gymnasium, including a fitness center and basketball court. The first floor contains the Graduate Center for Professional Studies and the lower-level houses offices for student clubs and the Polytechnic incubator Brooklyn Enterprise on Science and Technology (BEST).

- **Donald F. and Mildred Topp Othmer Residence Hall** opened in 2002 and is named after the late Dr. Othmer, a longtime Polytechnic professor of chemical engineering (1932-76), and his wife, Mildred. The 20-story building houses over 400 students in two-bedroom suites and two-bedroom apartments with kitchens and data, voice and cable television ports for every student. The building includes student lounges, study rooms, laundry facilities, health offices and storage space. The housing staff comprising two full-time professional staff members, graduate and undergraduate student resident assistants and security personnel supervise the students and building 24 hours a day.

- **Joseph W. and Samuel Wunsch Hall** is housed in a historic landmark. Built in 1846, the Greek Revival building was the home of the African Wesleyan Methodist Church, the first black congregation in Brooklyn, and reputed to be stop on the Underground Railroad. Polytechnic bought the property in 1968 and closed it for renovation in 1990. It was authentically restored through the generosity of the Wunsch family, in memory of brothers and Polytechnic alumni Joseph '17 and Samuel Wunsch '29, and reopened in 1996. The building houses the Office of Undergraduate Admissions.

- **Joseph J. Jacobs Administration Building** offices located in Jacobs Building, including registrar, student accounts, financial aid, student development and

career services. Other administrative offices include development, alumni relations, university relations and communications and media relations.

**Long Island Graduate Center
Melville Corporate Center
105 Maxess Road
Melville, NY 11747
Tel: (631) 755-4300
Fax: (631) 755-4404
E-mail: ligc@poly.edu**

The mission of the center is to help Long Island industry grow by producing skilled graduates needed by Long Island companies and, therefore, serve as an important resource for Long Island's engineering and technology community.

Students enrolled at the Long Island Graduate Center can choose to pursue a 30-credits master's degree program or a 15 credits graduate certificate program, or enroll in selected courses. Classes are offered in the evening, Monday through Thursday, and during the day on Saturday to accommodate the schedules of working professionals.

A corporate Advisory Council of noted Long Island business leaders advises Polytechnic University on the continuing education needs of Long Island industry. Polytechnic is active in organizations dedicated to the high-tech future of Long Island, including the Long Island Association (LIA) and the Long Island Forum for Technology (LIFT). From its Long Island Graduate Center, Polytechnic interacts with Long Island industry through its Center for Advanced Technology in Telecommunications (CATT) and other research efforts.

**Westchester Graduate Center
40 Saw Mill River Road
Hawthorne, NY 10532
Tel: (914) 323-2000
Fax: (914) 323-2010
E-mail: westinfo@west.poly.edu**

The Westchester Graduate Center has served the Hudson Valley area for near 30 years and is the area's premier center for graduate and continuing technical and managerial education.

The center offers part-time master's degree programs in management, chemistry, chemical engineering, computer science and telecommunication networks (with concentrations in e-business management, entrepreneurship, information management, technology management and operations management). Courses are scheduled in the evening and on Saturdays.

The Graduate Center is home to Polytechnic's MS in Information Systems Engineering, offered in the executive degree program format.

**Manhattan Institute
for Technology and Enterprise (ITE)
55 Broad Street, Suite 13-B
New York, NY 10004
Tel: (212) 547-7030
Fax: (212) 547-7029
E-mail: ite@poly.edu**

Polytechnic's Institute for Technology and Enterprise (ITE) is located in the heart of New York City's high-technology and financial district, serving the area's burgeoning population of technology workers. ITE offers graduate courses in technology management, financial engineering and telecommunication management. Poly has also recently launched an innovative, technology-focused MBA program that reflects the needs and trends of new business. In an executive degree program format, classes meet on Thursday evenings and Saturdays of alternate weeks over a four-semester period. Students complete their degree in a total of 28 weekends over a 15-month period. The MS in Management of Technology (MOT) and in Telecommunications and Information Management (TIM) are offered exclusively at Polytechnic's Manhattan location.

BERN DIBNER LIBRARY OF SCIENCE AND TECHNOLOGY

The Bern Dibner Library of Science and Technology serves as Polytechnic University's information hub. Wireless networks allow users to access the library's electronic services both from within the library and from other campus locations.

The library offers electronic access 24 hours a day, seven days a week. Its resources can be accessed through the main Polytechnic University web site (www.poly.edu) or directly through the library's site (<http://library.poly.edu>). Through the library's web site, users can access information about books and journals, many of them in full text, as well as imaged course materials and online courses. Subject-related web guides created by professional staff facilitate further study and research.

In-house library services are augmented by participation in regional and national cooperatives. The University library is an active member of the Academic Libraries of Brooklyn (seven participating libraries) the New York Metropolitan Reference and Research Library Agency (currently 270 mem-

ber institutions representing 1,200 libraries) and the Long Island Library Resource Council (over 200 participating libraries) The library is also a member of the Online Computer Library Center, which maintains an international database compiled and maintained by over 9,000 participating libraries as well as Nylink which offers access to New York State resources.

Skilled information professionals provide support through the following products and services:

- One-on-one assistance in the retrieval and use of online resources including the catalogue and electronic databases.
- Tutorials on effective research methods offered in conjunction with various academic departments. Workshops are open to all Polytechnic students, faculty and staff and provide training in the use of information services and software.
- An in-house collection of more than 150,000 books and journals, which provides basic support for undergraduate and graduate programs in engineering, the sciences, management and other fields.
- A document delivery service, which obtains, on request, books, journal articles and reports not available in Polytechnic's in-house collections or online.

CENTRAL COMPUTING FACILITIES

The computing facilities were designed to be aligned with the Polytechnic's course offerings in computer science and engineering and the University's role in educating and training knowledge workers of the future.

For the past several years, Polytechnic has required every student to have a laptop computer; mobile technology is integrated into the curriculum, using tools such as AutoCAD, LabVIEW, Common Space, MathLab, Visual Studio and the Microsoft Professional office suite. Mobile technology and timely, pervasive access to information are also integrated throughout the Poly campus with a full wired and wireless network infrastructure.

The University provides electronic access through state-of-the-art, standards-based, broadband wired and wireless networks, which allow students to roam seamlessly around campus while staying connected to the Internet and all educational support and information resources. The combination of student laptops, a ubiquitous broadband network, online in-

formation and learning support tools, promotes “congregate learning” and links the Poly community into an electronic learning community.

Several departments and laboratories have their own sub-networks that are part of the overall University network. These include the Electrical Engineering Wireless Communications Labs, the Mechanical Engineering Controls and Robotics Labs, the Computer Engineering Microprocessor Design Labs, the Computer Science Distributed Systems Labs, and the Freshman Engineering Labs.

The University also provides access to a multitude of central computing laboratories in support of various discipline-specific fields. These labs consist of a collection of top-end Intel-based desktops and Unix-based workstations. These resources access a multitude of server operating systems and applications, giving students exposure to a highly heterogeneous technology environment, which reflects the mostly widely used tools used in the engineering and technology professions.

The software provided in the central computing labs include Accolade; Adobe Acrobat, Illustrator and PageMaker; AutoCAD and Borland C++ Builder; CircuitMaker; Microsoft Office 2003, Visual Studio and Net; Object Ada; Primavera Project Planner; and Statistical Package for the Social Sciences (SPSS).

Since many of the learning and information support systems are web enabled, students can access these resources off campus as easily as on campus. Students living in the Othmer Residence Hall have state-of-the-art voice, data and cable connections in their rooms and throughout the building.

Through the Internet portal My Poly, students are able to examine their course information, keep track of tuition and financial aid records and monitor their degree progress. Faculty members use My Poly as a preferred method to enhance their courses by uploading syllabi and related documents and to communicate with students. Students are encouraged to interact with their instructors using electronic means, allowing students to have access to guidance, support, mentoring and advisement anytime, anywhere.

CLOSING

As the University moves forward in the 21st century, it holds fast to its mission to educate intellectually curious young men and women who are eager to change the world through innovation and invention. The Polytechnic education will prepare these individuals to become leaders in a global arena that demands scientific, technological and entrepreneurial acuity.

ACADEMIC DEPARTMENTS AND DEGREES

OTHMER-JACOBS DEPARTMENT OF CHEMICAL AND BIOLOGICAL ENGINEERING

- BS** Chemical and Biological Engineering
- MS** Chemical Engineering
- PhD** Chemical Engineering

DEPARTMENT OF CHEMICAL AND BIOLOGICAL SCIENCES

- BS** Biomolecular Science
- MS** Biomedical Engineering
- MS** Chemistry
- MS** Biotechnology
- MS** Biotechnology & Entrepreneurship
- PhD** Biomedical Engineering
- PhD** Materials Chemistry

Advanced Certificates: Bioinstrumentation, Biomedical Materials

DEPARTMENT OF CIVIL ENGINEERING

- BS** Civil Engineering
- BS** Construction Management
- MS** Civil Engineering
- MS** Construction Management
- MS** Environmental Engineering
- MS** Environmental Science
- MS** Transportation Management
- MS** Transportation Planning and Engineering
- MS** Urban Systems Engineering and Management
- PhD** Civil Engineering
- PhD** Transportation Planning and Engineering

Advanced Certificates: Construction Management, Executive Construction Management (Exec21), Hazardous Waste Management, Traffic Engineering, Transportation Management and Economics, Transportation Planning

DEPARTMENT OF COMPUTER AND INFORMATION SCIENCE

- BS** Computer Engineering¹
- BS** Computer Science
- MS** Computer Science
- MS** Information Systems Engineering
- MS** Telecommunication Networks
- PhD** Computer Science

Advanced Certificate: Computer Engineering², Software Engineering

DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

- BS** Computer Engineering¹
- BS** Electrical Engineering
- BS** Electrical and Computer Engineering (dual degree program)
- MS** Computer Engineering¹
- MS** Electrical Engineering
- MS** Electrophysics
- MS** System Engineering
- MS** Telecommunication Networks¹
- PhD** Electrical Engineering

Advanced Certificates: Computer Engineering¹, Image Processing, Telecommunication Network Management¹, Wireless Communications

DEPARTMENT OF FINANCE AND RISK ENGINEERING

- MS** Financial Engineering,
- Tracks:** Financial Markets and Corporate Finance, Computational Finance, and Financial Information Services and Technology
- PhD** Financial Engineering and Risk Analysis²
- Advanced Certificates:** Financial Engineering, Financial Technology Management, Risk Management

DEPARTMENT OF HUMANITIES AND SOCIAL SCIENCE

- BS** Liberal Studies
- BS** Technical and Professional Communication
- MS** Environment–Behavior Studies
- MS** History of Science
- MS** Integrated Digital Media
- MS** Technical and Professional Communication
- Advanced Certificate:** Environment–Behavior Studies, Technical Communications

DEPARTMENT OF MATHEMATICS

- BS** Mathematics
- MS** Mathematics
- PhD** Mathematics

DEPARTMENT OF MECHANICAL AND AEROSPACE ENGINEERING

- BS** Mechanical Engineering
- MS** Industrial Engineering
- MS** Mechanical Engineering
- MS** Manufacturing Engineering
- MS** Materials Science
- PhD** Mechanical Engineering
- Advanced Certificates:** Achieving World-Class Quality, Industrial Engineering, Manufacturing Engineering and Production Science, Manufacturing Excellence by Design: Holistic Approach

DEPARTMENT OF PHYSICS

- BS** Physics

DEPARTMENT OF TECHNOLOGY MANAGEMENT

- BS** Business and Technology Management
- MBA** Master of Business Administration
- MS** Management
- MS** Management of Technology
- MS** Organizational Behavior
- MS** Telecommunications and Information Management
- PhD** Technology Management
- Advanced Certificates:** Construction Management¹, Electronic Business Management, Entrepreneurship, Human Resource Management, Information Management, Project Management, Organizational Behavior, Technology Management, Telecommunications Management

DEGREES OFFERED OUTSIDE DEPARTMENTS

- MS** Bioinformatics
- ME** Interdisciplinary Studies in Engineering

1. Offered jointly by the Department of Electrical and Computer Engineering and the Department of Computer and Information Science.

2. Pending approval by New York State.

DEGREES OFFERED AT POLYTECHNIC

Polytechnic offers a wide range of degree programs leading to award of the degrees Bachelor of Science, Master of Science, Master of Engineering and Doctor of Philosophy. These programs are offered at four University locations: Brooklyn, Long Island, Manhattan and Westchester. In addition, an MS in Management is offered in Israel. The table below indicates the degrees registered at each campus. Please check with each department to confirm that a program is currently available at the locations indicated below.

Graduate courses taken at any campus are applicable toward MS and PhD degree programs officially offered at another campus. Most graduate courses are offered in the evening or late afternoon. While PhD seminars, qualifying exams, etc., are available only on the Brooklyn campus, dissertation research may be at another campus where the faculty adviser is resident.

Program Title	HEGIS code ¹	Brooklyn	Long Island	Westchester	Manhattan ³	Israel
Accelerated Management of Technology					MS	
Bioinformatics	1999.20	MS				
Biomedical Engineering	0905	MS, PhD				
Biomolecular Science	0499	BS				
Biotechnology	0499	MS				
Biotechnology & Entrepreneurship	0499	MS				
Business & Technology Management	0599	BS				
Chemical & Biological Engineering	0906	BS				
Chemical Engineering	0906	MS, PhD				
Chemistry	1905	BS, MS, PhD ⁵		MS		
Civil Engineering	0908	BS, MS, PhD				
Computer Engineering	0909	BS, MS	MS			
Computer Science	0701	BS, MS, PhD	MS	MS		
Construction Management	0599	BS, MS				
Electrical Engineering	0909	BS, MS, PhD	MS	MS		
Electrical & Computer Engin. (dual)	-----	BS				
Electrophysics	0919	MS	MS			
Environment–Behavior Studies	2201	MS				
Environmental Engineering	0922	MS				
Environmental Science	0922	MS				
Financial Engineering	0599	MS			MS	
History of Science	2205	MS				
Industrial Engineering	0913	MS				
Information Systems Engineering	0990			MS		
Integrated Digital Media	-----	BS, MS				
Interdisciplinary Studies in Engineering	0999	ME	ME	ME		
Liberal Studies	4901	BS				
Management	0506	MS,	MS	MS		MS ⁴
Management of Technology	0599				MS ²	
Manufacturing Engineering	0913	MS				
Master of Business Administration	-----	MBA		MBA	MBA	
Materials Chemistry	1905	PhD				
Materials Science	0915	MS				
Mathematics	1701	BS, MS, PhD				
Mechanical Engineering	0910	BS, MS, PhD				
Organizational Behavior	0514	MS				
Physics	1902	BS				
Specialized Journalism	0602	MS				
Systems Engineering	0901	MS	MS			
Technical Communication	0602	BS				
Technology Management	0599	PhD				
Telecommunication Networks	0799	MS	MS	MS		
Telecommunications & Information Management	0599				MS ²	
Transportation Management	0510	MS				
Transportation Planning & Engineering	0908	MS				
Urban Systems Engineering & Management	0999	MS				

1. Higher Education General Inventory System.

2. Executive format program.

3. Offered at 55 Broad Street, Manhattan, pending New York State approval.

4. More information is given in Department of Technology Management section of this catalogue.

5. See PhD program in Materials Chemistry.

CERTIFICATES OFFERED AT POLYTECHNIC

Program Title	HEGIS code ¹	Academic Department	Campus
Achieving WorldClass Quality	0913	Mechanical & Aerospace Engineering	Brooklyn
Bioinstrumentation	0905	Chemical & Biological Sciences	Brooklyn
Biomedical Materials	0905	Chemical & Biological Sciences	Brooklyn
Computer Engineering	0909	Computer & Information Science/ Electrical & Computer Engineering	Brooklyn Long Island
Construction Management	0599	Civil Engineering/Management	Brooklyn
Cyber Security	-----	Computer & Information Science	Brooklyn
Electronic Business Management	0599	Management	Brooklyn Westchester Long Island
Entrepreneurship	0506	Management	Brooklyn Westchester Long Island
Environment-Behavior Studies	2201	Humanities & Social Sciences	Brooklyn
Executive Construction Management (Exec21)	0599	Civil Engineering	Manhattan ²
Financial Engineering	0599	Finance and Risk Engineering	Brooklyn Manhattan
Financial Technology Management	0599	Finance and Risk Engineering	Brooklyn Manhattan
Hazardous Waste Management	0420	Civil Engineering	Brooklyn
Human Resource Management	0515	Management	Brooklyn
Image Processing	0999	Electrical & Computer Engineering	Brooklyn
Industrial Engineering	0913	Mechanical, Aerospace & Manufacturing Engineering	Brooklyn
Information Management	0702	Management	Brooklyn Westchester Long Island
Information Security Professional	-----	Computer & Information Science	Brooklyn
Information Systems Administration	-----	Computer & Information Science	Brooklyn
Manufacturing Engineering & Production Science	0913	Manufacturing Engineering	Brooklyn
Manufacturing Excellence by Design: Holistic Approach	0913	Manufacturing Engineering	Brooklyn
Operations Management	0506	Management	Brooklyn Westchester Long Island
Organizational Behavior	0515	Management	Brooklyn
Risk Management	0504	Finance and Risk Engineering	Brooklyn Manhattan
Software Engineering	0799	Computer & Information Science	Brooklyn
Technical Communication	0699	Humanities & Social Sciences	Brooklyn
Technology Management	0599	Management	Brooklyn Westchester Long Island
Telecommunication Network Management	0799	Electrical & Computer Engineering	Brooklyn Long Island
Telecommunications Management	0599	Management	Brooklyn Long Island
Traffic Engineering	0908	Civil Engineering	Brooklyn
Transportation Management & Economics	0908	Civil Engineering	Brooklyn
Transportation Planning	0908	Civil Engineering	Brooklyn
Wireless Communications	0909	Electrical & Computer Engineering	Brooklyn Long Island

1. Higher Education General Inventory System.

2. Offered at 2 Broadway in Manhattan.

ACADEMIC POLICIES AND DEGREE REQUIREMENTS

PROGRAM AREAS

Polytechnic is a university uniquely focused on the world of technology and its interactions with society. To fulfill its mission, Polytechnic offers degree programs in five general academic areas:

- Computer and Information Science
- Engineering
- Liberal Studies
- Management
- The Sciences and Mathematics

COMPUTER AND INFORMATION SCIENCE

Computer and information science has become an important and expanding field as today's society moves into the Information Age. Computer and information science includes the design of systems (computer hardware and software) and the development of principles for applying computers to new uses. It requires a high level of theory and practice and often involves the development and/or integration of complex software.

A multidisciplinary focus is required for computer and information science, since computers are everywhere in society. Computer and information science is a major element in modern information technology, allowing information to be used in analyzing and solving problems in diverse fields, such as telemedicine, health care, finance, entertainment, manufacturing, telecommunications, transportation and biomedicine.

The curriculum is an integrated program of basic science, computer science, mathematics, humanities and social sciences. Students take electives in technical and non-technical subjects to give them flexibility and breadth in their studies at Polytechnic.

The current faculty works in such state-of-the-art fields as high-speed imaging classification, software virus protection, high-speed graphics, text and data mining, fault tolerant computing, database management systems, software engineering, data compression, data security, parallel and distributed computation, scheduling theory, computer vision and Internet and Web technologies. This faculty experience, combined with a strong curriculum, integrating theory and practice, allows Polytechnic graduates to be well positioned for the 21st century.

ENGINEERING

Engineering is perhaps best described as the creation of devices and implements that can control or manipulate nature to produce a desired effect. It is the application of science to build the infrastructure, devices, tools and other implements needed by society to improve quality of life and environment.

The modern engineer must have a firm background in the sciences and mathematics. Science provides fundamental knowledge about the natural world; mathematics is the language most often used to describe it, and through which engineers manipulate it. A background in the liberal arts provides a fundamental understanding of society, its structures, needs and desires. No one can hope to improve society without such understanding. Engineers must also have a deep appreciation for the role they play in society, particularly their professional ethics and responsibilities. Finally, engineers must have excellent communications skills to work effectively with other engineers, other professionals, decision-makers and the public.

Polytechnic's engineering programs build on a firm foundation of mathematics and science to develop the analysis and design skills required of a practicing professional. State-of-the-art laboratories introduce students to devices and systems currently used in their fields as well as develop their skills in using computer-aided design packages. Undergraduate programs prepare students equally for entry into the profession and for continued education at the graduate level.

Above all, Polytechnic prepares engineering graduates for a lifetime of education and growing knowledge in the rapidly developing field of technology. By giving students a comprehensive education in the principles of science and engineering and by developing the creative skills required for engineering design and analysis. Polytechnic provides its graduates with the ability to continue to learn and grow as their careers progress.

Just as current Polytechnic faculty and alumni are advancing varied fields-such as telecommunications, microwaves, space electronics, imaging sciences, quantum electronics, pulse power, materials, aerospace, geotechnology, software engineering and earthquake performance of structures-

Polytechnic students are being equipped to carry this tradition forward to the next generation of technological breakthroughs.

LIBERAL STUDIES

Through the study of the liberal arts students learn to understand human society and its development, needs, desires and the means through which it makes these known. No one can adequately address technology or its creation and development without understanding the human and societal needs with which it seeks to serve. On the other hand, no humanist can adequately understand society and its development without a knowledge and understanding of how it interacts with and is affected by technology.

Liberal studies majors at Polytechnic study traditional programs in social sciences and humanities as well as a curriculum specifically addressing the interactions between society and technology.

MANAGEMENT

Polytechnic's Department of Technology Management is the premier learning, research and development hub in the New York City/tri-state region, explicitly devoted to the critical arenas of innovation, information and technology management.

The department has achieved this pre-eminent position with a continuous stream of high-quality and relevant research, development and pacesetter learning programs. Its faculty contributes to theory and practice in an increasingly knowledge-intensive age.

The research and development conducted within the Department of Technology Management is varied, including scholarly books and articles in the respected journals and timely case studies. Some of this material forms part of the content in educational programs, helping to keep programs up-to-date and distinctive. The department's Institute for Technology and Enterprise functions as an "engine" for high-level research and development for the whole department and for relevant firms and fields at large.

The department is also committed to integrating technology into all educational programs to enhance learning. Because all managers must now understand how technology and innovation are essential for de-

livering value to organizations and the market, the department offers a portfolio of educational programs dealing with the broad spectrum of innovation, information and technology management in the modern economy.

In addition to its academic programs, the Department of Technology Management offers short-term, non-degree programs, including programs tailored to the needs of specific firms and industries that are related in some fashion to the broadly defined technology and information management field.

THE SCIENCES AND MATHEMATICS

Science and mathematics are the underpinnings of modern technology. As scientists and mathematicians discover and describe new secrets of the natural world, engineers look to apply them to developing new technology. Without the physical sciences and mathematics, engineers would have no tools with which to invent the technology of tomorrow.

Polytechnic's undergraduate science and mathematics programs give students unique opportunities to study basic theory, while at the same time interacting with design disciplines. The structure of undergraduate programs in these areas encourages students to select concentrations of elective courses in technology areas.

Students use modern laboratories and interact with faculty who are world-class researchers. Many junior and senior classes are small, allowing students to develop one-on-one relationships with faculty and work with them in their appropriate research areas.

The future of technology critically depends on the ability to develop a better and more accurate understanding of nature and its opportunities and constraints. For technology to advance, scientists must continue to unlock the secrets of the universe, and mathematicians must continue to develop the analytic and logical processes through which they can extend and apply that which they discern. Polytechnic programs prepare scientists and mathematicians for this vital role, enabling them to lead society to a better future.

GENERAL POLICIES

TRANSCRIPTS

The issuance of transcripts and generally the release of any information about a student are subject to the provisions of Public Law 93-380, the Family Educational Rights and Privacy Act of 1974 as amended.

Unless Polytechnic's disclosure policy permits otherwise, official transcripts of the scholastic record will be issued only upon the submission of a written request or upon the submission of a signed release from the student. Official transcripts will be sent directly to a school or other properly authorized parties. In no case can students receive official copies of their own transcripts, unless specifically authorized by the Registrar. Such exceptions are strictly monitored and are rarely given.

Unofficial transcripts are available to students through the PSData system. Those students that do not have access to PSData may submit a written request for an unofficial transcript. There is a fee for each transcript issued.

Polytechnic reserves the right to withhold the issuance of a transcript due to a student's failure to meet financial indebtedness to Polytechnic.

Upon graduation, a student's transcript should be reviewed carefully and any errors immediately reported to the Office of the Registrar before the record is sealed.

INTELLECTUAL PROPERTY

The University has a written policy on intellectual property, which governs faculty and student project work, in terms of rights, benefits and releases. The policy is available from the Office of Undergraduate Academics.

UNDERGRADUATE DEGREE REQUIREMENTS AND ACADEMIC POLICIES

This section details the general University-wide degree requirements that apply to all Polytechnic undergraduate degrees. Academic departments may place additional requirements on individual degrees. Such additional requirements are explained in the programs section of this catalogue. In no case may a department specify requirements less stringent than those indicated here.

BASIC DEGREE REQUIREMENTS AND DEFINITION OF CREDITS

Programs for the degree Bachelor of Science require 128 to 130 credits, depending upon the major as described in the programs section of this catalogue. Undergraduate semester credits are based on the number of 55-minute periods scheduled each week during one semester. Normally, 1 credit signifies a minimum of either one 55-minute period of class work, or three periods of undergraduate laboratory, over a period of 14 weeks. In a few cases, more time per credit is given. The final examination period is an integral part of the semester.

Students may attend on a part-time or full-time basis, and all degrees may be completed in four years of full-time study. To earn the degree Bachelor of Science from Polytechnic, students must take a minimum of 32 credits of junior- and senior-level courses at Polytechnic in the student's major field in order to fulfill residency requirements. Nearly all undergraduate courses are given during the day. A selection of evening undergraduate courses is available, but it is no longer possible to complete any undergraduate degree by taking courses entirely in the evening.

To earn a bachelor's degree, students must have a cumulative GPA of 2.0 or better in all courses taken at Polytechnic. (See the section on academic standing and probation.) Some programs have additional requirements for grades involving specified courses or groups of courses. Most undergraduate engineering curricula require students to participate in team projects, including participation in team design project exercises. Students are required to participate in outcomes assessment, as described on the next page.

Undergraduate students admitted to Polytechnic are encouraged to declare their major upon admission, although incoming freshmen may initially enter as "undeclared" majors. Freshmen who wish to consider several program options are encouraged to use the first semester to explore major fields in consultation with departmental advisers. Polytechnic's freshman year is nearly uniform for all engineering majors and very similar for other majors. Thus, students who choose to delay selecting their major until the end of the freshman year must select courses in consultation with their academic advisers.

Students are free to change their major at any time, given that their scholastic standing is acceptable to the program into which they wish to transfer. Students entering Polytechnic with an undeclared major must declare any currently offered undergraduate major by the end of their first year. Changes in major may involve some loss of credit.

SELECTION OF A MINOR

A minor is an approved coherent concentration of academic study within a single discipline. In specified programs, undergraduate students may select a minor in a field distinct from or related to their major, with approval of advisers in both the major and minor fields. The name of the minor will appear on students' transcripts if the approved 15 credits in the minor field have been completed with at least a 2.0 GPA. With the consent of a student's major department, some of the courses used to satisfy the minor requirements may also satisfy the required or electives course requirements in the student's major program. The names and associated requirements for minors are listed in the sections of this catalogue devoted to related major programs.

COURSE PLACEMENT EVALUATION

Polytechnic gives incoming freshmen placement and diagnostic examinations in writing and mathematics. Transfer students are evaluated using some of these placement tools, in consultation with departmental advisers.

Polytechnic's placement evaluations are intended to ensure that each student receives the most appropriate instruction in basic areas needed to successfully complete the degree program they have chosen. Placement evaluations may supersede the results of Advanced Placement examinations and/or acceptable transfer credits from another institution of higher education, by the designated adviser and the department offering the course.

Writing Placement Examination

Both employers and accrediting organizations are placing an increasing amount of emphasis on the need for students to have well-developed written and verbal communications skills. No engineer or scientist can be an effective professional without the ability to communicate, not only with those in his or her own field, but also with professionals in other technical and non-technical fields, with private and public decision-makers, and with the general public.

As such, Polytechnic's degree programs involve frequent writing and speaking assignments across all areas of the curriculum; it is essential that all students have appropriate background skills before enrolling in upper-division courses related to their professional studies.

All incoming freshmen and some transfer students are required to take a writing placement examination. Although students are evaluated as individuals, students generally fall into two groups: those with an English-speaking background and those with an English-as-a Second-Language (ESL) background.

Based upon the results of the placement examination, students with an English-speaking background will be placed in either:

EN 1014	Writing & the Humanities I	4 credits
or		
EN 1090	Introductory Composition	0 credits [4 credits*]

Students with an ESL background will typically be placed in either:

EN 1034	Writing & the Humanities I	4 credits
or	(ESL)	
EN 1080	Reading & Writing (ESL)	0 credits [4 credits*]

*EN 1080 and EN 1090 do not carry credits toward a degree. However, they do contribute to the full-time credit load during the semester in which they are taken.

Students who successfully complete EN 1014 or EN 1034 continue into EN 1204 Writing and the Humanities II or EN 1234 Writing and Humanities II (ESL). Students who successfully complete EN 1090 continue into EN 1014, and those who successfully complete EN 1080 usually move into EN 1034. Occasionally, however, a student who has completed EN 1080 may have the choice of enrolling in EN 1014 if his or her instructor believes the student has achieved sufficient fluency in the English language. Students who are placed in EN 1080 or EN 1090 are encouraged to take these courses during the summer that precedes their freshman year; these courses are made available at a significantly reduced cost for students who take them in the summer. Students unable to take a course over the summer may take EN 1080 or EN 1090 during their first regular semester. Typical schedules can be rearranged to accommodate this. University guidelines do not permit undergraduate students placed into EN 1080 or EN 1090 to progress to more advanced humanities courses until they receive a passing grade in these courses.

Mathematics Diagnostic Examination

The Mathematics Diagnostic Examination is an extensive test designed to provide a profile of students' knowledge and skills in basic and advanced mathematics. The mathematics department uses the scores on various components of this examination to recommend students' assignments to an appropriate mathematics courses. Entering students who do not have transfer or AP credit and are majoring in civil engineering, construction management, biomolecular science or business and technology management are placed in MA 902/912 or in MA 1054. All other entering students (who do not have transfer or AP credit) are placed in MA 914, MA 1024, or MA 1324.

WRITING AND SPEAKING ACROSS THE CURRICULUM

Polytechnic has adopted a Writing and Speaking Across the Curriculum program to ensure graduates develop adequate communications skills. The program ensures that significant writing and speaking assignments are included in designated courses throughout students' undergraduate program, and that the course grades are influenced by the quality of presentation in addition to mastery of content.

To support this program, the Polytechnic Tutoring Center offers the writing center for students, staffed by instructors and qualified tutors. Students are encouraged to make an appointment to improve their writing and/or speaking skills.

Core courses such as EN 1014, EN 1034, EN 1204, HI 2104, EG 1004, all HU/SS electives and all senior design projects are writing- and speaking-intensive courses. Each disciplinary curriculum identifies other courses that fit into this category as well.

FRESHMAN SEMINAR AND ACADEMIC SKILLS SEMINAR

All incoming freshmen, including transfer students with less than 6 credits, are required to take SL 1010 Freshman Seminar. This course is non-credit and includes weekly discussions and presentations on time management, study and test-taking skills, available support services at Polytechnic and many other subjects of importance to new students. Students must submit a short paper on their selection of a major during the course.

At the end of this course, students will be given the opportunity to confirm or change their major. Undeclared majors may choose to select a major or remain unde-

clared until the end of the freshman year, at which time a major must be declared. In general, the major can be changed at the end of the first semester or at the end of the freshman year without loss of credits.

All first-year, first-time probationary students are required to register for and pass SL 1020 Academic Skills Seminar. The course consists of eight one-hour sessions, which meet once per week and is taught on a pass/fail basis. The seminar helps students learn to become more academically successful. The Academic Probation section in this part of the catalogue contains more information about this course

OUTCOMES ASSESSMENT

Polytechnic conducts outcomes assessment activities to monitor student academic achievement, effective teaching methods and continuous improvement of the University, as well as to facilitate compliance with accreditation standards. To obtain periodic measurements of student perceptions and intellectual growth, undergraduates are required to participate in surveys, focus groups, interviews or related activities. While individual input is collected, the data resulting from these assessments are published only in aggregate form. Effective fall 2000, undergraduate students are required to complete online course surveys for all courses in which they are registered each semester (except guided studies and courses in which the enrollment is less than six students). Graduating seniors are required to complete exit surveys online. Any additions to or exceptions to this requirement will be disseminated to the University each semester by the Office of Assessment. Student compliance with outcomes assessment activities generally is a precondition for receipt of semester grade reports, transcripts and degrees.

CORE REQUIREMENTS FOR ENGINEERING MAJORS

All engineering majors must follow the core curriculum outlined in this section. Non-engineering majors will take appropriate parts of this core, as described in the programs section of this catalogue. Students entering the University as undeclared majors are also required to closely follow this core curriculum and may select any Polytechnic major at the end of one year of study. Changes in major may involve some loss of credit.

The core curriculum is intended to ensure that every engineering student is exposed to an appropriate mix of general

preparatory courses in the liberal arts, mathematics and the basic sciences. It is also intended to ensure a breadth of knowledge of fundamental engineering principles and an appreciation and understanding of all engineering disciplines.

The four components to the core curriculum are the following:

(1) Liberal Arts Core

Every engineering student must take a minimum of 24 credits in the humanities and social sciences. These courses have two objectives: to develop students' communications skills and expose them to an appropriate balance of study in liberal arts. Both areas are critically important and contribute to the general literacy of engineering undergraduates as they deal with the world and societal issues that set the context for the practice of their professions.

All students must take the following required courses (12 credits):

EN 1014 or		
EN 1034	Writing and the Humanities I	4 credits
EN 1204 or		
EN 1234	Writing and the Humanities II	4 credits
HI 2104	Contemporary World History	4 credits

Students placed in EN 1080 Reading and Writing (ESL) or EN 1090 Introductory Composition must successfully complete these courses before beginning EN 1034 Writing and the Humanities I (ESL) or EN 1014, respectively. EN 1034, if required, must be completed before registering for HI 2104; EN 1204 is a desirable co-requisite. Most students proceed to EN 1204 Writing and the Humanities II their second semester freshman year, although the equivalent EN 1234 is available for those needing additional English language support.

The 12 credits of required HU/SS coursework include 6 credits of content in the area of humanities and social sciences and 6 credits of writing and speaking skills development. To complete the requirements of the liberal arts core, students must take three additional 4-credit elective courses as (1) two Level 2 electives in two different disciplines and (2) one Level 3 elective.

A Level 2 elective is a course that has EN 1204 and or HI 2104 as a prerequisite. Consult the Liberal Studies Program section in this catalogue for course descriptions and further detail. Electives are available in the following humanities disciplines: literature, philosophy, music and fine arts. Elec-

tives are also available in the following social science disciplines: history, history of science, economics, psychology and sociology/anthropology.

Courses with the following prefixes do not count as humanities or social sciences electives: LA Liberal Arts, LW, Law and TC, Technical Communications.

(2) Mathematics Core

Every engineering student must take a minimum of 16 credits of study in mathematics.

The following courses are required of all engineering students:

MA 1024 or MA 1324	Calculus I*	4 credits
MA 1124	Calculus II	4 credits
MA 2012	Elements of Linear Algebra I	2 credits
MA 2132	Ordinary Differential Equations	2 credits

*The Department of Civil Engineering prefers all of its students to take the MA 1054/1154 calculus sequence. This sequence includes two additional hours of precalculus review which the department believes is helpful, even for students with an excellent math background. Students may choose to take a placement exam to be placed in MA 1014/1124 (Calculus I, II), or may be advance-placed based upon AP test results.

Each engineering discipline specifies 8 to 12 additional credits of mathematics from the list below. Consult the programs section of this catalogue for information on specific requirements and preferred sequencing for each discipline. Students with AP credit or transfer credit for Calculus I and II are required to take the 2-credit bridge course MA 1132 Numerical Methods for Calculus before registering for higher-level mathematics courses. Transfer students who score 60 percent or better on the mathematics diagnostic examination will receive transfer credit for MA 1122 and be exempt from MA 1132.

MA 2112	Multivariable Calculus I	2 credits
MA 2122	Multivariable Calculus II	2 credits
MA 2212	Data Analysis I	2 credits
MA 2222	Data Analysis II	2 credits
MA 2312	Discrete Mathematics I	2 credits
MA 2322	Discrete Mathematics II	2 credits
MA 3012	Probability I	2 credits
MA 3122	Complex Variables I	2 credits

(3) Basic Science Core

The basic science core consists of 12 credits of study in the critical areas of chemistry and physics. The following courses are required of all engineering majors:

CM 004	General Chemistry for Engineers	4 credits
PH 004	Introductory Physics I	4 credits
PH 004	Introductory Physics II	4 credits

Some departments may require an additional 4 credits of science. See the program section of this catalogue for details.

(4) Engineering Design

The centerpiece of the core curriculum for engineering majors is the engineering design course. This portion of the curriculum is intended to ensure that all engineering majors have a common base of knowledge of key engineering principles and a thorough appreciation of the range of applications of these principles across the engineering disciplines. The freshman engineering course provides an early introduction and immersion in engineering both as an intellectual discipline and a professional pursuit.

The Accreditation Commission for Engineering and Technology (ABET) defines six fundamental areas of engineering: mechanics, electric and electronic circuits, materials science, thermodynamics, transport phenomena and computer science. The engineering design core is constructed to guarantee that every engineering major is exposed to many of these fundamental areas.

All engineering students are required to take the following courses:

EG 1004 Introduction to Engineering	4 credits
* Senior Design Project	3 credits

* Actual course code depends on department.

Transfer students may replace EG 1004 Introduction to Engineering with an advanced technical course if they enroll in the University at a sophomore or higher level, subject to adviser approval.

EG 1004 focuses on hands-on experiential learning and the process of engineering design as the single most unique professional function of the engineer. Each major defines its own capstone senior design projects, but every engineering student must complete one.

HONORS PROGRAM

The Honors Program offers academically superior undergraduate students a total learning environment which goes beyond traditional classroom learning. It provides students an enriched educational experience in an academically challenging surrounding fostering critical thinking and creativity. The Honors Program at Polytechnic University presents students a depth and breadth of education that is comprehensive, rigorous, and highly individualized. Students can enroll in Honors courses taught by outstanding faculty, participate in the mentoring program throughout their careers, engage in undergraduate research and benefit from presentations by renowned

faculty, inventors, innovators and entrepreneurs.

Rigorous intellectual development through active learning and faculty mentoring combine with the interdisciplinary focus and a global awareness to prepare students to become leaders in engineering, science, technology and entrepreneurship. Students selected for the Honors Program must have superior academic records in high school and participate in an interview with a member of the Honors Program Faculty Governing Board.

ENGINEERING COMPETENCIES

All Polytechnic undergraduate engineering programs are accredited by ABET. That agency identifies the following core competencies that every engineering program should address: (a) an ability to apply knowledge of mathematics, science and engineering; (b) an ability to design and conduct experiments, as well as to analyze and interpret data; (c) an ability to design a system, component or process to meet desired needs; (d) an ability to function on multidisciplinary teams, (e) an ability to identify, formulate and solve engineering problems; (f) an understanding of professional and ethical responsibility; (g) an ability to communicate effectively; (h) the broad education necessary to understand the impact of engineering solutions in a global and societal context; (i) a recognition of the need for, and an ability to engage, in life-long learning; (j) a knowledge of contemporary issues; (k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

Some of the course descriptions list the ABET competencies that they address.

MODIFICATIONS TO CURRICULA Course Substitutions

Curricula sometimes change in order to keep students abreast of the latest knowledge and methods within the subject area, especially in the science, engineering and technology areas taught at Polytechnic. Students will be informed of these changes by their major department.

Because of changes in curricula and course content, and to address special situations, it is occasionally necessary to substitute a course for one specified in the curriculum to meet degree requirements. Such substitutions are documented on an Adjustment of Degree Requirements form, commonly known as a “blue sheet,” and available from the Office of the Registrar. Each substitution must be documented on

the form and be approved by the student’s major faculty adviser and by the Office of Undergraduate Academics. If a graduation checklist has already been issued at the time of the substitution, the change should be formally entered on the checklist and approved by the major adviser and the Office of Undergraduate Academics.

Interruption of Study

Polytechnic graduates must fulfill degree requirements using courses that are current and meet the current standards in the field. Accordingly, students have up to eight years to complete the degree requirements in effect when they first enrolled in a Polytechnic undergraduate degree program. This time limit is irrespective of any leave of absence that may be granted during the eight-year period. As courses continuously evolve, the University may replace some courses in the original degree requirements with comparable ones with updated contents. Should the University institute a new set of degree requirements for new students, continuing students may choose to satisfy the new requirements. In such cases, the University will decide which portion of the new requirements may be satisfied by the courses students have already completed, and modification, if any, of the original eight-year time limit.

HONOR SOCIETIES

On the basis of their superior academic record and co-curricular achievement, students are selected during their junior and senior years to one of the Polytechnic chapters of a national honorary fraternity. Closely allied to the professional and technical societies, these honorary fraternities encourage and recognize outstanding scholarship and leadership.

Current Participating Societies at Polytechnic:

CHI EPSILON — civil engineering
 ETA KAPPA NU — electrical engineering
 OMEGA CHI EPSILON — chemical engineering
 PI MU EPSILON — mathematics
 PI TAU SIGMA — mechanical engineering
 SIGMA XI — research
 TAU BETA PI — engineering
 UPSILON PI EPSILON — computing sciences

GRADUATION CHECKLIST

Undergraduates nearing completion of their degree requirements receive a graduation checklist, which lists completed courses, assignment to required areas of study and courses remaining to be completed for the degree. After the list is approved by the major academic department, it is mailed to students by the Office of the

Registrar. Checklists are prepared for full-time students after they complete 80 credits. A revised checklist is issued to students who do not complete their degree program within a reasonable period after the initial checklist is mailed.

DEGREES WITH HONORS

Degrees with honors will be awarded to undergraduate students of high scholastic rank upon unanimous recommendation of the faculty. Honors are based upon the following schedule of cumulative GPAs:

BS Cum Laude	3.40 - 3.59
BS Magna Cum Laude	3.60 - 3.69
BS Summa Cum Laude	3.70 or better

Transfer students are eligible to graduate with honors, including being selected as valedictorian, after they complete a minimum of 60 credits toward their degree requirements at Polytechnic.

BS/MS ACCELERATED HONORS PROGRAM

Undergraduates with outstanding academic records in certain programs may apply for admission to the BS/MS Accelerated Honors Program, which leads to simultaneous award of a bachelor's and master's degree. This program allows students to make accelerated progress towards completing the two degrees through combinations of AP credits, summer course work and additional credits each semester.

The courses required for the two degrees in this program include all courses required for the individual BS and MS degrees, but the total number of credits may be less than the sum of the credits required for the individual degrees. Specific combinations of BS and MS majors that are available in this accelerated format are described in the programs section of this catalogue. Additional information can be obtained from departmental faculty adviser. International Students in F-1 or J-1 status must obtain prior permission and an appropriate I-20/DS-2019 from the Office of International Students and Scholars before enrollment in the combined BS/MS program.

UNDERGRADUATE THESIS

The undergraduate thesis allows students to apply knowledge gained in their major field of interest and use it to plan, conduct and report original research. The thesis may be a discourse upon a subject included in students' courses of study, an account of an original investigation or research, a report on a project or an original design accompanied by an explanatory statement.

The undergraduate thesis is optional except for students in the Honors Program who are required to complete an undergraduate thesis. All undergraduate students who plan to undertake a thesis should report to the head of their major department for choice of a thesis topic at least one year prior to graduation. Department heads approve requests and appoint a thesis adviser. Students should contact their thesis adviser immediately and register for a thesis during the next registration period. Thereafter, the student must register for the thesis every fall and spring semester until it is completed and accepted and the final grade is entered into the student's permanent record.

All theses and results obtained become the property of Polytechnic University. Regulations covering thesis registration and thesis format are available in the Office of Undergraduate Academics.

APPLICATION PROCESS FOR THE BACHELOR OF SCIENCE

Students must file a formal application for the award of the degree Bachelor of Science from Polytechnic. Filing dates for each semester are published in the Schedule of Classes. Students who do not file by the published deadline dates become candidates for the next graduating class.

Applications for BS degrees are available in the Office of the Registrar. Degrees are certified and diplomas issued twice a year, at the end of the fall and spring semesters. Degrees are conferred at the annual spring commencement held in late May or early June. All work for the degree must be completed and submitted prior to the graduation date. Upon graduation, no transfer of courses among degree programs is allowed.

Filing fees for diplomas are payable at the time of filing in the Office of Student Accounts. If the award of a degree is delayed, diploma fees are not charged again. By vote of the faculty, degrees are not awarded to members of the University teaching staff who hold the rank of assistant professor or higher.

UNDERGRADUATE CREDITS

Residency

To satisfy residency requirements for the BS degree at Polytechnic University, students must complete a minimum number of 32 credits at the University in approved junior and senior subjects at the time they are admitted to the University.

Transfer Credits from Other Undergraduate Institutions

Students who have completed some undergraduate courses at other colleges or universities before beginning studies at Polytechnic are encouraged to transfer credits into Polytechnic programs. Polytechnic will award transfer credit for appropriate courses satisfactorily completed at other accredited institutions. Students transferring to Polytechnic from other universities must have transcripts of their courses examined by the Office of Undergraduate Academics and an adviser from the student's major department to determine the acceptability of individual substitutions and general acceptance of credits from their former institution(s). Much of this can be accomplished during the application process if students' records are complete. All evaluations of transfer credits must be completed by the end of students' first semester of registration at Polytechnic. Some programs may choose to delay approval of transfer credits until the students have demonstrated satisfactory progress for a semester at Polytechnic.

Undergraduate transfer credit is not given for any course in which a grade less than C has been earned. In addition, students completing a course at Polytechnic for which transfer credit has already been given automatically forfeit the transfer credit for that course.

The contents and standards of courses vary from school to school. Thus, some transfer students find after a semester's work at Polytechnic that they will be better prepared for advanced courses if they re-enroll in a course at Polytechnic for which they have been given transfer credit. Students may be required to do this after consulting with their adviser. In some instances, course requirements may be waived for students who demonstrate sufficient knowledge of specific course content through either written or oral examination given by the appropriate academic department. In such cases, no credit is awarded, but students will be permitted to submit a more advanced course to satisfy degree requirements. This differs from "credit by examination," described below.

Grades of courses for which transfer credit is given are not included in the computation of students' cumulative or current semester GPA.

Articulation Agreements

To provide students with alternative pathways to a BS degree in engineering and to facilitate the transfer process, Polytechnic has developed cooperative programs with other liberal arts and two-year institutions.

Students completing approved programs at these institutions with sound academic achievement are guaranteed admission to the University. Students interested in learning more about the cooperative programs should contact the Office of Undergraduate Admissions.

Transfer Credits While in Residence

Undergraduates enrolled at Polytechnic are expected to take all course work at the University. Exceptions are rarely made in cases where Polytechnic does not offer timely courses of importance to the attainment of students’ academic goals.

To obtain credit for courses taken elsewhere while enrolled at Polytechnic, students must obtain written permission from the major academic adviser, the department head of the course for which transfer credit is requested and the Office of Undergraduate Academics. This must be done before registering for the course at another institution. Forms for such permission are available in the Office of the Registrar.

The following requirements apply:

- The other institution must be accredited.
- Grades earned must be C or better for undergraduate courses.
- Pass/fail courses are not acceptable under any conditions.
- Only credits will be granted; grades are not included in the computation of cumulative or current semester GPAs.

Undergraduate Validation Credits

When it is unclear whether a course taken outside Polytechnic is suitable for transfer credit, students may qualify for transfer credit by passing a validation examination. Permission to take such an examination must be recorded in advance on the student’s transfer evaluation form at the time of application to Polytechnic. The format of the examination is at the discretion of the department giving the course. Scheduling of the examination is by mutual agreement, but in no event more than one calendar year after the student begins study at Polytechnic. A grade of C or better is required to validate course credits for undergraduate students. An examination may not be taken more than once. Students who register for or attend the course at Polytechnic forfeit the right to take a validation examination.

Advanced Placement Credits

Polytechnic will grant students credit for appropriate Advanced Placement courses taken in high school, given acceptable per-

formance on AP examinations. Students must request evaluation of AP credits by no later than the end of their first semester of matriculation. Credit may also be granted for college preview courses taken at Polytechnic or other universities while a high-school student, if these courses are relevant to the student’s degree program and acceptable grades have been achieved. Grades for advanced placement or college preview courses are not included in the computation of the cumulative or current semester GPAs.

Credit by Examination

Undergraduate students with an outstanding record or with specialized competence may establish a maximum of 16 credits toward the baccalaureate degree by passing comprehensive examinations. Each department determines the courses in which such an examination is available and the examination format. Students must obtain the approval of the department giving the course, the department of major study and the Office of Undergraduate Academics.

A grade of B+ or better is required to achieve credit by examination. Students who register for or attend a course at Polytechnic may not subsequently take the examination for credit for this course or for a course with similar content. The examination cannot be taken more than once.

Students pay a specified fee to the Office of Student Accounts in advance of each examination. The course and credits are posted on a student’s permanent record without a grade and do not count toward the minimum residence requirement for the bachelor’s degree or for a degree with honors or toward the GPA.

CLASS STANDING FOR UNDERGRADUATES

Students are classified at the end of each semester by the Office of the Registrar on the basis of earned and/or approved transfer credits beginning September 1, as follows:

Freshman	1 - 27 credits
Sophomore	28 - 61 credits
Junior	62 - 94 credits
Senior	95 or more credits

UNDERGRADUATE REGISTRATION STATUS AND MAXIMUM CREDITS PERMITTED

Academic Year Full Time

Undergraduate students registered for 12 or

more credits per semester are categorized as full time*. The usual course load for full-time undergraduate students is normally 16 credits.

* For certain types of attendance and enrollment certifications, some students who are registered for less than 12 (undergraduate) credits may be certified as full time; specifically, undergraduates who are pursuing University-authorized full-time, full-semester co-op work assignments; a form to establish full-time equivalency is available from the Office of the Registrar.

Academic Year Part Time

Students registered for less than 12 credits per semester (except summer) are categorized as a part-time student. Part-time students pay tuition at the prevailing per credit rate and are not eligible for most financial assistance programs.

Summer and Intersession

Students may register for up to 8 credits during each six-week summer term, and for no more than 16 credits for the combined 12-week summer term. Six credits for a given summer term is considered full-time status, particularly for financial aid purposes. Courses taken during intersession are treated as if they were taken during the following semester or summer session for the purposes of student records and credit.

Undergraduate International Students Full-Time Status, Program and Degree Changes

To maintain non-immigrant student status, international students must enroll full-time, taking 12 credits on the undergraduate level for each fall and spring semester. Moreover, they may only register for one on-line course per semester. Students who wish to take more than one on-line course per semester are required to obtain prior approval from the Office of International Students and Scholars (OISS). Students may take less than a full course of study if fewer credits are needed during the last semester to graduate, or for valid academic and medical reasons. All reasons for exceptions must be approved in writing by (OISS) prior to the last day of late registration each semester so that courses can be added to students’ schedule if necessary.

Students in F-1 and J-1 status must obtain written permission from the OISS to withdraw from classes, if the withdrawal will result in less than a full course load, or to take a leave of absence. They must also obtain written permission and an appropriate I-20/DS-2019 form from the OISS before enrolling in a new degree program. The process of withdrawing from a course, changing degree level, or taking a leave of

absence through the Office of the Registrar keeps a non-immigrant student in good standing only with the University, but not with the U.S. Immigration and Citizenship Services (USCIS).

Failure to comply with the immigration requirements regarding full-time status, course withdrawals, degree changes or leave of absence violates the non-immigrant student status and make a student ineligible for any of the benefits of that status. According to USCIS, lack of compliance may also result in deportation.

POLICIES ON UNDERGRADUATE GRADING AND GRADES

Computing the Grade-Point Average (GPA)

The Office of the Registrar determines the weighted GPA of undergraduate students on the basis of the following numerical values assigned to the various letter grades:

Grade	Point Value	Description
A	4.0	Excellent
A-	3.7	Excellent
B+	3.3	Good
B	3.0	Good
B-	2.7	Good
C+	2.3	Passing
C	2.0	Passing
C-	1.7	Deficient, but passing
D+	1.3	Deficient, but passing
D	1.0	Deficient, but passing
F	0.0	Failing
S		Satisfactory
U		Unsatisfactory
W		Withdrawal
I		Incomplete
AUD		Audit
NR		Not Received*
P		Passing

* Grade not received by Office of the Registrar in time to report it.

In computing GPAs, Polytechnic does not consider or count courses graded W, I, S or U towards the total credits passed or earned. GPAs are computed by multiplying the numerical grade in each course by the number of credits for each course, adding these products for the courses taken and then dividing this sum by total number of credits represented by courses considered.

The W and I grades are described in greater detail in subsequent sections. Grades S or U are used to indicate progress in multi-semester research projects or theses, or for non-credit-bearing remedial or other courses. Undergraduates enrolled in graduate courses may not receive plus or minus grades or grades of D or AUDIT.

Repeating Courses

If undergraduate students take a course two or more times, only the second and subsequent grades will count toward their GPA. This policy holds regardless of the first and second grades earned, even when the second grade is lower than the first. The repeated course must be taken within one year of the first course, or at the first time it is offered, where a course is not available to repeat within one year.

No undergraduate course may be repeated more than twice, for a total of three attempts. If a student earns an F grade after the last permitted attempt in a course that serves as a prerequisite or a degree requirement, the student is then academically disqualified and is not eligible for readmission to any program with that requirement. If the last permitted attempt occurs after the first two semesters of a freshman's time at Polytechnic, then the assigned grade can only be the standard letter grades.

Course Withdrawal: the W Grade

Students may withdraw from a course or courses without academic penalty through the 10th week of the normal fall or spring semester. Approval by the instructor of the course is not required, but the withdrawal form must be signed by the student's major academic adviser. When the duration of the course varies from the norm, such as in six, nine- or 12-week courses, withdrawal must be filed before two-thirds of the sessions are completed. Withdrawals must be filed with the Office of the Registrar by 5PM of the day indicated in the current Schedule of Classes. In the case of a two-week course, withdrawal must be filed by 5PM of the seventh class day. Students who file a course withdrawal form with the Office of the Registrar by the scheduled deadline automatically receive a W grade. Once entered on the student's record, a W cannot be changed to any other grade. An F grade is recorded for any student who ceases to attend a course without formally withdrawing in the required fashion by the required deadline.

Incomplete Grades

If a student is unable to complete the course work at the usual time due to valid reasons, such as illness or other critical emergency, the instructor may give a grade of incomplete I. The date for completion is inserted next to the I grade on the grade sheet and will be communicated directly to the student by the instructor when possible. Instructor and student will develop a detailed

course plan which sets a specific completion date. Ordinarily this date will not extend beyond the intersession, in fairness to students who finish course requirements on time and to ensure that students complete prerequisites necessary for taking advanced courses. On no account will this date be later than one year after completion of the semester for which the grade of I was awarded.

The grade of I is used sparingly and only in cases with valid reasons, not merely because students have planned poorly or overloaded themselves. An I grade signifies that upon successful completion of the work, a passing grade will be issued.

An I grade lapses into an F if students fail to complete the course work within the specified completion date. If students reregister for a course in which an I grade was given, the I grade lapses to an F. All I grades must be converted prior to graduation.

UNDERGRADUATE ACADEMIC STANDING AND PROBATION Dean's List

Undergraduate students who achieve a semester GPA of 3.4 or better, with no grades of F, I or U for the semester, and are otherwise in good academic standing, are commended by the Department of Academic Success and placed on the Dean's List. This list is posted following the fall and spring semesters for full-time students and following the spring semester for part-time students. Only those who complete 12 or more credits during the fall or spring semester (or fall and spring semesters combined for part-time students) are eligible. Students who include project courses in their 12 or more credit programs are also eligible, provided that these courses represent no more than one-half of the credit load for a given period and all of the aforementioned requirements are met. Non-degree credit courses, EN 1080 or EN 1090, may count toward the 12-credit requirement as 4 credits. The Dean's List notation appears on the student's permanent record. Students who receive a grade of F, and then repeat the course in a subsequent semester, thereby, excluding the first grade from the GPA calculation, are not eligible for the Dean's List. However, students who convert a grade of I to a regular letter grade or receive a change of grade after a given semester that would then qualify them for the Dean's List may retroactively receive Dean's List honors by bringing the change to the attention of the Office of Academic Success. Any change of grades should be finalized

within one semester to be considered for the Dean's list.

General Academic Standing

To remain in good standing, undergraduate students must maintain term and cumulative GPAs of 2.0 or greater. In addition, students must successfully complete a minimum number of credits for each semester of full-time study, excluding summers and mini-sessions. In the case of part-time students, a semester indicates the point at which 12 or more credits are undertaken. Thus, the first semester of study ends when 12 credits are accumulated; the second semester is calculated from that time onward until 24 credits are accumulated. According to these semester equivalents, grade-point requirements for part-time students follow those for full-time students.

The minimum number of cumulative credits to be achieved by the close of each semester of full-time study appears below in Table 1.

Table 1: Minimum Credits and Minimum GPA Required by Semester of Full-Time Study

SEMESTER	Minimum Credits Successfully Completed	Minimum GPA
1	8	1.30
2	16	1.40
3	28	1.50
4	40	1.67
5	56	1.78
6	68	1.88
7	84	1.95
8	96	2.00
9	112	2.00
10	128	2.00

In calculating the number of successfully completed credits:

1. Courses with F grades do not count toward the criteria of Table 1.
2. Credits bearing an F grade and repeated within one academic year will be recalculated using the second grade earned, thus entering into the number of credits successfully completed (assuming that the second grade is not also F) during the semester in which they are repeated.
3. Credits with an I grade will be counted toward enrollment for one year. At the end of that time, any I grade that has not been changed by the instructor on record will automatically lapse to an F grade.
4. Credits assigned a W grade do not appear in the calculation of credits

undertaken, earned or successfully completed.

5. Transfer students enter the standard as calculated from the point at which transfer credits place them.

A second requisite for enrollment is the maintenance of a 2.0 GPA or better or performance approaching 2.0 in a steady and realistic fashion. Table 1 contains the absolute minimum cumulative GPA to be achieved by the close of each semester of full-time or full-time equivalent enrollment.

The Department of Academic Success provides regular academic monitoring of all undergraduate students to review each student's academic record after each semester and inform the student's academic adviser or other representatives from the student's major department of the results of that review. Students who are identified as being in academic difficulty may not register for more than 12 credits per semester unless otherwise approved by their adviser. Students in academic difficulty will be placed on academic probation following the steps and actions described below.

Academic Warning

Students whose midterm grades show they are in danger of failing receive e-mails of academic warning. E-mails are sent to these students warning them of potential problems, urging them to make use of the support services available to them, encouraging them to speak with their instructor to clarify what they need to improve, urging them to take whatever measures are necessary to maintain good standing and inviting them to meet with their academic adviser to discuss what is going on and what steps to take.

Academic Probation

Students are placed on academic probation when (1) their semester and/or cumulative GPAs fall below 2.0, but remain above the minimum standards of Table 1 their number of successfully completed credits falls below the minimum standards of Table 1. Students falling into these categories are notified by letter and e-mail and are directed to meet with their advisers.

All first-year, first-time probationary students must take SL 1020 Academic Skills Seminar. The seminar consists of eight one-hour sessions, meeting once a week and taken on a pass/fail basis. SL 1020 helps students develop and enhance an awareness of their individual learning styles, study skills and time management techniques so

they may become more successful students and return to good academic standing. Topics include establishing a mindset for success, discussing career opportunities, setting goals, managing time, overcoming procrastination, learning study and test-taking skills and self assessing. SL 1020 is structured in small, interactive group sessions designed to support students as they develop strategies for academic success.

Final Probation

Students whose academic records indicate an unacceptable level of academic progress may be placed on final probation. Notified by letter and e-mail of their standing, these students must meet with their adviser to determine a program of study aimed at improving their performance and are limited to a maximum of 12 credits for the next semester. Failure to improve their performance and to meet at least one of the minimum progress requirements results in disqualification. Students on final probation may not register before completing current courses.

Disqualification

The Academic Standing Committee, comprising the Department of Academic Success and a representative of the student's major department, shall jointly disqualify from the University any student whose cumulative average or number of credits successfully completed falls below the appropriate minima shown in Table 1 for two consecutive semesters. Additionally, a major department may disqualify a student at or above the minima listed if it is indicated that continuation will not lead to a successful completion of degree requirements.

Extenuating circumstances, such as serious medical problems (physical or psychological), must be documented by the Office of Student Affairs and can lead to a waiver of these criteria for one semester. Performance in the subsequent semester must meet minimum standards. Such arrangements must be made together with the head of the major department and the Office of Student Affairs.

Disqualification Appeal

If a student would like to appeal their academic disqualification, they can do so immediately and begin the appeal process. Disqualification Appeal forms can be obtained from the Academic Advisement Center. Students must begin the disqualification appeal process a minimum of three

weeks prior to the first day of classes of the semester immediately following their disqualification. If a student fails to begin the appeal process by this deadline they must wait for a period of one academic year before they can reapply for readmission to the University and initiate the appeal process.

WITHDRAWAL FROM THE UNIVERSITY

Voluntary Withdrawal

Undergraduates must notify the Office of Undergraduate Academics if they withdraw completely prior to the deadline listed in the Schedule of Classes and during a semester in which they are registered. No withdrawal is official unless a written form is approved and submitted to the Office of the Registrar. Mere absence from courses does not constitute official withdrawal, but will lead to F grades recorded for courses not completed. To receive W grades for the semester, the withdrawal must be completed by the withdrawal deadline indicated in the Schedule of Classes.

Involuntary Withdrawal

Polytechnic is concerned about the health, safety and well being of its students. Students judged to be a threat to themselves or to others may be involuntarily withdrawn from Polytechnic. The University seeks, whenever possible, for such students to be allowed to continue as active students if they agree to involve themselves in appropriate care of a professional. Full details concerning this policy are available from the Office of Student Development.

LEAVES OF ABSENCE AND READMISSION

Leave of Absence

Undergraduates taking a leave of absence must obtain permission from the Office of Undergraduate Academics. Students who want to re-enter after a period of absence of one year or more must file an application for readmission with the Office of Admissions.

Automatic Withdrawal

Undergraduates who do not formally file a leave of absence and who do not register for two consecutive semesters or two consecutive semesters beyond the authorized leave are automatically withdrawn. Students placed in this category must apply for readmission. If readmission is granted, students

will be governed by the catalogue and rules in effect at the time of readmission.

GRADUATE DEGREE REQUIREMENTS AND ACADEMIC POLICIES

This section details the general University-wide degree requirements that apply to all Polytechnic graduate degrees. Academic departments may place additional requirements on individual degrees. Such additional requirements are explained in the programs section of this catalogue. In no case may a department specify requirements less stringent than those indicated here.

Outcomes Assessment

Polytechnic conducts outcomes assessment activities to monitor student academic achievement, effective teaching methods and continuous improvement of the University, as well as to facilitate compliance with accreditation standards. To obtain periodic measurements of student perceptions and intellectual growth, graduate students are strongly encouraged to participate in surveys, focus groups, interviews or related activities. While individual input is collected, the data resulting from these assessments will be published only in aggregate form.

Definition of Credits

Graduate studies are expressed in terms of credits. One 50-minute period of graduate class work for a 15-week single semester carries 1 graduate credit. A standard graduate course meeting for two-and-a-half hours per week is equivalent to 3 credits. This is the most common format for graduate courses. Graduate laboratories meet three times per graduate credit. Courses meeting more or less than two-and-a-half hours each week are assigned credits in the appropriate proportion. The final examination period is an integral part of the semester.

GRADUATE DEGREES AND ADVANCED CERTIFICATES

Master of Science Admissions

Admission to Master of Science programs requires a bachelor's degree and at least four years of college-level courses in an appropriate preparatory discipline from an institution acceptable to Polytechnic. An undergraduate GPA of 3.0 or better is needed for admission. GRE scores are recommended for all applicants, especially

those seeking merit-based scholarships. The GRE score is mandatory for international students. Applicants seeking admission to management-related degrees may submit the GMAT score instead of GRE. Letters of recommendation and a Statement of Purpose are also needed to be considered for admission.

Graduation Requirements

Candidates for the degree Master of Science must complete no less than 30 credits of advanced study and/or research beyond the bachelor's degree in the program selected. Specific course requirements for each MS program are detailed in the programs section of this catalogue. In order to obtain the MS graduate degree, students must maintain a GPA of 3.0 (equivalent to a B letter grade) or better in all graduate work undertaken at Polytechnic, including those not used to fulfill specific program requirements. The average of B or better includes all guided studies, readings, projects, theses and dissertations. Students may offer no more than a combined total of 9 credits of project, guided studies and/or thesis towards fulfillment of the MS degree requirements. Students taking project or thesis must register for at least 3 credits of project and/or thesis every semester until the work is completed and a grade recorded.

Residency Requirements and Transfer Credits

Graduate students in the MS programs must take a minimum of 21 credits of graduate work at Polytechnic. A maximum of 9 credits may be accepted as transfer credits, if approved by the student's department/program. Credits transferred must be from graduate courses taken elsewhere, as long as those courses were taken after the undergraduate degree, not used to satisfy the graduation requirements for any undergraduate degree, and had a grade of B or better. Theses, projects and guided studies or readings courses cannot be transferred. Students must complete all requirements for the MS degree within a period of no more than five years after beginning their graduate studies at Polytechnic. This period includes any approved Leave of Absence. Extensions of this period are rarely granted and require a petition to the Provost's office. Individual programs may specify required courses, minimum GPAs in specific courses or course groups, and/or require a comprehensive examination, presentation of a seminar or completion of a project or thesis.

Master of Engineering

The admissions, graduation, residency requirements and other regulations are same as those for the Master of Science. The Master of Engineering is intended for students seeking in-depth knowledge in fields requiring courses from multiple disciplines, especially disciplines taught by several different academic departments. Students create their program of study with the approval of a graduate adviser which includes at least one graduate certificate. A capstone experience is required for graduation. Candidates for the degree Master of Engineering must complete no less than 30 credits of advanced study and/or research beyond the bachelor's degree in the program.

Doctor of Philosophy

Requirements for the degree Doctor of Philosophy are both qualitative and quantitative. Students will find that the formal requirements of residence, course units and dissertation provide a framework within which they are free to construct individual programs for creative learning at an advanced level.

Graduate students who wish to enter into a systematic program leading to a PhD should confer with an adviser in the department of major interest regarding (1) selection of courses, (2) major and minor fields of study, (3) formulation of a guidance committee, (4) qualifying and language examinations and (5) degree candidacy. Students must satisfy the detailed requirements of the degree program selected.

Admissions

Students may apply to the doctoral program either directly after a bachelor's degree or after completing a master's degree. In either case GPAs greater than 3.0 are needed in all previous degree programs and GPA greater than 3.5 is typically expected. The admissions requirements for the doctoral program are at least as stringent as those of the MS, and the admissions process follows the same path as that of the Master of Science and Master of Engineering applications. Noting that doctoral research is a one-to-one match between the research interests of the applicant and a member of the faculty, it is imperative that all applicants discuss their interests with the faculty in their program of interest. Highly qualified candidates whose interests are not compatible with the faculty's research interests may not be admitted. Additionally, most departments admit only the number of stu-

dents that they can financially support and qualified candidates may not be admitted because of limited funds to support only a given number of students.

Graduation Requirements

All doctoral students must maintain a GPA of 3 or better at all times and a B or better for the dissertation. Some departments have specific course or grade requirements that must be fulfilled. They must pass the qualifying examination(s) administered by their department or program and complete a doctoral dissertation. Students may not register for dissertation research until they have passed the doctoral qualifying examination given by their major department. These examinations are generally scheduled once or twice each year, and students should consult the academic department for specific information. Once students have started their dissertation, they must register for at least 3 credits every semester until it has been completed and accepted, unless a leave of absence is formally granted.

Residency Requirements and Transfer Credits

All doctorate candidates must complete a minimum of 75 credits of graduate work beyond the bachelor's degree, including a minimum of 21 credits of dissertation research (or more depending on major). They must take a minimum of 27 credits, including all dissertation credits, at Polytechnic. Transfer credits can include a 30-credit blanket transfer for a prior MS degree and additional courses not included in the prior MS that are individually transferred. For the blanket 30-credit transfer, the prior MS may not need to be a 30-credit MS. Additional courses individually transferred cannot include project, thesis, dissertation, guided studies or readings, or special topics credits. Full-Time students must complete all work for a PhD within six calendar years counted from the time of admission to graduate work at Polytechnic. Part-Time students must complete within twelve years. This period includes any approved leave of absence. Any extension of these periods requires prior approval of the Provost's office.

Milestones

Students in the PhD program have to take and pass doctoral qualifying examination(s) administered by their programs. It is highly encouraged that the students take the examination(s) in their first year of the program. If the students have not passed the

examination(s) by the end of their second year, they may be permanently disqualified from the PhD program. Students cannot register for dissertation credits unless they have passed the qualifying examination(s). Within six months of passing the examination(s) the student and the dissertation adviser must form a dissertation guidance committee. This committee will oversee the selection of courses for the student, provide guidance for research, and ensure that satisfactory progress is being made towards the completion of the dissertation in a timely manner. The selection of courses must ensure that requirements of major and minors set forth by the respective programs are met. The committee, at its discretion or bound by departmental regulations, may request the student to present a dissertation research proposal. The committee is expected to meet at least once a semester to assess the progress of the student. The doctoral student will defend the dissertation in front of this committee. The student must check with the Provost's office to obtain a checklist of the milestones and requirements.

Graduate Advanced Certificate Programs

Polytechnic offers a number of graduate advanced certificate programs in specialized subject areas for students who do not wish to enroll in a full-degree program. Students must officially enroll in a certificate program when they begin graduate study at Polytechnic. Detailed descriptions of the certificate programs are available from the responsible departments.

Depending on the program, 12 to 15 credits must be taken at Polytechnic in order to earn a certificate, and the courses may also be applied to MS, ME, or PhD graduate degrees, but not to another certificate. No transfer credits are allowed. Applicants must be formally admitted to a certificate program before beginning course work. Admission requirements are the same as those for related MS programs. Students must have a cumulative GPA of 3.0 in all graduate courses taken at Polytechnic to receive a certificate. Requirements for certificates must be completed within three years.

Students in such a program who subsequently decide to pursue another graduate degree must file a separate application for admission to the respective graduate program. The following graduate advanced certificate programs are currently available:

- Achieving World-Class Quality
- Bioinstrumentation
- Biomedical Materials

- Computer Engineering
- Construction Management
- Electronic Business Management
- Entrepreneurship
- Environment-Behavior Studies
- Executive Construction Management
- Financial Engineering
- Financial Technology Management
- Hazardous Waste Management
- Human Resource Management
- Image Processing
- Industrial Engineering
- Information Management
- Manufacturing Engineering and Production Science
- Manufacturing Excellence by Design: Holistic Approach
- Operations Management
- Organizational Behavior
- Risk Management
- Software Engineering
- Technical Communications
- Technology Management
- Telecommunication Network Management
- Telecommunications Management
- Traffic Engineering
- Transportation Management and Economics
- Transportation Planning
- Wireless Communications

GRADUATE CREDITS AND REQUIREMENTS

Residency

To satisfy residency requirements for a graduate degree at Polytechnic University, students must complete the following minimum number of credits at the University:

- Master of Science: all but 9 credits needed for graduation (at least 21 credits of residency)
- Master of Engineering: all but 9 credits needed for graduation (at least 21 credits of residency)
- Doctor of Philosophy: 27 credits (including all dissertation credits)
- Graduate Certificate: all credits needed for graduation

Continuity of Registration

All graduate students must be registered each fall and spring semesters until they graduate. If the student is unable to attend the University for a semester, they must obtain a leave of absence for the semester. Failure to do so will require the student to reapply to the graduate program to resume studies.

Transfer Credits

Students may transfer a limited number of credits toward meeting the requirements for master's, doctoral or graduate certificate at Polytechnic, if the graduate courses are (1) consistent with Polytechnic's residency requirements, (2) completed with grades B or better, (3) from accredited institutions (4) consistent with the curriculum that the student is registered in and (5) taken after receipt of a bachelor's degree (with the exception of Polytechnic's undergraduate students, see below). The student's major academic department evaluates the graduate transfer credits. Credits submitted for transfer must conform to a period of validity as discussed in the subsequent section.

No transfer credit is permitted for graduate certificates.

Grades for the transferred credits or courses are not rewarded and do not impact the GPA for the graduate program at Polytechnic.

MS or ME students may transfer up to 9 credits. No project, thesis, dissertation, nor guided studies/readings courses can be transferred.

PhD students may transfer up to 48 credits of course work. Transfer credits for PhD can include a 30-credit blanket transfer for a prior MS degree and additional courses not included in the prior MS that may be individually transferred. For the blanket 30-credit transfer, the prior MS may not need to be a 30-credit MS as long a MS degree (or equivalent) was granted and a copy of the degree and detailed transcripts are presented. Additional courses individually transferred cannot include project, thesis, dissertation, guided studies or readings, or special topics credits.

Graduate courses taken at Polytechnic while a student was pursuing an undergraduate degree at Polytechnic may be subsequently applied toward a graduate degree, provided that they earned a B grade or better and the individual courses were not used to fulfill requirements for an undergraduate degree at Polytechnic. Such courses are not subject to the 9-unit maximum transfer limitation for the MS degree, and the grades are not figured into the cumulative GPA for the graduate program.

Period of Validity

More than undergraduate, graduate courses reflect the current state-of-the-art in their respective fields. Thus all courses that have been taken over 10 years prior to request date for transfer of credits will not be eligible to be individually transferred to Poly-

technic by the routine transfer process. The exceptions are approved articulations and administrative actions. The blanket 30-credit transfer into the PhD program for a MS degree taken at Poly or elsewhere will be exempt from this period of validity and will not have any expiration stipulation.

Graduate Validation Credits

When it is unclear whether a course taken outside Polytechnic is suitable for transfer credit, students may qualify for transfer credit for that course by passing a validation examination. Permission to take the examination must be recorded in advance on the student's transfer evaluation form. The format of the examination is at the discretion of the department giving the course. Scheduling of the examination is by mutual agreement, but in no event can it be scheduled more than one calendar year after the student begins study at Polytechnic. A grade of B or better is required for graduate students. An examination may not be taken more than once. A student who registers for or attends the course at Polytechnic forfeits the right to take a validation examination.

The sum of validation credits, special student credits and transfer credits is limited to a maximum of 9 credits for the MS and ME degrees.

Multiple MS Degrees from Polytechnic

Students should be aware that New York State regulations prohibit graduate credits applied toward the first Polytechnic MS degree be applied towards subsequent MS degrees from Polytechnic.

Graduate Registration Status

Graduate students pay tuition at the per-credit rate. Full-time status is defined by the following:

- Full-time MS students are registered for 9 credits or more each semester. Students who are normally full-time may register for less credits during their last semester by registering for only the number of credits needed for graduation. During this last semester they are part-time, but can be treated as full-time-equivalent for immigration and other legitimate reasons by requesting full-time-equivalency.
- Full-time MS students in the lock-step, cohort-based, executive format MS programs are registered for all the courses specified by the program published in the catalogue each semester. These programs will have distinct courses and/or projects, each bearing credits deemed appropriate by the program, but in no case less than

a total of 7.5 credits per semester.

- Full-time PhD students may register for 3 credits per semester upon passing the PhD qualifying examination. Prior to passing the exam, they are registered for 9 credits or more.

Non-matriculated or visiting student status allows students to take up to three graduate courses at Polytechnic without formally applying for admission to the University. If these students desire to continue at Polytechnic as a matriculated student in a graduate degree or certificate program, they have follow the formal application process.

Maintenance of Studies

PhD Students: PhD students, including international students, who have completed all required course and dissertation credits may register for up to two semesters of “maintenance of studies” for no tuition charge (a University fee will apply). This category of registration officially maintains the degree candidacy of the student and is intended to extend the time needed for completing the writing and defense of the dissertation.

MS Students: Under exceptional and well-documented circumstances, graduate students, including international students, seeking an MS degree in a program that requires a MS thesis or MS project may, with the permission of the thesis or project supervisor, request one semester of maintenance of study to complete the project or thesis. Adequate written justification must be provided to the Office of Academic Affairs for permission to be granted.

Maximum Time for Completion

The program for graduate certificate must be completed in a maximum of 3 years. The MS or ME degree programs must be completed within 5 years of starting the program at Polytechnic. The PhD program must be completed in 6 years for full-time students and 12 year for -part-time students from the time of admission to graduate work at Polytechnic. These time limits include any approved leave of absence.

Students exceeding these time limits will have to petition the Provost’s Office (Associate Provost for Graduate Studies) for allowing them to continue.If granted, not all courses taken may be counted towards the degree.The Associate Provost, in consultation with the department, will prepare a plan for the student to follow in order to obtain the degree.

GRADUATE INTERNATIONAL STUDENTS

Full-time Status, Program and Degree Changes

To maintain non-immigrant student status, international students must maintain full-time status each fall and spring semester. For the entire semester, respectively (i.e. withdrawing from a course during the semester may jeopardize full-time status). Students are not required to enroll during the summer semester, and may enroll for credits at their discretion. Students may take less than a full course of study if fewer credits are needed during the last semester to graduate, or for valid academic and medical reasons. All reasons for exceptions must be approved in writing by the Office of International Students and Scholars (OISS) prior to the last day of late registration each semester so that courses can be added to the student’s schedule if necessary. If the reduction in load is permitted, the students will be granted full-time-equivalency for the respective semester.

Students in F-1 and J-1 status must obtain written permission from the OISS to withdraw from classes, if the withdrawal will result in less than a full course load, or to take a leave of absence. They must also obtain written permission and an appropriate I-20/DS-2019 form before enrolling in a new degree program. The process of withdrawing from a course, changing degree level, or taking a leave of absence through the Office of the Registrar keeps a non-immigrant student in good standing only with the University, but not with the U.S. Immigration and Citizenship Services (USCIS) unless approved by OISS.

International students are allowed to enroll in at most one on-line course per semester of their study.

Failure to comply with the immigration requirements regarding full-time status, course withdrawals, degree changes or leave of absence violates the non-immigrant student status and makes a student ineligible for any of the benefits of that status. According to USCIS, lack of compliance may also result in deportation.

POLICIES ON GRADING AND GRADES

Computing the Grade-Point Average for Graduate Students

For the purposes of computing GPAs for graduate students and graduate courses, the following schedule is used. Note that the range of grades for graduate students is limited to A, B, C and F.

Grade	Point Value	Description
A	4.0	Excellent
B	3.0	Good
C	2.0	Deficient, but Passing
F	0.0	Failing
S		Satisfactory
U		Unsatisfactory
W		Withdrawal
I		Incomplete, converts to F after 1 year
AUD		Audit
NR		Not Received, converts to F after 1 year

Grades S and U are used to reflect progress on continuing research efforts. Once the thesis or dissertation is completed, the appropriate letter grade is entered on the transcript. Non-credit seminar courses are also graded S or U. Grades S, U, I, W and AUD are not included in computing the GPA, which is computed as indicated for undergraduate students.

Repeating Courses

The first time a graduate student repeats a course, the lower grade will not be counted towards the GPA. All subsequent grades in a course repeated more than once will be included in the GPA, although degree credit is earned only once.

Course Withdrawal: the W Grade

Students may withdraw from a course or courses without academic penalty through the 10th week of the normal fall or spring semester. Approval by the instructor of the course is not required, but the withdrawal form must be signed by the student’s major academic adviser. When the duration of the course varies from the norm, such as in six-, nine- or twelve-week courses, withdrawal must be filed before two-thirds of the sessions are completed. Withdrawals must be filed with the Office of the Registrar by 5PM of the day indicated in the current Schedule of Classes. In the case of a two-week course, withdrawal must be filed by 5PM of the seventh class day. Students who file a course withdrawal form with the Office of the Registrar by the scheduled deadline will automatically receive a W grade. Once entered on the student’s record, a W grade may not be changed to any other grade. An F grade will be recorded for any student who ceases to attend a course without formally withdrawing in the required fashion by the required deadline.

Auditing Courses

Graduate students have the option of au-

ditng courses instead of receiving units and grades for them. Regular tuition is charged and courses are treated as part of a full-time load. An AUD notation is made on the student's permanent record.

Interested graduate students should see their advisers and must notify the Office of the Registrar within the first six weeks of the semester if they select courses for audit status. Under no circumstances may an audit status be changed to credit status once elected.

Incomplete Grades

If students are unable to complete the course work at the usual time due to valid reasons, such as illness or other critical emergency, the instructor may give an incomplete I grade. Whenever feasible, the date of completion will not extend beyond the intersession, in fairness to students who finish course requirements on time and to ensure that students complete prerequisites necessary for taking advanced courses. On no account will this date be later than one year after completion of the semester for which the I was awarded. If the I grade is not converted to a letter grade by the instructor within one year, the I grade will automatically be converted to the F grade.

The I grade is used sparingly and only in cases with valid reasons, not merely because students have planned poorly or overloaded themselves. An I grade signifies that upon successful completion of the work, a passing grade will be issued.

Not-Received Grades

A grade of NR may be recorded on the student's record by the registrar if the registrar does not receive a grade from the instructor. This grade will automatically turn into a failing F grade after one year has passed.

Change of Grade

Instructors may change grades for academic reasons after assigning an initial grade. The time period for change of grade is one year after the course was completed. The registrar will not process change of grade requests by the instructors after this one-year period. Changes requested later than this one year period will be accepted only in case of errors or other administrative action and have to be approved by the Provost's office (associate provost for graduate studies).

GPA Restart

For graduate students pursuing the MS degree, GPA can be restarted under the following conditions: (1) student changes

major and the change of major is approved by both the new department and the graduate dean, and (2) the student requests that the GPA is restarted and the request is approved by the Provost's office (associate provost for graduate studies). The request to restart the GPA must be made during or before the first semester in the new major. Courses taken prior to the GPA restart cannot be counted towards satisfying the degree requirements of the new major. GPA restart is only for the MS degree; GPA cannot be restarted at the beginning of the PhD degree program. GPA restart will be noted on the student's transcript.

ONLINE LEARNING-ePOLY

Polytechnic's online programs, ePoly, are designed specifically for working adults who want to remain current and advance in their careers or for graduate students who aspire to a Polytechnic degree but cannot attend classes at any of the University locations. All courses are presently designed and instructed by Polytechnic full-time and adjunct faculty. Some MS degrees, graduate certificates, individual courses and continuing education seminars are available completely online. An increasing number of Polytechnic's traditional graduate courses are available online for convenient study. Online courses are considered equivalent to classroom counterparts in terms of similar topics and requirements.

Continuation of Studies Beyond the Initial Master of Science

Students who plan to pursue additional studies immediately following the award of an advanced degree by Polytechnic should complete a Request for Continuation of Studies form in lieu of a new application for admission and hand it in for review and approval to the department in which the new degree will be pursued. This form is available from the Office of the Registrar. Examples are (1) progressing from an MS program to a PhD program or (2) seeking a second MS degree from Polytechnic. In the latter case, students should be aware that New York State regulations prohibit graduate credits applied toward the first degree be applied towards a second MS degree.

ACADEMIC STANDING AND PROBATION

Graduate students are expected to progress in their studies and maintain a 3.0 GPA. Failure to do so results in students being placed on academic probation or disquali-

fied based upon the guidelines set in the table below. For additional information, contact the Provost's Office (Associate Provost for Graduate Studies).

Grade-Point Average Required to Avoid Disqualification (All Graduate Students)

Students whose cumulative GPA falls below that specified in the following table will be disqualified from the University and will not be allowed to attend.

Number of Credits	GPA
1-6	2.0
7-12	2.33
13-18	2.66
>19	3.0

The entries are credits taken, not credits earned. Courses with W grades are excluded from the computation, as are project/thesis grades when assigned an S or U.

Students with GPA below the entries in above table are disqualified and, with rare exception, cannot be readmitted. All students with GPA less than 3.0 are notified that they are on graduate probation and informed that they will be disqualified if the GPA falls below the entries in the above table. Such students will have to complete and submit a Plan for Removal of GPA Deficiency approved by their graduate adviser to the Provost's office (associate provost for graduate studies). Upon approval by the Provost's office, the student will be allowed to continue in the program.

Academic probation (cumulative GPA < 3) results in an automatic hold placed on the student's account that prevents the student from registering for subsequent courses. This hold and the Plan for Removal of GPA Deficiency serve to remind both the student and the academic program that the student is not performing at the academic standard needed, that both the student and the program are cognizant of the need for planning to help the student to succeed, and that both have prepared such a plan of action.

In addition to the academic probation process described above, a major department may request that a graduate student be placed on academic probation at any time. The request and its justification is signed by the department head and sent to the Provost's office.

The student is permitted to register when the students plan is approved by the Provost's office and the hold is subsequently removed. The statement will be kept on file in both the Provost's office (Office of the Associate Provost for Graduate Studies) and

the major department office. Students are cautioned that if they fail to follow the approved plan or fail to maintain a 3.0 cumulative GPA, they may lose regular status and/or be refused permission to register in subsequent semesters.

No indication of academic probation will appear on a student's transcript, but a record will be kept on file.

WITHDRAWAL FROM THE UNIVERSITY

Voluntary Withdrawal

Graduate students must notify the Office of Academic Affairs if they withdraw completely prior to the deadline published in the Schedule of Classes and during a semester in which they are registered. No withdrawal is official unless a written form is approved and submitted to the Office of the Registrar. Mere absence from courses does not constitute official withdrawal, but will lead to F grades recorded for courses not completed. To receive W grades for the semester, the withdrawal must be completed by the withdrawal deadline indicated in the Schedule of Classes.

Involuntary Withdrawal

Polytechnic is concerned about the health, safety and well being of its students. Students judged to be a threat to themselves or to others may be involuntarily withdrawn from Polytechnic. The University seeks, whenever possible, for such students to be allowed to continue as active students if they agree to involve themselves in appropriate care of a professional. Full details concerning this policy are available from the Office of Student Development.

LEAVES OF ABSENCE AND READMISSION

Leave of Absence

Graduate students taking a leave of absence for a specified period of time, usually not exceeding one year, must obtain permission from the Provost's office (Office of Associate Provost for Graduate Studies). Such requests, when approved by the Provost's office, will constitute assurance of readmission to the degree program from which the leave was taken. If the period of absence exceeds the approved leave, students must apply for readmission.

Once PhD students begin their dissertation, they must continually register for dissertation or maintain their studies; they must file a leave of absence for semesters they do not register for dissertation credits.

Students failing to obtain a leave of ab-

sence who subsequently wish to attend Polytechnic have to apply to be readmitted and their subsequent attendance in the program will be guided by the terms and conditions of the readmission, and the catalogue and rules in effect at the time of readmission.

Leave of absence will be recorded on the student's transcripts by the registrar.

Automatic Withdrawal

Graduate students who do not formally file a leave of absence and who do not register for the semester beyond the authorized leave are automatically withdrawn. Students placed in this category must apply for readmission. If readmission is granted, students will be governed by the catalogue and rules in effect at the time of readmission, and the terms and conditions of the readmission.

APPLICATION PROCESS FOR THE MASTER OF SCIENCE AND DOCTOR OF PHILOSOPHY

Graduate students must file a formal application for the award of any Polytechnic degree or certificate. Filing dates for each semester are published by the Office of the Registrar. Students who do not file by the published deadline dates become candidates for the next graduating class.

Applications for the MS degree and graduate certificate are available in the Office of the Registrar. Applications for the PhD degree are also available in the Office of Associate Provost for Graduate Studies. Degrees are certified and diplomas issued twice a year, at the end of the fall and spring semesters. Degrees are conferred at the annual spring commencement held in late May or early June. All work for the degree must be completed and submitted prior to the date of graduation.

Filing fees for diplomas are payable at the time of filing in the Office of Student Accounts. If the award of a degree is delayed, diploma fees are not charged again. By vote of the faculty, degrees are not awarded to members of the University teaching staff who hold the rank of assistant professor or higher.

Please note that a degree will not be awarded unless the student applies for the award, even if all requirements have been completed. The date of the degree follows the date of the application for its award, not when all requirements are completed. If the application has not been filed within two years of completion of degree requirements,

the approval process once an application is made is not automatic and additional administrative actions may be needed on a case-by-case basis.

PROJECTS, THESES AND DISSERTATIONS

Graduate Research

Investigations undertaken for graduate research help develop students' independent and creative thinking. Through them, students are trained to analyze, research and synthesize and contribute to the advancement of science and engineering.

Research for an advanced degree embodies knowledge of the field of science or engineering chosen by the candidate, encompassing an understanding of basic principles, together with commensurate acquaintance with current practices, the literature and the work of leaders in the field of study.

MS students may elect to complete an MS project or MS thesis and may be required to do so in certain programs. Consult the programs section in this catalogue for details. A thesis is generally a more extended piece of work, usually entailing 6 to 9 credits, while the project usually entails 3 to 6 credits. At this level, research should exhibit a thorough understanding of advanced scientific thought or ability to apply advanced principles constructively to engineering planning and design.

Each PhD student must complete a PhD dissertation. Research at this level must demonstrate critical and constructive thought as well as the ability to use the techniques necessary in exploring and developing new areas of knowledge in science or engineering. A successful dissertation must demonstrably advance the subject area of research. University requirements for dissertations set a minimum of 21 credits of registration. All research should be characterized by accuracy of observation and measurement and by clarity and completeness in presentation. The conclusions presented must be supported by adequate studies and investigations and supplemented by a complete bibliography.

Registration for Projects, Theses and Dissertations

After a project, thesis or dissertation adviser and/or guidance committee has been appointed, candidates should register each semester for the number of units that realistically reflects the amount of time and effort they expect to devote to their research. They must continually register each fall and spring until they adequately com-

plete their research effort and pass the required oral examination. Registration cannot be interrupted until a grade is entered on the permanent record except with the permission of the Office of Academic Affairs. If, at the end of any semester, the adviser deems unsatisfactory any work covered by the credit of registrations, students may be required to re-register for the same unit and be obligated to pay for full tuition and laboratory fees involved. Continuous registration is required until a final grade is submitted to the Office of the Registrar.

PhD students must continue to register for dissertation credit until they have completed all research and the dissertation. Students may be allowed to register for one semester of “maintenance of study” if they have completed all research and only have to finish writing, defending, or revising their dissertation in that semester. Similarly MS candidates registered for thesis or project may, under well-documented circumstances, apply for one semester of “maintenance of study” as described above.

Manuscript Presentation

Degree candidate must present their research to the appointed guidance committee in final manuscript form for official acceptance on or before the Monday seven weeks before commencement. The accepted format for the bound research document is detailed in the “Regulations on Format, Duplication and Publication of Project Reports, Theses and Dissertations” brochure available from the Provost’s office and in departmental offices. Some of the regulations are summarized below.

MS candidates must submit four bound final copies of their research; PhD candidates must submit four bound final copies and one unbound final copy to be used for microfilming. Duplication processes of high quality are acceptable. In addition, each PhD candidate must submit two copies of an abstract of not more than 350 words suitable for publication in “Dissertation Abstracts.”

All graduate students must submit the four final bound copies to their department for appropriate signatures and then present them to the Office of Academic Affairs before noon on the first Friday in December (for fall degrees) or the first Friday in May (for spring degrees). At the same time, PhD candidates must submit the unbound copy in a labeled envelope along with the two copies of the abstract. The original copy is kept permanently in the Polytechnic library.

Publication

Doctoral dissertations will be microfilmed by University Microfilms, Ann Arbor, Michigan, and abstracts of them will be published in the journal “Dissertation Abstracts.” The cost of this service will be charged to the student. Any interested person can purchase copies of these microfilms from University Microfilms.

The faculty regards publication of the major content of a doctoral dissertation in a recognized scientific journal as a necessary final step if the work performed is to achieve maximum usefulness. The publication must indicate, by footnote or otherwise, its basis as a Polytechnic University dissertation.

TRANSITION FROM UNITS TO CREDITS

Polytechnic University switched to the new system of academic load at the beginning of the fall 2007 semester. The prior system of graduate units was replaced by graduate credits as summarized below.

Prior to fall 2007 each graduate unit at Polytechnic equaled 625 minutes of contact per semester while the New York State definition of a credit requires 750 minutes of contact each semester. This New York State credit definition has been adopted by Polytechnic from the start of fall 2007. Under this change the following equivalencies are defined:

$$3.0 \text{ Credits} = 3.6 \text{ Old Units} = 2,250 \text{ contact minutes per semester}$$

$$2.5 \text{ Credits} = 3.0 \text{ Old Units} = 1,875 \text{ contact minutes per semester}$$

Details related to the specific academic programs will be available from the respective departments.

MS Degrees

The total length of the MS degree is 22,500 minimum contact minutes, and has not changed. Under the current system, using the definition of New York State credit, the minimum number of credits for the MS degree will be 30. Previously the minimum number of units was 36.

$$\text{Total MS} = 30 \text{ Credits} = 10 \text{ Full Courses (of 3 Credits Each)}$$

$$= 36 \text{ Prior Units} = 12 \text{ Full Courses (of 3 Prior Units Each)}$$

$$\text{Total MS} = 30 \text{ Credits} = 750 \text{ minutes/credit} = 22,500 \text{ contact minutes}$$

$$= 36 \text{ Units} = 625 \text{ minutes/unit} = 22,500 \text{ contact minutes}$$

Transition Plan

Each department has developed and has available its own transition plan of required courses and approved electives. Below are some of the items that are common for each department:

Each department will offer a variable credit course (or courses) available in increments of 0.5 credits between 0.5 and 2.5 to ensure that students will meet the 30-credit total exactly. These variable credit courses will be offered for two academic years only (i.e., 2007-08 and 2008-09). Thus students needing to adjust their total in new credits to be in multiples of three should take this course at their earliest convenience and not wait until their last semester at Poly. Individual departments may offer additional and/or alternate methods to satisfy the variable credit requirements as they see fit.

Each graduate course taken by the student under the previous system until the transition date will count towards the student’s degree, provided the courses were approved for the program under prior rules and graduation requirements.

Exceptions

Some programs have elected not to conform to the new 30-credit requirement needed to keep the total contact hours the same as before and may require more than 30-credits. Such programs have more contact hours for the MS degree for students starting in fall 2007 or later relative to the prior requirements when all MS degrees were of a total of 36 prior units or 30-credits. Students enrolled in such MS degrees prior to fall 2007 will be allowed to graduate with 30-credits, and the higher credit requirements will be imposed only on new students starting in Fall 2007 or later.

PhD Degrees

PhD degrees will change from a minimum of 90 prior units to minimum of 75 credits. Details of the changes are to be conveyed by individual departments to their respective students.

Cumulative GPA Calculations

Cumulative GPA calculations will not consider the fact that prior units have fewer contact minutes per semester than the new credits. For GPA calculations the weight of prior units will be the same as credits and each unit will be considered equal to a credit in all the formulae for computing the cumulative and other GPAs.

ACADEMIC SUCCESS, ADVISING AND TUTORING SERVICES

The mission of the Department of Academic Success is to enhance the likelihood of students successfully completing the studies they begin at Polytechnic University. To this end, academic support functions are integrated and delivered in a comprehensive and seamless manner.

To ensure students' needs are met and addressed, Polytechnic has collaborated and coordinated services among all areas reporting to the Department of Academic Success and key offices overseen by the Division of Student Affairs.

The Department of Academic Success is ready to address students' needs that range from proper course placement to advisement and monitoring to tutoring. In addition, referrals and advocacy are provided as needed. The department oversees the following academic support services: Academic Advisement Center, the Polytechnic Tutoring Center, the Higher Education Opportunity Program (HEOP), the General Studies Program and the Office of Special Services (TRIO).

For more information about the department, visit www.poly.edu/academicuccess.

ACADEMIC ADVISEMENT CENTER (AAC)

The mission of the Academic Advisement Center is to provide academic advising to new matriculated first year students in the following majors: Biomolecular science, business and technology management, computer science, computer engineering, electrical engineering, chemical and biological engineering, civil engineering, construction management, mechanical engineering, and undeclared. The academic departments advise students in the following majors: integrated digital media, liberal studies, technical and professional communication, and mathematics. After the first year, those students that are advised by the Advisement Center are assigned advisers in their respective major departments.

Students may make an appointment or drop in to see their adviser. Advisement sessions cover an array of topics including major requirements, University regulations, and life skills development. The AAC refers students to appropriate campus resources for additional support and guidance in an effort to address any University-related issues affecting them. In addition, academic

advisers advocate for first-year students with the offices of the Registrar, Financial Aid, Student Accounts, and Admissions, as well as other University offices.

The center also directs the review of students' progress each semester to determine academic standing. The academic advisers make decisions regarding the Dean's List, probation and disqualification, and send notifications to the students and the respective academic offices and departments. Students are directed to meet regularly with their advisers to discuss academic progress and address questions concerning their academic standing. All first-year, first-time probationary students are required to enroll in and attend SL 1020 Academic Skills Seminar.

For more information about the center, visit www.poly.edu/academicadvisement.

POLYTECHNIC TUTORING CENTER (PTC)

The Polytechnic Tutoring Center (PTC) offers a range of academic support services to all registered Polytechnic students. Tutoring is offered in math, science, and computer science courses for first- and second-year students. Tutoring is provided on a drop-in basis and in exam review sessions.

The PTC also includes the Writing Center, where students receive help with college-level writing, reading and speaking assignments and with English-language mastery. The Writing Center is open to Polytechnic students at any level, from first-year undergraduates through doctoral candidates. Writing Center staff work with students individually and in small groups.

Tutors are carefully selected and trained. They include undergraduate peer tutors, graduate students and instructors. Tutors know their subjects well and understand where students may have difficulty. They are skilled at explaining material in a variety of ways for maximum comprehension. All students' questions are respected; no question is too basic to ask. The PTC also helps students improve their learning skills in order to become more successful in college and throughout their careers.

PTC services are free of charge. For more information about the center, visit www.poly.edu/tutoring.

HIGHER EDUCATION OPPORTUNITY PROGRAM (HEOP)

The Higher Education Opportunity Program (HEOP) is a New York State-funded program designed to provide broad and varied educational instruction to capable students who, due to limited academic and financial resources, might otherwise not have the opportunity to attend Polytechnic. Once admitted to the HEOP program, students are provided with financial assistance, counseling, tutoring, advisement and other support services throughout their college career. HEOP's goal is to retain and graduate students who are traditionally underrepresented in the fields of engineering and science. More information on HEOP is included in Part 4 "Special Programs" in this catalogue or, visit www.poly.edu/heop.

GENERAL STUDIES PROGRAM

The General Studies Program provides students who do not meet the traditional admissions requirements an opportunity to obtain a science, engineering, humanities and management-based education in a supportive environment. To ensure student success, the General Studies students receive a broad variety of services, beginning with a mandatory summer program prior to the start of their freshman year, and continuing throughout the academic year with mandatory, weekly tutoring and advisement sessions. Once admitted into Polytechnic, students must successfully participate in the program for one year before they are allowed to officially declare their major. For additional information, please refer to Part 4 "Special Programs" in this catalogue or visit www.poly.edu/generalstudies.

OFFICE OF SPECIAL SERVICES

The Office of Special Services provides tutoring, academic counseling and various other support services to Polytechnic students. The office is a TRIO program funded by the U.S. Department of Education; therefore, students requesting assistance must first meet eligibility requirements. The program provides eligible students with a variety of free and confidential services developed to enhance students' academic performance and maximize their potential.

Individualized tutoring is available to

students through the TRIO program. The office staff assigns qualified upperclassmen to tutor students one-on-one in physics, math, chemistry and computer science for the entire semester. Students meet weekly throughout the semester with an assigned tutor who addresses their individual concerns regarding course work. Small-group exam review sessions in upper-level courses are also scheduled for students throughout the semester and a variety of study aides, instructional software and other resources are available to students who participate in the program.

Academic counseling is available to assist students in managing the academic challenges of University life. The office offers individualized study skills advisement and workshops dealing with various topics including goal setting, time management and test taking. These academically related skills assist students in successfully mastering the technical curriculum at Polytechnic. The office also provides career guidance and testing and arranges on-site visits and tours to help students explore various opportunities available to them when they graduate.

Various cultural and educational workshops and trips are scheduled throughout the academic year. Workshops geared towards student personal development are scheduled monthly. Free trips, which consist of Broadway plays, industry visits, museums and other cultural events, are also scheduled throughout the academic year. In addition, the program provides eligible students with financial assistance through grants and scholarships.

For more information about the Office of Special Services, visit www.poly.edu/trio.

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ADMISSIONS

The course of studies at Polytechnic is academically rigorous and intellectually challenging; therefore, admission to Polytechnic is highly competitive. Candidates for admission to graduate programs are evaluated by the department to which they apply. Students seeking admission to the undergraduate programs are evaluated by the professional staff of the Office of Undergraduate Admissions.

UNDERGRADUATE APPLICATION PROCESS

Application materials and information about undergraduate admissions may be obtained by contacting the Office of Undergraduate Admissions:

Office of Undergraduate Admissions

Polytechnic University
Six MetroTech Center
Brooklyn, NY 11201
Tel: 718/637-5955
Fax: 718/260-3446
E-mail: uadmit@poly.edu
Web: www.poly.edu/admit

Undergraduate applicants should complete the application for admission and forward it to the Office of Undergraduate Admissions with either the non-refundable application fee or a fee waiver request form. Applicants should request that their secondary school and/or college forward official copies of transcripts to the Polytechnic Office of Undergraduate Admissions. All freshmen applicants and transfer applicants with less than two complete years of college are required to submit test scores of the Scholastic Assessment Test (SAT1) or the American College Testing Program (ACT).

Polytechnic's Office of Undergraduate Admissions reviews applications once all required documents have been received and notifies students within two weeks of decision. Applicants are encouraged to apply early. Preference for admission and scholarship will be given to applicants who submit all of their documents according to the following timetable:

Full-time undergraduate study

November 2 – for the spring semester
January 18 – for fall semester
May 16 – deadline for admitted student deposit.

The preceding timetable does not apply to international applicants. Because of the extra time required to process applications from abroad, consideration will not be given to applications received after December 1 for the spring semester, or after June 1 for the fall semester. All official records, together with notarized translations, must also be received by these dates. (See "Admission as an International Student" for additional information.)

If accepted for admission, applicants should submit an enrollment deposit of \$300 in order to reserve a place in the entering class. This deposit is applied to tuition and fees for the first semester and is not refundable. Deadline for deposit to reserve a place in the entering class is May 16. Students who submit deposits after the deadline will be placed on a waiting list for the fall semester.

Applicants accepted for the fall semester may begin their studies in the summer session. Polytechnic offers two summer sessions to help students who wish to accelerate or supplement their studies.

THE EARLY ADMISSION PLAN

On occasion, Polytechnic offers early admission to outstanding high school juniors. Programs can be arranged so that these students simultaneously satisfy high school requirements while completing their freshman year of college. Candidates for this program must complete the required entrance examinations in their junior year of high school and must present with their application a letter from their principal stating the secondary school's approval.

ADMISSION AS A FRESHMAN

Requirements

Applicants for admission as freshmen are required to take the Scholastic Assessment Test (SAT1). The American College Testing (ACT) Program may substitute the SAT1. Students who are admitted to Polytechnic and plan on enrolling are required to take two placement examinations prior to registration. Students who score a 4 or 5 on the Math and English Advanced Placement Exams or who achieve a high score on the SAT II Math and English subjects exams may be exempt from Poly's placement exams.

The preferred secondary school course of study is:

Course	Years
English	4
Science	4
<i>(Chemistry is required and physics is strongly recommended.)</i>	
Mathematics	4
<i>(Sequential I, II, III, precalculus, calculus)</i>	

This course of study is only a directive, not an absolute requirement. The primary concern of the members of the Committee on Admissions is to determine an applicant's potential for success at the University.

Interviews and Campus Tours

Prospective students are strongly encouraged to visit the campus. Arrangements can be made by calling the Office of Undergraduate Admissions at 800-POLYTECH or (718) 637-5955. If arrangements are made in advance, prospective students are welcome to have an interview with a member of the admissions staff during their visit to Polytechnic.

Freshman Admission with Advanced Standing

Freshmen may receive advanced standing with college credit at Polytechnic by scoring exceptionally well on the Advanced Placement Examinations given by the College Board. Specific requirements for administering college credit, for the Advanced Placement and the International Baccalaureate Exam, French Baccalaureate or General Certificate Exam A levels, etc., vary from department to department. Students are required to take a placement exam in order to determine their freshman course selection.

ADMISSION UNDER THE HIGHER EDUCATION OPPORTUNITY PROGRAM

The Higher Education Opportunity Program (HEOP) provides educational opportunity to economically and educationally disadvantaged students of New York. Economic eligibility is based on New York State guidelines, which consider family size, family members who are students and family income.

Freshmen entering HEOP are required

to take six weeks of work during the summer prior to beginning the freshman year, to make up prerequisites and courses in which weakness is shown. Freshmen are admitted to this program in the fall only.

Transfer students may enter HEOP provided there is space available. Only students coming from similar programs approved by the HEOP central office are eligible to transfer into HEOP.

For further information, contact the office of HEOP at (718) 260-3370

ADMISSION AS AN INTERNATIONAL STUDENT

International students must meet four basic criteria for admission to Polytechnic and be in receipt of a valid I-20 or DS-2019:

- Academic credentials (grades, certificates, degrees) must be assessed as suitable for entry to the appropriate University program. Transcripts must be submitted along with official translations. One source for official translations is World Education Services at www.wes.org. Submission of SAT or ACT scores is required.
- The Test of English as a Foreign Language (TOEFL) is required of all students whose native language is not English.
- Admitted international students applying for an F-1 or J-1 student visa are required to submit a signed and completed Polytechnic Declaration and Certification of Finances (Affidavit of Support) accompanied by a bank statement signed by a bank official in order to receive an I-20 or DS-2019.
- Students holding F-1 or J-1 visas must enroll as full-time students.

If transfer credit is desired, candidates must include catalogue or syllabus descriptions of courses completed. English translation must be provided where necessary. An official transfer credit evaluation will be done when the student arrives at Polytechnic and meets with a member of the admissions staff and a departmental adviser.

ADMISSION AS A TRANSFER STUDENT

Polytechnic welcomes transfer students from accredited colleges and universities, provided they have maintained a strong academic record; a minimum GPA of 2.5 is required. Students with less than 30 college credits need to submit high school transcripts and SAT scores. Students who have completed 60 college credits need only submit official college transcripts.

Once accepted, transfer students meet with a member of the admissions staff and a departmental adviser to determine which credits are transferable. Students are required to submit their college catalogue describing courses under consideration for transfer credit.

Transfer credits will be evaluated prior to the end of the first semester the transfer student is enrolled at the University by the Office of Undergraduate Admissions in consultation with academic departments. Transfer credit is awarded on the basis of current standards and curriculum. Therefore, it is possible that credits Polytechnic had previously awarded for courses taken at other universities may no longer be granted at this time. Transfer credit will not be considered for any course with less than a C grade. Any student who completes a course in residence at Polytechnic for which transfer credit has already been granted will automatically forfeit the transfer credit for that course.

In certain instances, course requirements may be waived for students who demonstrate sufficient knowledge of a specific course content through either oral or written examinations given by the appropriate department. When course requirements are waived, the student will not receive credit for the course, but must substitute a more advanced course to satisfy the degree requirement.

The grades for transfer courses are not included in the computation of the Polytechnic grade-point average. New transfer students may be admitted on a part-time or full-time basis and may be required to take placement examinations in writing and/or math. The minimum residence requirement for transfer students who wish to qualify for a Polytechnic bachelor's degree is 34 semester hours in approved upper-division subjects taken at Polytechnic.

ADMISSION AS A PART-TIME STUDENT

Students seeking a bachelor's degree may enroll on a part-time basis (11 credits or less). Part-time undergraduate students should be aware that it is not possible to complete a bachelor's degree program by attending only evening courses.

Regulations concerning subject requirements and admissions procedures are given in the section "Admission as a Freshman."

Following notification of acceptance, students are told when to contact the adviser of their major department. In some cases, this may be accomplished during

registration.

SPECIAL AND VISITING STUDENTS

Undergraduate students may also register for a maximum of two courses per semester on a non-degree basis with the exception of international non-degree students who are attending Polytechnic pursuant to an exchange agreement with a foreign university. Application for admission under this special status may be completed during registration. A special non-degree status satisfies the needs of:

- Applicants for graduate admission seeking courses to satisfy undergraduate or prerequisite deficiencies.
- Students seeking specific courses.
- Students seeking specialized proficiency in a major area of knowledge.
- Students from other colleges wishing to transfer credit back to their college.

Courses taken on a non-degree basis are not automatically applied to a degree program. Some courses, however, may be applied to a degree program with the approval of a departmental adviser. Students may enroll in up to 9 credits as a special student before formal admission is required.

READMISSION

Polytechnic students who have not been in attendance for one semester or more and have not been granted an approved leave of absence (see "Leave of Absence") are required to apply for readmission through the Office of Undergraduate Admissions. Students who have been academically disqualified must apply for readmission through the Office of Undergraduate Admissions. Students applying for readmission are expected to state their reasons for leaving the University and explain why they want to return. They must also submit with their application for readmission official transcripts of college-level courses taken during this period of absence from Polytechnic.

UNDERGRADUATE ADVISERS

Most undergraduate students are advised by the Academic Advisement Center in their first year of study. After the first year, those students are assigned advisers in their respective major departments. These departmental advisers are available for individual appointments to discuss academic and related matters. A student's adviser must sign all registration, program adjustment and course withdrawal forms.

GRADUATE

To be eligible for admission as a graduate student, an applicant must first hold a bachelor's degree from an institution acceptable to Polytechnic. The bachelor's degree program must be comprised of at least four years of college level work. In case the bachelor's degree program is less than 4 years, additional college-level course work should be taken to satisfy the requirement of four years of college-level preparation. Attention will be given to listings by the Accreditation Board for Engineering and Technology, the American Chemical Society, the Computer Science Accreditation Board and the various regional accrediting associations. An applicant applying to a graduate program in an area of study different from the undergraduate field in which a bachelor's degree or its international equivalent was earned may be required to take additional courses for which credit towards degree requirements may not be given. (See "Conditional Status.")

The previous program of study must be acceptable, in quality and quantity, to Polytechnic. Reprints of published articles, copies of scientific patents, copies of professional reports and other evidence of superior attainment and aptitude for graduate study and research are encouraged.

Graduate admission information can be obtained from the Office of Graduate Admissions, Polytechnic University, Six MetroTech Center, Brooklyn NY 11201, (718) 260-3182, or online at www.poly.edu/admissions/graduate.

ADMISSIONS PROCEDURES

In addition to the application form and fee, an applicant must have transcripts of any previous undergraduate (and graduate) records sent directly to the Office of Graduate Admissions. An application should be supported by letters of recommendation from persons qualified to comment on the applicant's aptitude for graduate study and research, and standardized admission test results where required. A Statement of Purpose from the applicant is also required. Action on an application will be taken as soon as possible after all supporting documents have been received.

All applicants are requested to send the entire application, including transcripts, letters of recommendation, and all other supporting documents, in one package to facilitate the processing and avoiding delays due to missing documents.

APPLICATION DEADLINES

The deadlines for sending in completed applications for fall semester are:

April 1: (1) all applicants applying for scholarships, assistantships and financial awards, and (2) all international applicants. July 15: all other applicants.

For spring semester the deadlines are:

October 1: (1) all applicants applying for scholarships, assistantships and financial awards, and (2) all international applicants. December 15: all other applicants.

EXAMINATIONS

The Graduate Record Examination (GRE) or Graduate Management Admission Test (GMAT) is required for admission to some graduate programs, and are recommended for all others. However, all international applicants must submit scores for the GRE (or GMAT if applicable) to be considered for admission. GRE or GMAT scores are also highly recommended for those applying for merit based scholarships, fellowships, and assistantships. Consult the departmental section of this catalogue for specific requirements about the degree program to which you are applying.

INTERNATIONAL APPLICANTS

An international student must complete an application for admission by April 1 (fall admission) or October 1 (spring admission) to be reviewed for the term requested. Late applications or an incomplete file will delay review and perhaps entrance by at least one term.

The Test of English as a Foreign Language (TOEFL), administered by the Educational Testing Service, is normally required of all international applicants who have earned a bachelor's degree from an institution in a non-English speaking country. For detailed information, see "English Requirement for International Students." The Test of Spoken English (TSE) is required of all teaching fellowship applicants from non-English speaking countries.

Certification of ability to meet financial obligations is also required.

ENGLISH REQUIREMENT FOR INTERNATIONAL STUDENTS

In order to be granted regular admission to a graduate degree program, international students are normally required to demonstrate proficiency in English by obtaining a score of at least 550 on the traditional or 213 on the computer-based Test of English as a Foreign Language (TOEFL).

This requirement may be waived for international students who:

- Have earned a degree from an institution in a country where English is the official language.
- Have successfully completed an undergraduate program in the United States in which English was the official or major language of instruction.
- Can demonstrate a level of English proficiency deemed equivalent to a TOEFL score of 550 (paper-based test) or 213 (computer based test: CBT) or 80 (internet based test: IBT) through submission of evidence acceptable to the University.

International students who obtain a TOEFL (or equivalent) score of between 490 and 550 (CBT: 163 and 213, IBT: 57 and 80) may be admitted to a graduate degree program on condition that they successfully complete an English program at the University. Upon successful completion of the approved English program, students will not be required to submit a new TOEFL score.

POLYTECHNIC UNIVERSITY'S ENGLISH PROGRAM

In certain cases, international graduate students may be required to attend an intensive English program at Polytechnic upon enrollment. Students may attend this program while taking a reduced graduate academic load of two courses per semester. This decision is made at the time of admission and is normally only offered to students with TOEFL scores between 490 and the required level of 550.

STATUS

Within the full-time and part-time classifications of graduate admission are three status groups: regular, conditional, and special. A change in status from conditional to regular should be applied for when the conditions of admission are satisfied. A special student must file an application for graduate admission with the Office of Graduate Admissions.

Regular Status

A graduate degree or certificate applicant who is adequately prepared to begin the program applied for is assigned regular admission status upon the recommendation of the major department's faculty.

Conditional Status

A graduate degree or certificate applicant who is required to demonstrate additional ability to pursue the program applied for is assigned conditional status. Conditions may include taking introductory level or undergraduate courses, taking intensive English courses, or attainment of a specified grade-point average.

Special Status

An individual requesting permission to register for one or two courses in a specific semester is assigned special admission status. A special (non-degree) student application must be submitted to the Office of Graduate Admissions. Included in this status are individuals who want to take courses for professional advancement or personal development, but who do not want to earn a degree; and part-time degree applicants with incomplete admission files. A maximum of six credits or two courses may be taken in one semester and no more than nine credits or three courses may be applied to a Polytechnic degree program. If such courses are applied toward a degree, they are considered as having been taken “in residence” at Polytechnic. A special student application must be filed each semester the individual remains in this status. Permission to take courses as a special student does not imply admission to a degree program. Special (graduate) students must hold a bachelor’s degree from an institution acceptable to Polytechnic. Proof of that degree is required.

Readmission

Students who last attended Polytechnic within a one-year period before the semester in which they seek to be readmitted need no formal readmission and are automatically permitted to register. Students who have not attended within the past year must file an application for readmission, which is available from the Office of Graduate Admissions.

Students who want to interrupt their studies must request a leave of absence for a specified period of time, usually not exceeding one year. Such requests, when approved by the Office of Academic Affairs (and the Office of International Students and Scholars for international students), will constitute assurance of readmission to the degree program from which the leave was taken. Students must apply for readmission when the period of absence exceeds the approved leave of absence.

EARLY GRADUATE ADMISSION

A Polytechnic undergraduate student who is within 18 credits of completing a BS degree and meets all criteria for graduate admission may apply for admission to graduate study in a given department. If accepted, the student will pursue two degrees simultaneously, taking both graduate and undergraduate courses for no longer than one year. Graduate courses taken during that year that do not satisfy undergraduate degree requirements are counted toward the master’s degree program, and the grades are recorded on the graduate transcript. A formal application for graduate admission must be filed through the Office of Graduate Admissions.

GRADUATE ADVISERS

Representatives of the various departments are assigned as advisers to assist graduate students in the selection of courses to meet their individual needs, to aid them in planning a program for an advanced degree and to guide them in their professional advancement.

ATHLETICS, INTRAMURALS AND RECREATION

The Office of Athletics, Intramurals and Recreation offers a wide range of physical activities for the benefit and use by the Polytechnic community. Whether students belong to a varsity team, work out in the Fitness Center or participate in a class or intramural event, they should consider the activity part of their Polytechnic education. Sports teach students to work in teams, make decisions, respect peers and solve problems under stress. The more physically fit students are, the better they cope with the pressures and stress of college life.

Through sports, students have fun, make friends, improve their self image and retain long-lasting memories. All Polytechnic students are encouraged to engage in some sort of physical activity on campus.

PHILOSOPHY OF ATHLETICS

As an NCAA Division III institution, Polytechnic University places the highest priority on the quality of the overall educational experience and success of each scholar-athlete. The Physical Education and Athletics Program's goal is to produce and support the leaders of tomorrow by establishing and maintaining an environment that values cultural diversity and gender equality among athletes and the athletic staff.

Polytechnic believes that athletics is a vital part of students' education, although their academic program has top priority. As a Division III institution, Polytechnic does not award athletically related financial aid to any students.

Student athletes, coaches and athletic staff are encouraged always to exhibit good sportsmanship, respect, fairness and honesty towards each other and their competitors. The University seeks to develop each athlete as a leader and believes that participation in athletics teaches this philosophy and continues the student's development as a well-rounded, individual.

Maximum participation in athletics is encouraged and the program offers a variety of opportunities in varsity, club and intramural sports. Polytechnic supports students in their efforts to reach high levels of performance by providing adequate facilities and competent coaching to ensure a positive student-athletic experience.

The athletic program at Polytechnic offers students an area of personal growth they will need to be successful once they graduate. Athletics teaches teamwork and self-control and improves mental and physical condition. The program works to instill students' respect for themselves and their opponents as well as have them experience the great feeling of winning and be able to deal with losing, which makes them stronger as people in the long run.

The University proudly looks to its student-athletes as role models and expects their behavior, both on and off the court/field, to bring honor to themselves and to Polytechnic. While the University's goal is for every student athlete to feel successful, it will not compromise the school's mission, vision or spirit in the pursuit of winning.

INTERCOLLEGIATE ATHLETICS

Polytechnic is a member of the NCAA (National Collegiate Athletic Association), Skyline Conference, ECAC (Eastern Collegiate Athletic Conference), NECVA (North Eastern Collegiate Volleyball Association), and USJI (United States Judo Inc.). The University fields the following teams: men's and women's basketball, volleyball, soccer, tennis, cross country and track, women's softball, men's baseball and men's golf.

All full-time undergraduate students who are in good academic standing and meet the NCAA eligibility requirements for team membership are encouraged to participate and win their varsity letter.

INTRAMURALS

Intramural sports enjoy substantial success at Polytechnic. All undergraduate and graduate students are eligible for competition in basketball, soccer, flag football, handball, volleyball and badminton. New sports are offered if there is sufficient interest.

CLASSES/CLUB SPORTS

Aerobics/Pilates

Basic aerobic steps and conditioning to music. Class consists of warm-up, stretching and low impact aerobics. Floor exercises focus on stomach, legs, hips and buttocks, strengthening exercises with light weights.

Martial Arts-Judo/Beginner and Advanced

All aspects of Sport Judo from beginner to advanced. Lessons include conditioning, drills, mat work, standing techniques and contest rules. Class is offered for recreation and/or competition. Rank is given.

Martial Arts- Tae Kwon Do /Beginner and Advanced

Tae Kwon Do is taught as a traditional martial art. Lessons include patterns, basic striking, blocking and kicking techniques, calisthenics, light sparring, self-defense releases and throws. Class is offered for recreation and/or competition. Rank is given.

Swimming

Recreational swimming hours are offered at St. Francis College, 180 Remsen Street, Brooklyn, NY (about a five minute walk from the campus).

Table Tennis

We offer both recreational hours and opportunities to get involved in intercollegiate competition. Recreational players can try-out for a place on the team.

Yoga

We offer yoga for beginners. Class consists of stretching and toning muscles; release tension; improve circulation; calm restless thoughts and promote self-awareness through practicing gentle postures.

FACILITIES

Gymnasium

NCAA regulation gym located on first floor of the Joseph J. and Violet J. Jacobs Academics Building (JAB).

Trainers Room

Located in the lower level of the Joseph J. and Violet J. Jacobs Academics Building (JAB). Includes whirlpool, ice machine, hydroculator (hot packs), and ultra-sound and electrical stimulation machines. An athletic trainer is present at all home games and is on campus three days a week.

Fitness Center

Located in the lower level of the Joseph J. and Violet J. Jacobs Academics Building (JAB). Equipment includes treadmills, stepers, stationary bicycles, rowing machines, a heavy bag and a speed bag for cardiovascular work. Strength equipment includes both single and dual weight machines and a free weight area including barbells and dumbbells.

Recreation Center

Located in the lower level of the JAB, includes billiards, ping pong,

Athletic Fields

Polytechnic's athletic fields for baseball, softball and soccer are located at Floyd Bennett Field in Gateway Recreation area off the Belt Parkway, Exit 11 South.

STAFF

Maureen Braziel

Director of Athletics and Recreation

James Barrett

Facilities Manager/Intramural Director

Dave Yorke

Sports Information Director/
Compliance Officer

Margie Iacono

Administrative Assistant

COUNSELING CENTER

The Counseling Center offers an array of free and confidential services designed to help Polytechnic University students achieve their maximum potential academically, professionally and personally.

Throughout one's undergraduate or graduate experience it is not uncommon for one to be overwhelmed by the demands of being a student as well as juggling other responsibilities at home and at work. Managing these demands in addition to other difficulties can interfere with your ability to succeed academically or function at your best. For example, many students struggle with depression, test taking, loneliness, procrastination, excessive worries, problems with family or relationships, or lapses in motivation, which can interfere with their Poly experience. Our staff members of licensed psychologists and psychological trainees are extensively trained to help students overcome these and other concerns.

Services offered at the Counseling Center include:

- Short term individual psychotherapy
- Group counseling
- Workshops
- Consultation regarding concerns one may have about a Poly student
- Referrals to local mental health resources
- Self-Help Library from which Poly students can borrow books

COUNSELING CENTER STAFF

Luis Manzo

Director

Scott Feldman

Staff Psychologist/Coordinator of
Clinical Training

CAREER SERVICES AND COOPERATIVE EDUCATION

The Office of Career Services and Cooperative Education is the bridge between the academic world and the world of work. We provide students with services and resources that will enable them to develop life-long career capabilities. Polytechnic students are encouraged to begin taking an early and active role in planning their career development. The goals of the Office of Career Services are to assist students in:

- Becoming better informed of their career options.
- Identifying and pursuing career options.
- Finding work experiences that will give opportunities to apply skills and academic background in paid or non-paid work assignments.
- Reviewing options for graduate study or full-time employment.

Students at every academic level are encouraged to speak with the office's professional staff about their career development and job placement needs. Ongoing developmental career services include: career exploration classes, workshops seminars, individualized counseling on job skills (résumé writing, job search and interviewing techniques) career fairs, internships, co-ops, mentoring programs, and company/industry presentations and on campus recruiting.

Job placement services help students gain valuable work experience in their respective fields. To help meet the needs of job-seeking students we offer full-time and part-time job banks, summer job assistance and the extensive Polytechnic job recruiting program. The demand for Polytechnic graduates is great, as evidenced by the 650 companies that recruit on campus annually. These companies conduct approximately 2,600 interviews yearly, resulting in employment for many of our graduates. The placement rate for Polytechnic students who graduated in 2006 was 89 percent.

Alumni are welcome to use the resources of the office when planning or making career or job changes. In addition to the corporate library, job bank and other reference periodicals and literature, individualized counseling is available.

INTERNSHIPS/CO-OPERATIVE EDUCATION

These programs provide students with paid work experience in industry, government and public service agencies. These experiences contribute to a student's career decision-making ability, motivates academic performance and provides a competitive advantage in the job market. Students can also earn a substantial salary while employed in a co-op position.

Co-op at Polytechnic is an optional, non-credit program. It is a partnership involving the student, the employer and the Office of Co-op Education. Students may opt to participate in the alternating or parallel programs:

• Alternating Co-op (full time)

Students alternate semesters of full-time co-op employment. Students work a full semester (fall or spring) and return to Polytechnic the next semester to continue their courses. Students who have a full-time co-op position and are not attending classes do not pay tuition fees for that semester. Students will need to inform Career Services and the Financial Aid Office of their co-op position.

• Parallel Co-op (part time)

Students work on a part-time basis (15-20 hours a week) while they are enrolled full time in classes.

At the end of each co-op assignment, students complete an evaluation provided by the Office of Co-op Education. Their co-op assignment is recorded on their transcript and is graded on a pass/fail basis.

An undergraduate student may participate in the program for up to seven work periods or semesters. Each co-op student designs a co-op work-study program with the help of an academic adviser. Eligible students begin the program in their sophomore year. Companies select students based on their employment needs, and the process is competitive. Co-op students are given work directly related to their career goals and level of academic experience. Co-op students are paid salaries based on their experience and academic level.

UNDERGRADUATE ELIGIBILITY

Before applying for the initial co-op work assignment, students must:

- Be enrolled as a full-time undergraduate.
- Complete two full-time semesters at Polytechnic.
- Achieve and maintain a 2.5 GPA.
- Have sophomore status (28+ credits) with no course deficiencies.
- Complete at least one technical course in their major as determined by their academic department.
- Successfully complete CP 101 Career Development Seminar.
- Obtain adviser approval for program participation (work-study plan signed by adviser).

Transfer Students are required to:

- Complete one semester of full-time study at Polytechnic before beginning their first work period.
- Successfully complete CP 101 Career Development Seminar.
- Achieve a 2.5 GPA at Polytechnic.
- Obtain departmental approval for program participation (work-study plan signed by adviser).

CO-OP SEMINARS

CP 101 Career Development Seminar helps prepare students to enter into professional environments and is a prerequisite to participating in a work experience sequence.

CP 101 covers self-assessment, résumé-writing, interviewing, company networking and other topics that foster the students' successful adjustment in the workplace. Students may also have an opportunity to meet co-op employers and other co-op students.

Students entering work assignments after sophomore year can complete up to seven field experience courses, CP 201 through CP 501. Types, complexities and challenges of field assignments vary depending on the student's academic preparation, ability and interest. The initial field experience (CP 201) usually serves as an introduction to the technical work environment. Students are assigned work under supervisors, who are usually senior staff professionals. As students progress through subsequent field assignments, more complex tasks and duties are added.

GRADUATE

CP 900 Career Planning Seminar prepares graduate students to enter into professional environments and is a prerequisite to participating in a work experience. CP 900 covers self-assessment, résumé-writing, SWOT analysis, company research and other topics that foster students' successful adjustment in the workplace. Students also have an opportunity to learn and share information with other co-op students via the web. CP 900 is an online course designed specifically to be used on My Poly. Each student is required to log into the course, participate on the discussion board, complete readings and submit assignments on a weekly basis. CP 900 is a non-credit bearing course that lasts for nine weeks or sessions and is graded on an S (satisfactory) or I (incomplete) basis.

The initial field experience, CP 991 usually serves as an introduction to the technical work environment. Students are assigned work under supervisors, who are usually senior staff professionals. As students progress through subsequent field assignments, more complex tasks and duties are added. At the mid point and at the completion of each co-op assignment, the students' supervisor will submit an evaluation form, provided by the Office of Co-op Education. Students must also complete a final report detailing their technical observations, challenges encountered, solutions developed and outcomes. The co-op assignment is recorded on the students' transcript and is graded on a P (pass)/I (incomplete) basis.

A student may participate in the program for up to three-work periods or semesters. Each co-op student must obtain approvals for a co-op work experience from the Graduate Co-Op adviser. Eligible students may begin the program in the semester immediately following the completion of two full-time semesters of graduate study. Companies select students based on their employment needs, and the process is competitive. Co-op students are required to find work directly related to their career goals and level of academic experience. Co-op students are paid salaries based on their experience and academic level. All courses are non-credit and free of charge.

GRADUATE ELIGIBILITY

Before applying for the initial co-op work assignment, graduate students must:

- Be enrolled as a graduate student full-time
- Complete two semesters at Polytechnic University.
- Achieve and maintain a 3.0 GPA.
- Successfully complete CP 900 Career Development Seminar
- Obtain adviser approval for program participation (co-op plan signed by Graduate co-op Adviser).

Transfer Students

Graduate are required to:

- Complete at least one semester of study at Polytechnic before beginning their first work period.
- Successfully complete CP 900 Career Development Seminar.
- Achieve a 3.0 GPA at Polytechnic.
- Obtain adviser approval for program participation (co-op plan signed by Graduate co-op adviser).

Grades of P (pass) or F (fail) are recorded upon completion of each course. Courses will not be computed in the GPA. These grades are based upon final reports and work evaluations written by students and evaluations submitted by supervisors.

STAFF

Nina K. Weber

Director of Career Services

Herb Scheftel

Manager of Career Fair, Internship/Co-op and Work-Study

Kara Mitchell

Graduate Internship/CO-OP and Career Counselor

JoAnne Davis

Coordinator of On-campus Recruitment/ Administrative Assistant

Greys Jessurum

Administrative Assistant

FINANCIAL AID

GRADUATE

GRADUATE FELLOWSHIPS

Fellowships are available for study leading to master's and PhD degrees in engineering and science. They are awarded through the department in which applicants are enrolled, or to which they have applied. Entering students apply for a fellowship by completing the appropriate question on the Application for Graduate Admission form. Continuing students should consult their academic department.

Research Fellowships

Students receiving research fellowships are assigned to research that fulfills the thesis requirement of the graduate curriculum in which they matriculate. They receive a living allowance and remitted tuition. Fellows must be registered as full-time students taking 12 or more units per semester, which may include their thesis. Typically, funding comes from grants and contracts that faculty have secured from government agencies or industry. In these cases, the student's research is also reported to the funding agency or company as part of the grant or contract requirements.

University Scholars

University scholars participate half time throughout the academic year in assignments from the department in which they matriculate. They receive a living allowance and up to 12 units of tuition scholarship. Scholars must be registered as full-time students taking 12 or more units per semester, which may include their thesis. Students working toward a PhD must also complete the thesis requirement of the department and University.

Special Fellowships

Individual departments administer special fellowships sponsored by industry and foundations, each with its own conditions, for students in the department. Contact departmental offices for information on special fellowships.

REDUCED TUITION PROGRAM FOR HIGH SCHOOL AND TWO-YEAR COMMUNITY COLLEGE TEACHERS

A reduced tuition program is offered for full-time high school and two-year community college teachers to encourage their pursuit of graduate studies at Polytechnic. The program provides a one-half tuition reduction for graduate courses taken at any campus. Degree candidates and special students are eligible.

Prospective students must submit to the Office of Graduate Admissions written verification of employment as a full-time high school or college teacher, signed by the department head and an officer of the applicant's institution. Substitute, part-time, adjunct or temporary appointments are not valid. Only those holding full-time, permanent teaching appointments in a public or private secondary school or accredited two-year community college located in the New York metropolitan area are eligible to participate in this program.

This policy is not retroactive, and students may not participate in more than one tuition reduction or remission program. This policy is subject to annual review.

GRADUATE TUITION ASSISTANCE PROGRAM (TAP)

Graduate Tuition Assistance Program (TAP) is an entitlement grant program administered annually by the New York State Higher Education Services Corporation (NYSHESC).

Eligible students must (1) be New York State residents and U.S. citizens or eligible non-citizens, (2) enroll full-time as a matriculated student and (3) meet income requirements established by New York State.

The award amount depends upon the tuition charge and net taxable income. Students may receive TAP for eight semesters of graduate studies. Applicants must complete the Express TAP application (ETA) through New York State Higher Education Services Corporation (NYSHESC). There are two methods for applying: (1) complete your FAFSA online at www.fafsa.ed.gov. As a New York State resident, you will be provided a link on the final page of the FAFSA website that will direct you to complete the online ETA. Students who do not use the online application will be mailed a pre-

printed ETA to their home after they have completed the FAFSA. If you will be attending Polytechnic University, you must make sure that the ETA lists Polytechnic as your institution for the fall and spring semesters, along with our school code 0610. If Polytechnic is not listed, write our school code into the boxes provided on the ETA. After reviewing the application for accuracy, sign and return it directly to NYSHESC.

FEDERAL SUBSIDIZED STAFFORD LOAN

Graduate students may apply for a Federal Subsidized Stafford Loan for \$8,500 per academic year. The interest rate is an annual variable rate based on a 91-day T-bill plus 2.3 percent with a cap of 8.25 percent. Eligible students must (1) be U.S. citizens or eligible non-citizens, (2) enroll for at least 6 credits per semester and matriculate, (3) make satisfactory academic progress and (4) demonstrate financial need. All applicants must complete a Free Application for Federal Student Aid (FAFSA) to determine need. All interest and principle payments are deferred as long as the student is enrolled for at least 6 credits per semester. Repayment begins six months after graduating or withdrawal from school. Immediate repayment is required if the borrower is enrolled less than half time. Contact the Office of Financial Aid regarding the application process.

FEDERAL UNSUBSIDIZED STAFFORD LOAN

The Federal Unsubsidized Stafford Loan is open to students who do not qualify for the above Federal Subsidized Stafford Loan. The same terms, conditions, annual borrowing limits and interest rates apply. In addition, graduate students may borrow an additional \$10,000 annually. The one exception is that the borrower is responsible for interest that accrues while enrolled in school and during the six-month grace period. Contact the Office of Financial Aid regarding the application process.

UNDERGRADUATE

Polytechnic University administers a broad range of scholarship and financial aid programs designed to assist students in pursuing their educational goals. To meet the total cost of education, students may draw upon such available sources as student income, family income, University grants, and federal and state funding.

All financial aid is limited to the need of the student as determined by the federal government. Students receiving financial assistance from Polytechnic must notify the director of financial aid of all scholarships, loans and other forms of educational assistance from sources other than those directly administered by the Office of Financial Aid. The following are three basic types of financial aid:

1. **Scholarships and grants:** funds awarded to students based on academic ability and financial need and that do not require repayment.
2. **Loans:** specific sums awarded to students with repayment conditions. Education loans generally have low-interest rates with extended repayment terms.
3. **Employment:** part-time and summer jobs either on- or off-campus.

Approximately 90 percent of Polytechnic's undergraduate students receive aid including scholarships, grants, work-study jobs and student loans.

Applying for Financial Aid

Incoming freshmen should file a Free Application for Federal Student Aid (FAFSA) during the month of January. (Later applications will be considered on a rolling basis as funds are available.)

Transfer students should file a FAFSA by May 1, or as soon as possible thereafter.

Renewing Financial Aid

All currently enrolled students must re-apply for financial aid annually by completing the Free Application for Federal Student Aid (FAFSA) before March 1st for the upcoming academic year.

There are three methods for completing the FAFSA: (1) Complete the FAFSA online at www.fafsa.ed.gov. (2) Complete the paper Renewal FAFSA, which is mailed directly to all students who applied for federal aid in the previous year. (3) Complete a paper FAFSA application and mail it directly to the Federal Student Aid Programs. Paper applications are available at the Office of Financial Aid.

Before sending an application, students should make sure that they complete all required sections of the form, including the following:

- For the FAFSA and Renewal FAFSA, students and their parents (if applicable) must sign the application.
- For online FAFSA applications, students can download the signature page, sign and submit to the U.S. Department of Education, or sign the application with an electronic signature via the federal Personal Identification Number (PIN) system.
- Enter Polytechnic University's federal school code (002796), along with residency status for the upcoming academic year (on-campus, commuter, etc.).
- Include state residency information. This information is required to apply for the New York State Tuition Assistance Program (TAP).

Contact the Office of Financial Aid for the filing deadline date and for additional questions.

FEDERAL CAMPUS-BASED PROGRAMS

Students eligible for one of the federal campus-based programs must (1) show need, (2) be enrolled at least half time (the equivalent of at least 6 credits per semester) and (3) be either U.S. citizens or eligible non-citizens.

To apply for any of these programs, students must have been accepted to Polytechnic and have filed a FAFSA. The Office of Financial Aid determines the awards.

To continue to receive an award, students must make satisfactory academic progress, provide the Office of Financial Aid with all requested documents and report any changes in their financial situation annually.

Federal Supplemental Education Opportunity Grant (SEOG)

The Federal Supplemental Education Opportunity Grant (SEOG) is awarded to undergraduates with exceptional financial need. Qualified applicants receive between \$500 and \$2,000 per year. Usually, the award will continue to be offered for four years, but it is based upon financial need.

Federal Perkins Loans (formerly National Defense Student Loans, NDSL)

Federal Perkins Loans are low-interest (5 percent) and available through the Office of Financial Aid. They are awarded as part of

a financial aid package, with a range of \$500 to \$2,000 per academic year and limited to \$4,500 for the first two years of college study. Total undergraduate Perkins Loans may not exceed \$9,000.

The repayment period and interest for Perkins Loans do not begin until nine months after students complete their studies. Interest of 5 percent per year is charged during the repayment period. Repayment begins nine months after termination of full- or half-time study and may continue over a 10-year period. Terms for deferment of payment and cancellation of the loan are found in the Perkins Loan Promissory Note.

Federal Work-Study Program

The Federal Work-Study Program provides part-time jobs for undergraduate students to help meet college-related expenses. The Office of Financial Aid Employment determines eligibility. The Office of Career Services arranges the work schedules.

At Polytechnic, the average federal work-study award is \$2,000 per academic year and may be higher depending upon financial need. Jobs are arranged on-campus, along with community service opportunities. Most assignments average 15 hours per week, and the work schedule is adjusted to the student's and the employer's needs. The hourly rate varies depending on the position. Students are paid biweekly.

FEDERAL AND STATE SPONSORED PROGRAMS

Federal Pell Grants

The Federal Pell Grant is a need-based program. Awards are determined by the U.S. Department of Education according to an eligibility index and by the level of appropriations available. Grants are for study leading to a first bachelor's degree and are usually the first component of all financial aid packages.

Eligible students must (1) be U.S. citizens or permanent residents, (2) make satisfactory academic progress, (3) enroll at least half time (the equivalent of 6 credits per semester) and (3) meet federal income requirements.

Students apply for the Federal Pell Grant by completing a FAFSA. Students applying for financial aid at Polytechnic (including the Stafford Loan) are required to apply for a Federal Pell Grant. Students must file an application by May 1 for the current academic year.

Tuition Assistance Program (TAP)

The Tuition Assistance Program (TAP) attempts to minimize the difference in cost normally found between New York’s public and independent colleges so that students are able to make their choice based on program characteristics alone and not the difference in cost.

The amount of a TAP award depends on level of study, tuition charge and net taxable income. (This income is adjusted to reflect other family members enrolled full-time in post-secondary study.)

Eligible students must (1) be New York State residents and U.S. citizens or permanent residents, (2) enroll full-time at an approved New York State post-secondary institution, (3) meet income requirements established by New York State and (4) complete a TAP application by May 1 for the current academic year.

To apply for a TAP award, students should complete an Express TAP Application (ETA) at www.hesc.com. The ETA will be pre-printed and mailed directly to students once they have completed a FAFSA.

If Polytechnic University’s name does not appear on the TAP certificate, use the NYSHESC web site at www.hesc.com to update your state school code to Polytechnic University 0610.

To continue to receive TAP benefits, students must demonstrate satisfactory academic progress. All TAP recipients must achieve a 2.0 cumulative GPA after the completion of four full-time semesters of study.

In addition, students must fulfill the following academic requirements:

1. Complete a minimum number of credits by the end of each term of full-time study.
2. Maintain a minimum grade-point average. The table below provides the correspondence between TAP payment points and academic progress.

Academic Progress (For TAP Purposes)

TAP Payment Points	Min. Credits Completed Successfully	Min. CUM GPA
3-6	0	0.00
9-12	6	1.30
15-18	15	1.40
21-24	27	1.50
27-30	40	2.00
33-36	54	2.00
39-42	68	2.00
45-48	83	2.00
51-54	98	2.00
57-60	113	2.00

TAP Waiver: Students who do not meet the criteria as indicated on Requirements 1 & 2 may be eligible for a one-time TAP waiver. For appeal and consideration by the TAP Waiver Committee, students must file a TAP waiver request form with the TAP Certifying Officer in the Office of Student Accounts.

Contact the Office of Student Accounts for additional information.

Aid for Part-Time Study (APTS)

The Aid for Part-Time Study (APTS) Program provides state grants to less than full-time students.

Eligible students must (1) be working toward an undergraduate degree as a part-time student, (2) be in good academic standing, (3) be a resident of New York State, (4) be either a U.S. citizen, permanent resident alien or refugee, (5) not have exhausted TAP or other New York State student financial aid eligibility for full-time study and (6) qualify under the New York State-mandated income requirements.

To apply, students should file an application with the Office of Financial Aid no later than the second week of classes for the current semester. Students must apply annually.

Vietnam Veterans Tuition Awards (VVTA) Supplement

The Vietnam Veterans Tuition Award is an entitlement program. Eligible applicants must (1) be residents of New York State since April 20, 1984, or at the time of entry into service and resumption of residency by September 1, 1988; (2) have served in the U.S. Armed Forces in Indochina between January 1, 1963, and May 1, 1975; (3) be honorably or medically discharged from the U.S. Armed Forces; (4) enroll in an approved undergraduate program in a degree-granting institution in New York State; and (5) apply for TAP and Federal Pell Grant awards. There are no income restrictions connected with this program.

VVTA provides up to \$500 per semester (full-time attendance) or \$250 per semester (part-time attendance). If students receive a TAP award, the combined awards cannot be greater than tuition or the TAP award will be reduced accordingly. VVTA is available for up to eight semesters (four years) or 10 semesters (five years) of undergraduate study if programs specifically require five years of full-time study and double the amount of time for part-time study.

To apply, students should complete an application and other materials available at the Office of Financial Aid or any Veterans Office or by writing to the New York State Higher Education Services Corporation, VVTA, Albany, New York, 12255. Part-time students must file an application by May 1. Full-time students must submit both Vietnam Veterans Tuition Supplements and the Student Payment Applications (TAP Application) by May 1.

Students must reapply each year.

Higher Education Opportunity Program (HEOP)

HEOP is sponsored by New York State and Polytechnic for entering freshmen who meet special academic and economic criteria. All inquiries are handled directly through the Office of HEOP. Consult the “Admissions” section and Part 4 of this catalogue for more information.

UNIVERSITY SCHOLARSHIPS AND GRANTS

Polytechnic awards scholarships to freshmen and transfer students with strong academic backgrounds for full-time study (12 credit hours per semester). Scholarships are offered through the Promise Fund, which administers more than 100 different programs. Students apply directly to the Office of Undergraduate Admissions through the application for admission. Awards may cover up to full tuition. Scholars must maintain a 2.5 or 3.0 cumulative GPA (depending on the award) and apply for Pell and TAP. Scholarships are not added to external scholarships nor coupled with multiple Poly scholarships.

Polytechnic awards the following scholarships:

Geiger/Fialkov Scholarships

Awarded to superior freshmen majoring in engineering or computer science. Scholarship amounts are equal to full tuition less any outside aid for which the students are eligible. Scholars must maintain a 3.0 cumulative GPA and apply for Pell and TAP. This award is for undergraduate study only.

Dean of Engineering Scholarships

One scholarship of \$10,000 awarded per year to a student with superior academic credentials in each of the following engineering disciplines: aerospace engineering, chemical engineering, civil engineering, computer science, electrical engineering, industrial engineering, mechanical engineer-

ing and metallurgical engineering.

Scholars must maintain a 2.5 cumulative GPA and apply for Pell and TAP. Eligible students must complete a separate application form for this scholarship, available from the Office of Undergraduate Admissions.

High School Principal's Scholarship

High school principals in the New York metropolitan region are invited to nominate their outstanding graduates for a scholarship of \$10,000 per year. A Scholarship Committee selects recipients from among nominees. Scholars must maintain a 2.5 cumulative GPA and apply for Pell and TAP. Application forms are available in the student's high school and from the Office of Undergraduate Admissions.

Promise Scholarships

Awarded in varying amounts, based upon scholastic achievement, to students who participated in the Center for Youth in Engineering and Science (YES Center) while in high school, or to other graduates of participating high schools. No award may be greater than the amount of tuition less any other aid for which students may be eligible. Scholars must maintain a 3.0 or 2.5 cumulative GPA (depending upon the amount of the award) and apply for Pell and TAP. No separate application is required.

Outstanding Transfer Scholarships

Awarded to superior transfer students. The award amounts vary depending upon the GPA of the student and interview. Scholars must maintain a 2.5 cumulative GPA, enroll full-time and apply for Pell and TAP. No separate application is required.

Polytechnic Grants

Awarded to students who demonstrate a high need. Students apply directly to the Office of Financial Aid by completing a FAFSA.

MERIT BASED SCHOLARSHIPS AND AWARDS

Othmer Honors College Scholarship Award

Amount: Up to Full Tuition

Who is considered: Students selected for this program are in the top 10 percent of all students accepted to Polytechnic University, and traditionally have a high school GPA of 94 or higher, and a minimum SAT score of 1350 upon entering Polytechnic. Students applying to this program must have an on-campus interview.

Renewal Process: In order for this scholarship to be reneWed, students must maintain a 3.0 cumulative GPA and complete a FAFSA for each academic year.

PROMISE FUND—CORPORATE AND INDIVIDUALLY SPONSORED SCHOLARSHIPS

Polytechnic scholarships are established through the generosity of sponsors. Students are notified if their particular scholarship is corporate or individually donated.

The following is a list of current scholarships at Polytechnic:

Benjamin Adler Memorial Scholarship
 Sidney G. Albert Scholarship
 Alden Challenge Scholarship
 Anthony Alonzo Scholarship
 Alumni Scholarship
 Joseph M. Amendolara Scholarship
 Donald J. Amoruso Scholarship
 George Bachman Scholarship
 Paul C. Bauerle Memorial Scholarship
 Beltran Family Endowed Scholarship
 Orin Dodge Berry Scholarship
 Bender-Fishbein Endowed Scholarship
 Eugene Blank Scholarship
 Blecker/Hinden Scholarship
 Joseph Bommarito Scholarship
 Rodney Brabson '32 Scholarship
 R. Brown Scholarship
 Joseph Bucich Scholarship
 Dr. George Bugliarello Scholarship
 Salvatore E. Cannizzaro Scholarship
 L. F. Case Foundation Scholarship
 George & Assunta Cha Scholarship
 Chinese Institute of Engineers Endowed Scholarship
 Kuilo Cheng Scholarship
 J. B. Chittenden Scholarship
 Claessens Family Scholarship
 Arthur Clapp Scholarship
 Philip Clark Scholarship
 Class of 1942 Scholarship
 Class of 1944 Scholarship
 Class of 1960 Scholarship
 Samuel and Grace B. Cohen Scholarship
 Donald and Maria Cox Endowed Scholarship
 Davis/Durborow/Brierly Scholarship Fund
 Joseph D'Aprile Memorial Scholarship
 DeWitt Scholarship
 Willard H. Dickinson Scholarship
 Herman Dock Scholarship
 Peter Dollard Scholarship
 Aaron and Simcha Dubitzky Scholarship
 W. E. Duryea Scholarship
 A. S. Dwight Scholarship
 Eirich/Morawetz Scholarship

Burton Erickson Scholarship
 Bernard Farkas Scholarship
 I. W. Fay Scholarship
 Federal Cyber Service Scholarship for Service
 Fisher (estate of J.R. Fisher) Scholarship
 Harold and Martha Forstrom Scholarship
 Sidney and Katherine Friend/NACME Scholarship
 W. L. Family Endowed Scholarship
 Geiger-Fialkov Scholarship
 Roger Gilmont Scholarship
 Dr. Anthony B. Giordano Scholarship
 Amir Gold Scholarship
 Goldman Sachs & Company Scholarship
 Harold and Helen Gottlieb Scholarship
 Gordon Gould Scholarship
 James Douglas Graham Scholarship
 Ying Chavas Greene Scholarship
 Francis and Mildred Hallenbeck Foundation Scholarship
 William Randolph Hearst Scholarship
 Charles J. Hinkaty '70, '72 Endowed
 Alfred Helwig Scholarship
 Herbert Henkel Scholarship
 Professor Hessel Award
 HTI Scholarship
 F. M. Jabara Scholarship
 Jephson Educational Trust Scholarship
 William T. Hudtwalker Scholarship Endowed
 James H.J. Hughes Award
 Dr. Peter Kabasakalian Scholarship
 Susan Kamen Scholarship
 Jacob Kaplan Scholarship
 The Harry S. and Toby Katz Scholarship
 Ade Howe Kent Scholarship
 Nathan Kleinman Scholarship
 Kirk Scholarship
 Ping Ku Scholarship
 Eugene R. Kulka Scholarship
 John F. Kunc Scholarship
 Dr. Irving Kuntz Scholarship
 Bernard and Pauline Lee Scholarship
 Saul Leitner Scholarship
 Dorothy Lemelson Scholarship
 Alfred and Beatrice Lerner Memorial
 Leona Levine Scholarship
 Steve Levy Scholarship
 Robert Linoki Memorial
 Litton Industries Scholarship
 Lockheed Martin Scholarship
 Helen T. Lowe Scholarship
 Lyons Scholarship
 Maggio Scholarship
 P.R. Mallory Memorial Scholarship
 Dr. Ines Mandl '47 '49 Scholarship
 Arthur C. and Elizabeth R. Martinez Endowed Scholarship
 Raymond Mauro Scholarship

Stephen J. Meoli Memorial Scholarship
 E. Mitchell Scholarship
 Colonel Frank Mott Scholarship
 Alfred B. Muscari Memorial Endowed
 Scholarship
 NACME Block Grant Scholarship
 Bonnie Nagler Scholarship
 NEC Scholarship (in Dr. Sekimoto's
 honor)
 NECA (Northeastern Chemical
 Association) Endowed Scholarship
 William Nichols Scholarship
 Nippon Electric Scholarship
 Stanley Nisenson Memorial Scholarship
 Nordheimer Scholarship
 Theodore Nowak Scholarship
 NSC–Eddie Mitchell Scholarship
 NSS–Hughes Aircraft Co. Scholarship
 Oceanic Scholarship
 Dr. John C. Olsen Scholarship
 Open Door Foundation Scholarship
 Lilyan and Milton Oran Scholarship
 Ruth and Richard Orford Scholarship
 Dr. Donald Othmer Scholarship
 PamAmSat Scholarship
 Donald Pascal Scholarship
 Rajendra Paul Scholarship
 George S. Pearson Scholarship
 Louis J. Pignatoro Memorial
 G. Jeffrey Poletti Memorial Scholarship
 Polytechnic 100 Scholarship
 Polytechnic Fellows Scholarship
 PROMISE Scholarship
 Radio Club Scholarship
 Bengt G. Ranby Scholarship
 Dr. Julian R. Reasenberg Memorial
 Scholarship
 Steve and Lee Rittvo Scholarship
 Julian Rogoff Scholarship
 Nicholas and Angelica Romanelli
 Scholarship
 Myron Rosenthal Scholarship
 Samuel Ruben Scholarship
 Sidney J. Rubin Scholarship
 Helena Rubinstein Foundation Fellowship
 Richard and Emily Sbaschnig Scholarship
 Dr. John P. Schaefer Endowed Trustee's
 Scholarship
 Edward C. Schmidt Scholarship
 Paul J. Schwanenflugel Scholarship
 Dr. Sekimoto (NEC) Scholarship
 Mitsuzo Shida Scholarship
 Silleck Family Scholarship
 Skeist Scholarship
 James M. Smith Scholarship
 Frank R. and Emily E. Stammer
 Scholarship
 Michael Stock Scholarship
 William Stolze Scholarship
 Won Bong Sull Endowed Scholarship
 Solon Summerfield Foundation

Scholarship
 Wai Nam Tam Scholarship
 Arlene and Irving Tashlick Scholarship
 Tau Beta Pi Scholarship
 Arnold Thompson Scholarship
 Guy Torre Memorial Book Scholarship
 Robert Tsao Endowment Fellowship
 USS Scholarship
 Kenneth G. Van Wynen Scholarship
 Dr. Ernst Weber Scholarship
 Ernst and Sonya Weber Scholarship
 Donald N and Susan C. Weisstuch
 Scholarship
 Williams Industries Inc. Endowed
 Scholarship
 Warren E. Winsche Memorial Scholarship
 William Wishnick Scholarship
 WSTA Scholarship
 Howard J. and Audrey R. Wulfken
 Scholarship
 Frank and Iris Young President's
 Scholarship
 Edward H. Zucker Scholarship

**OTHER OPPORTUNITIES
 Veterans Administration (VA)
 Educational Benefits**

Eligible students must (1) be veterans who served over 180 days between January 31, 1955, and January 1, 1977; (2) continue on active duty; (3) have been honorably discharged at the end of their tour of duty; and (4) qualify because of service-connected disabilities. Veterans are entitled to benefits for full-time study at an approved post-secondary institution, for one and one-half months for each month of active service (up to 45 months). Eligible veterans who served 18 continuous months are entitled to benefits for 45 months of full-time study. In each case, the equivalent in part-time study may be authorized. Eligibility extends for 10 years after release from service, but not after December 31, 1989. Children, spouses and survivors of veterans whose deaths or permanent total disabilities were service-connected, or who are listed as missing in action, may be eligible for post-secondary education benefits under the same conditions as veterans.

To apply, students should complete an application available at the Office of Student Records, all VA offices, active duty stations and American embassies, and submit it to the Office of Student Records.

A Summary of Veterans' Benefits booklet is available from the Office of Student Records. Current monthly benefit rates are available through VA offices. Veterans may borrow up to \$2,500 for an academic year of full-time study through a special loan

program for veterans.

Students requesting VA education benefits should notify the Office of Student Records each semester after completing registration. Students must report interrupted attendance or termination of study. Details of Polytechnic's requirements are given to all applicants. Questions concerning veterans, benefits or paperwork should be directed to the Office of Student Records either in person, by telephone or by completing a Request for Veteran's Benefits form.

**Cooperative Education
 Program (Co-op)**

Co-op is an alternative means of financing education by combining outside employment with college attendance in alternate semesters.

Contact the Office of Career Services and Cooperative Education for more information.

**Grant Aid To Non-New York
 State Residents**

Some state-aid programs frequently require that awarded funds be used within the state, while other programs sometimes allow funds to be used out of state. Students who are residents of Pennsylvania, Rhode Island, Vermont or Washington, D.C., should contact the following agencies for more financial aid information:

Pennsylvania Higher Education
 Assistance Agency
 Education Building
 Harrisburg, PA 17126

Office of Scholarships
 Rhode Island Department of Education
 199 Promenade Street
 Providence, RI 02908

Vermont Student Assistance Corporation
 156 College Street
 Burlington, VT 05401

Washington, D.C., Grant Program
 Educational Assistance Office
 1329 E. Street NW
 Room 1050
 Washington, DC 20004

**LOAN PROGRAMS
 Federal Subsidized Stafford Loan Program**

The Subsidized Stafford Loan Program allows students to borrow money from a local lending institution to help them meet the costs of college or vocational school training. Students borrow this money at a low-interest rate and do not repay as long as they

meet the program's academic requirements or until six months after they graduate or withdraw from school.

Eligible students must (1) be a U.S. citizen or eligible non-citizen, (2) enroll for at least 6 credits per semester and matriculate, (3) make satisfactory academic progress and (4) demonstrate financial need. Applicants must complete a FAFSA to determine financial need and eligibility for a Pell Grant.

Academic year loan limits are \$2,625 for freshmen, \$3,500 for sophomores, and \$5,500 for juniors, seniors and fifth-year undergraduates. The interest rate is an annual variable rate based on a 91-day T-bill plus 2.3 percent with a cap of 8.25 percent.

Students with more than \$5,000 in loans (Stafford, Perkins, Supplemental Student Loan) can consolidate their loans into one repayment package with an interest rate that is the weighted average of the loans being consolidated, rounded up to the nearest whole percent. Repayment is extended up to 25 years depending on the aggregate amount borrowed. Lenders can offer a graduated or income-sensitive repayment option.

To apply:

New Students: Once new students apply for financial aid and receive an award letter, their loan eligibility is electronically transmitted to the New York State Higher Education Services Corporation (NYSHESC), which then mails a preprinted loan application, referred to as a Master Promissory Note (MPN). Students must complete the reference information, select a lender, sign and return the application to NYSHESC for final processing. The loan amount is deducted directly from the tuition bill. NYSHESC also deducts a 3 percent processing fee. All funds are sent directly to Polytechnic via electronic funds transfer from the lenders. Since this is a federal program, all lenders offer the same interest rates. For assistance in selecting a lender, contact the Office of Financial Aid.

Currently Enrolled Students: If students signed a MPN while attending Polytechnic they do not need to sign a new MPN every year. The MPN is valid for up to 10 years of continued borrowing. Once students apply for financial aid and receive an award letter, their loan eligibility is electronically transmitted to NYSHESC. The loan amount is deducted directly from the tuition bill. NYSHESC also deducts a 3 percent processing fee. All funds are sent directly to Polytechnic via electronic funds transfer

from the lenders.

When student borrowers graduate, withdraw from school or enroll in less than half-time study, they must see their lender and make formal arrangements for repayment, as well as attend a loan exit interview with the Office of Financial Aid. Borrowers must begin repaying the loan six months after graduating or withdrawing from school.

Students are required to repay the total amount borrowed and all interest on the declining balance in accordance with the following regulations:

1. The minimum monthly installment is \$50 plus interest. (The monthly installment is determined by the amount borrowed.)
2. The maximum repayment period for the entire loan is 10 years.
3. Repayment of part or of the entire loan may be made in advance at any time without penalty.
4. The maximum period of a loan, from the date of the original note, may not exceed 15 years on all loans guaranteed after November 3, 1965, except in cases of authorized deferment (not to exceed three years) while the student is a member of the Armed Forces or a volunteer under Title VIII of the Economic Opportunity Act of 1964.

The length of the payment period depends upon the date the promissory note matures as well as the total amount borrowed. Student borrowers are permitted to make payments of less than \$50 per month under unusual and extenuating circumstances. Request for such forbearance must be made to the lender.

Federal Unsubsidized Stafford Loan

The Federal Unsubsidized Stafford Loan is open to students who do not qualify for a Federal Subsidized Stafford Loan (listed above). The same terms, conditions, annual borrowing limits and interest rates apply. The only exception is that the borrower is responsible for interest that accrues while enrolled in school and during the six-month grace period. In addition, independent students may borrow an additional \$4,000 annually at the freshmen and sophomore levels, or \$5,000 annually at the junior, senior and fifth-year undergraduate levels. Loan applications are available at lending institutions or the Office of Financial Aid.

Parent Loan for Undergraduate Studies

Parents may borrow up to full tuition per

year for each financially dependent student. A Free Application for Federal Student Aid (FAFSA) is not required. However, the parent loan combination with other financial assistance cannot exceed the total cost of education. Repayment begins within 60 days from the date you receive the loan. The maximum repayment period is 10 years.

Polytechnic University-Sponsored Loan

Polytechnic sponsored loans are available to both incoming and continuing students based on financial need and the availability of funds. Students are considered for Poly loans when they apply for financial aid. Students are generally awarded from \$1,000 to \$2,000 per academic year. The current interest rate is 7 percent. Repayment begins three months after graduation or when the student withdraws from school.

Eligibility is primarily based on need; special circumstances can influence determination. Students must be U.S. citizens or permanent residents to apply and must be matriculated and enrolled at least half time (6 credit hours).

OTHER RESOURCES

Students should contact the Office of Financial Aid for information concerning financial aid programs available, the companies that sponsor them and the necessary application procedures.

POLYTECHNIC PAYMENT PLANS

The University currently offers three types of payment plans: monthly, deferred and third party.

Monthly Payment Plan

A monthly payment plan spreads out annual tuition charges over 10 months, beginning in July and ending in April. The monthly payment plan is interest-free, regardless of the balance amount, with a one-time enrollment fee accessed at the beginning of the plan. Monthly payment plans are also available on a semester basis.

Deferred Payment Plan

Students who submit written proof of eligibility for tuition reimbursement from their employers will be allowed to defer payment until the end of the semester. Eligibility is contingent upon the signing of a promissory note, with a one-time enrollment fee accessed at the beginning of each semester.

Third Party Payment

Students receiving sponsorship from government agencies, employers or other organizations must provide the University with proof of coverage and permission to bill a third party. Students are required to pay or make arrangement for payment of any uncovered portion of the bill. Sponsorships are arranged between the student and a third party; students are responsible for University debt if the third party does not make payment.

HOME EQUITY LOAN/HOME EQUITY LINE OF CREDIT

Many parents underestimate the resource value of the equity in their homes or apartments. Currently, numerous lenders offer loans or lines of credit that enable families to put this significant asset to work in financing a college education. Those wishing to pursue this option should contact a local lender.

OTHER OPPORTUNITIES

There are several scholarship programs, usually directed by local and civic organizations, that are not based on need. High school guidance offices and the Internet are the best sources of information. Also, parents' places of employment sometimes sponsor programs for employees' children. These employer benefits are often full- or half-time tuition and sometimes merit-/need-based.

IMPORTANT FINANCIAL AID POLICIES

- To be eligible for financial aid, students must enroll for at least 6 credits per semester. However, all TAP grants and Polytechnic scholarships and grants require students to enroll full-time to qualify.
- Financial aid applicants (including Stafford Loan applicants) must apply for a Pell Grant and, in the case of New York residents, for TAP. Polytechnic scholarships and grants, combined with Pell Grant and TAP awards, may not exceed tuition.
- Prospective students should not wait until they have been admitted to apply for financial aid. These are concurrent processes. Applicants should make every effort to apply for admissions and financial aid by the preferred application dates. Once students are admitted, they are reviewed for financial aid.

- Financial aid is renewable annually, based on the student's reapplying, continuing to demonstrate financial need where applicable and fulfilling of other requirements stipulated by the awards.
- Standards of achievement for scholarship maintenance are established each semester. Students who fall below the established criteria will be given one semester of grace to restore their GPA. If they are not successful, the scholarship will be revoked. It will be reinstated when the student is successful. Scholarships cannot be received retroactively.
- Since financial aid and scholarship funds administered by Polytechnic are limited, students should be aware that it is unwise to enroll at Polytechnic without financial aid support on the assumption that financial aid will be available at a later date. Given the fixed amount of resources, Polytechnic deems it unethical to withdraw support from students who have based attendance at Polytechnic on the financial aid awarded them in order to release funds to assist new applicants. Funds from financial aid programs not administered by Polytechnic, such as Pell Grants, TAP and the Stafford Loan Program, are available to eligible students whether or not they have already received funds from these programs.
- Grants of Title IV Aid (Pell Grants, Supplemental Educational Opportunity Grant, College Work Study, Perkins Loan and Stafford Loan) are contingent upon provision of the following six documents:
 1. Properly signed Financial Aid Acceptance Forms explaining the terms of the awards
 2. Financial aid transcripts from all previously attended institutions of higher education
 3. Copies of students' (or parents') IRS Form 1040 or 1040A/EZ, if requested
 4. Signed affidavits acknowledging Selective Service Registration
 5. Proof of permanent residency status
 6. Any other requested documents
- Students must assume responsibility for reading, understanding and abiding by the terms of all financial aid documents they sign; they should also keep copies of them.
- Students must know each financial aid program's limits on the amount of aid and number of years they can receive such assistance and must make appropriate plans to finance that part of their education that exceeds the limits.
- Students must report any outside financial aid received or any changes in their family situation so that the Office of Financial Aid can make proper adjustments in awards offered.
- Students must not default on a Perkins Loan or a Stafford Loan, nor can they owe a refund on a Pell Grant or a Supplemental Educational Opportunity Grant, if they wish to continue receiving financial aid.
- In order to continue receiving financial aid, students must maintain full-time, matriculated (degree) status and must complete a minimum number of quarter credit hours with a minimum GPA to be considered making satisfactory academic progress toward their degree, as illustrated in the "Academic Policies" section of this catalogue. Failure to make satisfactory academic progress may result in the loss of financial aid.
- Students who lost eligibility for financial aid may request reinstatement due to unusual or extraordinary circumstances. Students who wish to appeal must submit a written appeal to the Financial Aid Committee on Academic Progress within 20 days of notification. Students must give reasons for the appeal and provide documentation. If necessary, students will also be expected to appear in person to meet with a member of the committee.



INTERNATIONAL STUDENTS AND SCHOLARS

Graduate and undergraduate international students come from more than 47 countries and make up 25 percent of the student body. They are an integral part of the Polytechnic community. All new international students and visiting scholars (researchers and faculty) are required to report with immigration documents, including I-20's, DS-2019's, and passports, to the Office of International Students and Scholars (OISS) immediately upon arrival. In addition, all new students and scholars must attend a mandatory orientation held at the beginning of every semester.

The office provides information and counseling regarding immigration compliance, travel, employment, acculturation, housing, health insurance and special events. International students, researchers and faculty may contact the office in person or by telephone, and are encouraged to attend on-site workshops offered at designated times during the academic year. All international students, research scholars and faculty are required to carry health insurance.

For additional information regarding admissions and academic requirements, please consult those sections dealing with undergraduate and graduate admissions and academic policies and degree requirements.

STUDY ABROAD

Opportunity to study abroad offers students a chance to experience life in countries rich in history, culture and accomplishment. Immersion experience in another culture strengthens understanding of the world and appreciation of international contribution to knowledge. It offers an opportunity to learn how to cope in international environment and communicate across barriers of language, custom, geography and politics. Skills developed in the course of this experience will add another invaluable dimension to the quality of well-rounded education that will ultimately enhance professional and personal endeavors in this developing global community.

Students may apply for short-term, faculty-sponsored programs, a semester or an academic year of study abroad. Students may select from one of 50 institutions around the world with which Polytechnic has entered into direct exchange agreements.

Participation in the study abroad program is open to undergraduate students who completed one year of academic study and are maintaining a 2.5 GPA. While these are the minimum Poly requirements to participate in the program, please note that host institutions will be making their own determinations about admissibility.

Academic credits earned during study abroad are transferable to Polytechnic University and may be applied to degree requirements subject to university policies and the approval of the student's major department.

STAFF

Michael Gendel, Director

Sherly Thomas, Administrative Assistant

PROGRAMS AND SERVICES FOR FIRST-YEAR STUDENTS

ACADEMIC ADVISEMENT CENTER

The mission of the Academic Advisement Center is to provide academic advising to new matriculated first-year students in the following majors: biomolecular science, business and technology management, chemical and biological engineering, civil engineering, construction management, computer science, computer engineering, electrical engineering, mechanical engineering, and undeclared. The academic departments advise students in the following majors: integrated digital media, liberal studies, technical and professional communication, and mathematics. After the first year, these students who are assigned advisers in their respective major departments. The staff advises students on an array of topics including major requirements, university regulations, and life skills development. The Advisement Center refers students to appropriate campus resources for additional support and guidance in an effort to address any university-related issues affecting them. In addition, academic advisers advocate for first-year students with the offices of the registrar, financial aid, student accounts, and admissions, as well as other university offices.

NEW STUDENT ORIENTATION

Polytechnic seeks to ease the transition for new students into their new environment with a variety of programs designed to orient and welcome them every semester. These programs include an on-campus new student orientation program during the summer and in the fall and spring semesters. In addition, there is a course devoted to assisting first-year students during their first semester at Polytechnic called SL 1010 Freshman Seminar (see following section).

FRESHMAN SEMINAR (SL 1010)

The Freshman Seminar (SL 1010) is required for all entering first-year college students with fewer than six matriculated transfer credits. This zero-credit course counts toward the bachelor's degree requirements. SL1010 is an extended orientation to the academic and social challenges of higher education and a preparation for the critical choices and decisions college students must make.

SL 1010 introduces first-year students to Polytechnic University, provides campus resources information, opportunities for them to develop new skills and supports their efforts to achieve success in the college environment. New academic challenges and responsibilities; new people and situations;

and, new time demands and commitments are among the factors in the transition to college. The SL 1010 educational experience incorporates the richness of resources from both inside and outside the Polytechnic community. The seminar consists of a variety of guest lecturers, small group workshops, presentations and sessions reserved for small group discussion on topics of particular importance to college-aged students. This diversified experience sets the stage for all first-year students at Polytechnic to explore their learning style and study habits, assumptions about themselves and others, as well how they can get the most out of their Polytechnic education and beyond.

Topics covered in the course include:

- Study skills (note taking and test taking)
- Time management and goal setting
- University resources and support services
- Campus involvement and student activities
- Effective library research skills
- Career awareness and development
- Effective communication techniques
- Diversity and multiculturalism
- Sexual harassment
- Healthy lifestyles choices (eating, sleeping, stress management, safe sex/abstinence, and alcohol and drug abuse prevention)

REGISTRATION

Registration is the process of obtaining academic advisement and approval of courses from a faculty adviser, recording courses with the Office of the Registrar and paying tuition and fees to the Office of Student Accounts, according to published deadlines. To receive academic credit, registration is required each semester for every course, including theses, projects and guided studies. Class attendance without registration is not permitted.

ADVISEMENT FOR REGISTRATION

Polytechnic University encourages close faculty-student relationships. The faculty advising system is the basis for selection of courses and registration. Each academic department identifies faculty who will serve as student advisers. Before registration, students must meet with their adviser and receive approval for their anticipated program of study. A list of advisers and their office numbers may be obtained from each respective departmental office and is available from the Office of the Registrar prior to each registration.

Approval to register for a course does not necessarily constitute approval to use that course as a substitution for another course in order to satisfy a specific degree requirement. If the course is not normally used for that purpose, such approval should be explicitly requested from the adviser and must be formally granted on the form used for this purpose, the Request for Adjustment of Degree Requirements, and filed with the Office of the Registrar. For example, approval to register for a guided readings course is not necessarily approval to substitute that course for another, similar course prescribed in the curriculum.

Incoming freshmen are required to take Polytechnic placement exams in mathematics and English. These exams are free and used solely for advisement and course placement; they do not affect admission to Polytechnic.

REGISTERING FOR CLASSES

Polytechnic offers three registration periods for each semester and mini-session and two for the summer terms. In addition, new freshmen entering in the fall semester are registered during the summer preceding their admission.

Regular Registration: All continuing degree-seeking students (graduate and undergraduate) are expected to register for the next semester during the latter part of each ongoing semester. All students are required to take advantage of regular registration using PS Data, the student on-line registration system. Payment of tuition and fees, or arrangement for payment, is due to the Office of Student Accounts no later than the deadline date announced.

Late Registration: This usually takes place during the week preceding the start of classes. A late fee is assessed to all continuing students. New students and special students receive information from the Office of Undergraduate Admissions. Payment of tuition and fees is due on the day of registration.

Final Registration: The first five days of classes in a semester provide students with the final opportunity to complete registration. Students who do not complete registration by the end of the final registration period will not be registered for that semester, except by special permission of the dean of undergraduate academics or associate provost for graduate studies, registrar and the course instructor(s). Although permitted, final registration is not desirable as classes may be filled and early meetings of classes missed. A late fee is assessed to all continuing and readmitted students. Payment of tuition and fees is due on the day of final registration.

PROGRAM ADJUSTMENTS (ADD/DROP)

Additions or deletions to a student program or course schedule may be made during the first five class days of the fall and spring semesters or summer sessions. Written approval from the faculty adviser, on the Program Adjustment Form, is required for each course added or dropped.

RESIDENCE LIFE

A residence life program is an integral part of college life and can greatly enhance students' college experience. Resident students become members of a supportive peer community in an academic environment which offers the opportunity to more fully develop academically and socially. The residence life experience helps students develop personal responsibility as it supports them in meeting their academic goals. Polytechnic is committed to providing safe and affordable housing for students who are interested in a residence life experience.

Campus housing is available for all students. It is not appropriate for students seeking housing for their families. Inquiries about campus housing should be made to the Office of Residence Life at (718) 260-4160.

CAMPUS HOUSING FACILITY

Located on the Brooklyn campus, the Donald F. and Mildred Topp Othmer Residence Hall is a 20-story building, housing over 400 students in two-bedroom suites and two-bedroom apartments with kitchenettes. Each room has Internet and TV cable ports. This innovative building is wireless and includes student lounges, study rooms, laundry facilities, outdoor space and 24-hour security. The residence life staff, made up of a two full-time professional staff, graduate and undergraduate student resident assistants and security personnel.

CAMPUS HOUSING REQUIREMENTS

All students living in the Othmer Residence Hall are required to be full-time Polytechnic students and to be on the University meal plan.

STAFF

Rosa M. Rizzo, Director of Residence Life

Daniel Aniello, Assistant Director of Residence Life

Rona Tyson, Administrative Assistant

STATISTICS ON ENROLLMENT AND THE STUDENT BODY

ENROLLMENT 2006-2007

FALL 2006

	Undergraduate			Graduate			Total
	FT	PT	TOT	FT	PT	TOT	
Brooklyn	1403	77	1480	639	386	1025	2505
Long Island	—	—	—	17	117	134	134
Westchester	—	—	—	13	29	42	42
Broad Street	—	—	—	167	71	238	238
Total	1403	77	1480	836	603	1439	2919

STUDENT BODY

FALL 2006

	Undergraduate		Graduate	
	Men	Women	Men	Women
Brooklyn	1190	290	771	254
Long Island	—	—	115	19
Westchester	—	—	33	9
Broad Street	—	—	179	59
Total	1190	290	1098	341

STUDENT RETENTION

As required by the New York State Education Department Higher Education Data System, Polytechnic conducts a yearly cohort survival analysis. This study is designed to collect data for a group or cohort of first-time, full-time freshmen (students who never attended college before) who enter Polytechnic. The data measures retention patterns and indicates the amount of time needed to complete undergraduate degrees at Polytechnic. For a cohort study of first-time, full-time students who entered Polytechnic as freshmen in fall 2000, 29 percent received their Bachelor of Science degree within four years, 47 percent graduated in five years and 50 percent completed their degree within six years.

PERSISTENCE AND COMPLETION INFORMATION

First-time, full-time undergraduate students continuing at the University, 2003 2004 to 2004 2005

University-wide: 82.6% 76%

ENROLLMENT BY RACIAL/ETHNIC STATUS USING STANDARD FEDERAL CLASSIFICATIONS)

	Undergraduate Students	Graduate Students
Asian, Pacific Islander	31%	10.3%
Caucasian	29%	16.6%
Black, non-Hispanic	11%	4.4%
Hispanic	12%	1.6%
Native American	0%	0%
International*	10%	42.8%
Unknown	7%	24.3%

*International students come from more than 47 countries.

STUDENT DEVELOPMENT, STUDENT LEADERSHIP, STUDENT ACTIVITIES

DEPARTMENT OF STUDENT DEVELOPMENT

The Department of Student Development is concerned with the holistic education and development of all Polytechnic students, both inside and outside the classroom. Student development helps students put the various pieces of their educational, personal and professional development puzzle together from orientation to commencement. The department provides a variety of programs and services that enhance the first-year student transitional experience, develop student leadership excellence, promote campus community citizenship, foster campus-wide diversity awareness and provide general student advocacy. Some of the areas handled by this office include:

- New Student Programs
- Services for Students with Disabilities
- Student Activities and Leadership Development
- Student Advocacy
- Student Disciplinary Affairs

NEW STUDENT PROGRAMS

Polytechnic seeks to ease the transition for new students into their new environment with a variety of programs designed to orient and welcome them every semester. These programs include an on-campus new student orientation program during the summer and in the fall and spring semesters. In addition, there is a course devoted to assisting first-year students during their first semester at Polytechnic called SL 1010 Freshman Seminar (see following section).

New Student Orientation Business Days

Generally held in July, New Student Orientation Business Days provide an introduction to the Polytechnic University community offers opportunities for incoming first-year and transfer students to finalize various aspects of enrollment activities well before classes begin. The program is coordinated by a team of administrators, faculty and students to welcome new students to the Polytechnic community.

New Student Convocation

New Student Convocation the first major academic program new students experience as members of the Polytechnic community.

At convocation, new students are inducted into the Polytechnic academic community and pledge to abide by the University Code of Conduct, refrain from academic dishonesty, respect intellectual property, actively participate in their education and uphold the exemplary reputation of the Polytechnic alumni.

New Student Camp Experience (NSCE)

All new first-year and transfer students are invited to attend an overnight trip to a camp site in upstate New York. The New Student Camp Experience (NSCE) is offered during the week before classes begin and helps new students make friends, become comfortable with their new classmates and introduces them to some of the key administrators and student leaders who will be vital to their success at Polytechnic University. The NSCE is noted as one of the most memorable highlights of the Polytechnic experience.

Freshman Seminar (SL 1010)

The Freshman Seminar (SL 1010) is required for all entering first-year college students with fewer than six matriculated transfer credits. This zero-credit course counts toward the bachelor's degree requirements and is co-facilitated by upper-level students known as peer counselors. SL1010 is an extended orientation to the academic and social challenges of higher education and a preparation for the critical choices and decisions college students must make.

SL 1010 introduces first-year students to Polytechnic University, provides campus resources information, opportunities for them to develop new skills and supports their efforts to achieve success in the college environment. New academic challenges and responsibilities; new people and situations; and, new time demands and commitments are among the factors in the transition to college. The SL 1010 educational experience incorporates the richness of resources from both inside and outside the Polytechnic community. The seminar consists of a variety of guest lecturers, small group workshops, presentations and sessions reserved for small group discussion on topics of particular importance to college-aged students. This diversified experience sets the stage for all first-year students at

Polytechnic to explore their learning style and study habits, assumptions about themselves and others, as well how they can get the most out of their Polytechnic education and beyond.

Topics covered in the course include:

- Study skills (note taking and test taking)
- Time management and goal setting
- University resources and support services
- Campus involvement and student activities
- Effective library research skills
- Career awareness and development
- Effective communication techniques
- Diversity and multiculturalism
- Sexual harassment
- Healthy lifestyles choices (eating, sleeping, stress management, safe sex/abstinence, and alcohol and drug abuse prevention)

SERVICES FOR STUDENTS WITH DISABILITIES

Polytechnic University supports Section 504 of the Rehabilitation Act of 1973 and the Americans with Disabilities Act. In this regard, it makes every effort to provide full and barrier-free program accessibility. Likewise, the University does not discriminate in its admissions practices and bases acceptance decisions primarily on academic records.

Polytechnic is committed to assisting students with disabilities in developing the personal, as well as academic, skills necessary to fully participate in student programs. To that end, services are provided to students with disabilities based on their individual needs. The University is particularly interested in working with these students so they may become effective self-advocators.

Services for students with disabilities do not include the waiving of academic course requirements.

Students with disabilities are encouraged to register with student development whether or not services are requested. If appropriate, services can be requested by meeting with student development staff and submitting supporting documentation. Contact the Department of Student Development for more details.

STUDENT ACTIVITIES AND LEADERSHIP DEVELOPMENT

Student activities are an integral part of the educational process. Participation in student activities fosters the development of leadership and interpersonal skills. Polytechnic believes that involvement in student activities broadens the academic experience of students who participate. Therefore, every student is encouraged to actively participate in co- and extra-curricular student activities. These activities help promote and produce a balanced educational experience. In support of student activities, the University sets aside three hours a week, referred to as Club Hours, for student organizations to meet and conduct business: Mondays from 1pm - 2pm and Wednesdays from 12pm - 2pm.

Student Council

The student council is the undergraduate student voice and governing body at Polytechnic. The Student Council is the umbrella organization for all student clubs and organizations. It is responsible for administering student activities fees, social and cultural programming and other co- and extra-curricular activities.

Student Clubs & Organizations

There are more than 66 student organizations, honors societies and fraternities and sororities at Polytechnic. Each group is responsible for fulfilling the purposes of the organization as set forth in its constitution or charter. Student organization documents are filed with the Department of Student Development and the student council at the University. New groups and organizations can be created by complying with the appropriate procedures set by the student council. A list of student organizations is published by the student council and Department of Student Development at the beginning of each academic year.

Professional and technical societies are established in conjunction with the various academic departments to enhance the curricula at Polytechnic. These student chapters are branches of national parent organizations. In chapter meetings, members hear distinguished guest speakers, plan field trips, read professional papers and work on technical projects. As a part of the clubs and organization framework under the auspices of the student council, these chapters are funded, in part, by student activities fees.

There are student organizations at Polytechnic to suit almost every interest,

whether social, intellectual, religious, musical, cultural or athletic. Many of the organizations have a long and distinguished history.

Fraternities and Sororities

Polytechnic currently has four social and service fraternities and two social sororities. The fraternities and sororities hold an impressive array of social functions for their own members and provide service to the University community. They coordinate blood donation drives, annual charity drives, athletic tournaments, parties and more.

Orientation Leader Program

This program is comprised of upper-level, enthusiastic student volunteers who want to share their love of Poly with new students. Orientation leaders are selected during the spring semester and train in preparation of running new student orientation programs such as the New Student Orientation Business Days and the New Student Camp Experience.

Peer Counselor Team Program

The Peer Counselor Team is comprised of a group of upper-level students who assist first-year students in making the transition from high school to college. They also assist in facilitating the SL1010 Freshmen Seminar course. The program includes extensive leadership training during summer months with in-service training throughout the academic year. The Peer Counselor interview and selection process occurs early each spring semester for the following academic year.

STUDENT ADVOCACY

The Department of Student Development plays a vital role in supporting and encouraging students who are faced with challenging situations during their student careers. It is one of several places that students can go to for confidential help. As student advocates, the staff of the Department of Student Development work with various other offices to solve help student problems and assist students in developing self-advocacy skills.

Absence Notification to the Faculty

It is important for instructors to know when students are experiencing difficulty that might interfere with their studies. However, it is also important that student personal matters be kept confidential. Therefore, student development is the office designated to receive documentation regarding private matters. Documentation is

required for an official verification notice to be sent to instructors. The notice informs the instructor that appropriate documentation has been received but does not share personal details. Notification can be provided for the following matters: death in the family, medical conditions and illnesses, other emergencies and situations, and representing the University at conferences.

STUDENT GRIEVANCES AND COMPLAINTS

Student Development is one of the offices where student grievances and complaints are heard and action is taken on behalf of students.

STUDENT MISCONDUCT AND ACADEMIC DISHONESTY

Incidents of student misconduct and academic dishonesty are reported to student development for review and appropriate action according to the University Code of Conduct and other University policies.

The University Code of Conduct, edited and administered by the Department of Student Development, gives notice to the Polytechnic community of prohibited behavior and outlines the procedures to be followed in the event of a breach of this code. This code is dedicated to the protection and promotion of the academic enterprise and is indispensable in maintaining an academic environment appropriate to teaching, learning and the development of individuals.

The University Code of Conduct is available to students and all members of the Polytechnic community at www.poly.edu/_doc/PolytechnicCodeofConduct2005.pdf. For further information, contact the Department of Student Development at (718) 260-3800 or visit Room 158 in the Jacobs Building.

OTHER PROGRAMS

The Department of Student Development also coordinates or assists other programs such as health fairs, graduation fairs, Dean's List Ceremonies, the annual Poly Pride Day celebration, Commencement & Achievement Awards, and Commencement.

STAFF

Cheryl A. McNear, Director of Student Development

Robert Demetrius Griffin, Coordinator for Student Programs and Services

Bonnie Harper, Administrative Assistant

TUITION AND FEES

Up-to-date and detailed information on tuition and fees as well as announcements of cost changes can be obtained from the Office of Student Financial Services before the start of each semester and on the office's website, <http://www.poly.edu/studentaccounts/tuition/index.php>. Tuition rates are set by the Polytechnic Board of Trustees. Due primarily to economic conditions and inflationary costs, the University reserves the right to change tuition charges and fees when it is deemed necessary. The University is mindful of the economic challenges of attending a first-rate private school such as Polytechnic; accordingly, the University will continue to make every effort to keep cost increases to the lowest possible level consistent with maintaining educational quality.

Undergraduate Tuition:

Full-time (12-20 credits*)	
per semester	\$14,947
Credits in excess of 20 credits,	
per credit	\$951
Part-time (less than 20 credits),	
per credit	\$951
Remedial courses	\$3,806

**All credits in excess of 20 are charged at the per credit rate.*

Undergraduate University Fee:

Full-time (12 credits or more)	
per semester	\$539
Part-time (6-11 credits)	
per semester	\$341
Part-time (less than 6 credits)	
per semester	\$197

Graduate Tuition:

per credit	\$1,027
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Graduate University Fee:

Full-time (9 credits or more)	
per semester	\$528
Part-time (6 credits), per semester	\$352
Part-time (3 credits), per semester	\$186

Housing:

Dorm Deposit	\$300
Suite, per semester	\$3,250
Suite-Meal, per semester	\$1,000
Apartment, per semester	\$4,500
Apartment-Meal, per semester	\$750

Other Fees:

Alumni Audit Fee, per course	\$600
Graduate Application Fee:	
Hardcopy	\$50
Online	\$50
Undergraduate Application Fee	\$50
Credit by Examination Fee,	
per credit (undergraduate only)	\$80
Diploma Replacement Fee	\$50
Doctoral Dissertation Microfilm Fee	\$75

Monthly Late Payment Fee:

Balances under \$5,000	\$50
Balances of \$5,000 or more	\$100

Late Registration Fee \$150
Charged to all students who register on or after the first day of classes.

Maintenance of Studies \$186
No other fees apply

Undergraduate Orientation Fee, one-time fee \$100

Technology Fee \$500
Applies to all undergraduates admitted to the University prior to fall 2003 who are required to lease a laptop computer.

TMS Enrollment Fee	\$85
Tuition Deferment Fee	\$150
Tuition Deposit	\$300
Tuition Deposit - HEOP Students	\$200

PAYMENT OF TUITION AND FEES

Each semester, tuition and fee payments are due in full from all students at the time of registration. The University reserves the right to de-register students from classes and deny access to campus buildings if payment or payment arrangements are not made at the time of registration. Payment in full refers to various methods, used alone or in combination, including cash, check, money order or credit card (MasterCard, American Express and Discover only), financial aid, grants and loans or tuition arrangements authorized by the Office of Student Financial Services. Evidence of financial aid must be presented to the Office of Student Financial Services in order to use the anticipated aid to satisfy tuition costs.

Tuition must be paid in full, including disbursement of loans and all other aid, in

order to receive permission to register for the next semester. Students participating in a payment plan or the graduate deferment plan must pay in full according to the rules of the plan. The University reserves the right to withhold transcripts, diplomas and other services, including registration and participation in graduation activities, from students whose financial obligations have not been fully met.

Tuition Management Systems (Budget Plan)

The University provides monthly, by semester and yearly payment options. The monthly tuition payment plan is available through Tuition Management Systems, an independent agency. Specific information about these plans is outlined below and in the "Financial Aid" section of this catalogue.

Semester Payment Plan

Tuition bills are sent on a semester basis. After deducting all forms of scholarships, grants and loans for the semester, students must pay the remaining tuition balance in full at the beginning of each term. Students who use semester payment plan do not incur finance charges.

Monthly Payment Plan

A monthly payment plan spreads out annual tuition charges over 10 months, beginning in July and ending in April. The monthly payment plan is interest-free, regardless of the balance amount, with a one-time enrollment fee assessed at the beginning of the plan on an annual basis. Monthly payment plans are also available on a semester basis. The enrollment fee is the same as for the annual plan.

Deferred Payment Plan

Students who submit written proof of eligibility for tuition reimbursement from their employers will be allowed to defer payment until the end of the semester. Eligibility is contingent upon the signing of a promissory note, with a deferment fee assessed at the beginning of each semester.

Third Party Payment

Students receiving sponsorship from government agencies, employers or other organizations must provide the University

with proof of coverage and permission to bill a third party. Students are required to pay or make arrangement for payment of any uncovered portion of the bill. Sponsorships are arranged between the student and a third party; students are responsible for University debt if the third party does not make payment. Third parties are billed at the beginning of the semester, and payment is due upon receipt of the bill.

DROP/WITHDRAWAL POLICY

TUITION LIABILITY

Upon selecting and reserving courses, you become responsible for all tuition and fees associated with that registration. You must officially drop or withdraw from classes in order to remove or reduce tuition liability. Your liability will not automatically be voided for non-attendance or non-payment.

REFUND/TUITION LIABILITY

This section pertains to all students, regardless of the method of payment or the manner of covering tuition costs. Once registered, students must officially drop or withdraw from classes in order to be eligible for any applicable tuition refund or to avoid responsibility for payment of charges already assessed. The University Fee is **NON-REFUNDABLE AFTER THE START OF THE SEMESTER**. This applies regardless of whether or not classes have been attended. Recipients of financial aid who incur a tuition liability after registration due to a reduction in the aid or to withdrawal from class will be personally responsible for payment to the University.

REFUND SCHEDULE

The refund schedule applies only during the first four weeks of the semester. It is based on calendar dates, not on the number of class sessions held or attended. The official withdrawal date is the date the withdrawal form (available in the registrar's office) is received in the Office of the Registrar, not the last date of class attendance.

Whenever a student drops or withdraws from a course or from all courses, tuition charges are adjusted according to the Refund/Tuition Liability Schedule that appears on this page, provided that (1) the withdrawal notice is filed within the refund period, (2) it is submitted in writing to the Office of the Registrar and (3) the withdrawal lowers the student's program to less than 12 credits.

IMPACT OF WITHDRAWAL ON FINANCIAL AID

In summer 2000, Polytechnic University adopted a new Federal Refund Policy to comply with federal regulations (Section 668.22) of Higher Education Amendments of 1998. In accordance with federal regulations, students who withdraw from the University and have Federal Title IV financial assistance (Federal Stafford Loan, Federal Parent Loan for Undergraduate Students, Federal SEOG, Federal Perkins Loan or Federal Pell Grant) that has been credited to their tuition account will be subject to the Federal Refund Policy regarding the possible return of Title IV funds awarded. In addition, the amount of refundable institutional charges will be determined based upon the University's policy. The amount of the semester's Federal Title IV aid that is not earned must be returned to its source. The amounts to be returned to the federal programs will vary based upon type of program, the total amount to be returned, and the government's determination of the order in which aid is returned to the various programs. If there is a student account balance, resulting from these adjustments, the student is responsible for payment.

When returning Federal Title IV aid, federally mandated priority listing will be used:

1. Federal Unsubsidized Stafford Student Loan Program
2. Federal Subsidized Stafford Student Loan Program
3. Perkins Loan
4. Federal Parent Loan for Undergraduate Student (PLUS)
5. Federal Pell Grant
6. Supplemental Educational Opportunity Grant (SEOG)
7. ACG
8. SMART

The calculation for impact of withdrawal on financial aid is the same for all students. The determination of tuition refund is based on length of attendance.

Drop/Withdraw: Prior to and including the first seven (7) days of the semester – 0% Liability

Drop/Withdraw: 1st Week – 10% Liability

Drop/Withdraw: 2nd Week – 25% Liability

Drop/Withdraw: 3rd Week – 50% Liability

Drop/Withdraw: 4th Week – 75% Liability

Drop/Withdraw: 5th Week and beyond – 100% Liability

Refund Appeals

Appeals for an exception to the refund schedule must be submitted in writing to the Office of Student Accounts, along with documentation supporting the request. Students are expected to be aware of the University refund policy and withdrawal procedures; lack of knowledge is not sufficient reason for making or granting an appeal.

UNIVERSITY COMPLIANCE POLICIES AND OTHER GUIDELINES

UNIVERSITY CODE OF CONDUCT

The University Code of Conduct, edited and administered by the Department of Student Development, gives notice to the Polytechnic community of prohibited behavior and outlines the procedures to be followed in the event of a breach of this code. This code is dedicated to the protection and promotion of the academic enterprise and is indispensable in maintaining an academic environment appropriate to teaching, learning and the development of individuals.

The University Code of Conduct is available to students and all members of the Polytechnic community at www.poly.edu/_doc/PolytechnicCodeofConduct2005.pdf. For further information, contact the Department of Student Development at (718) 260-3800 or visit Room 158 in the Jacobs Building.

UNIVERSITY ANTI-HARASSMENT POLICY FOR EMPLOYEES AND STUDENTS

Polytechnic University is committed to a work and learning environment in which all individuals are treated with respect and dignity. Each individual has the right to work and learn in a professional atmosphere that promotes equal employment and academic opportunities and prohibits discriminatory practices, including harassment. Therefore, Polytechnic University expects that all relationships among persons at the University (in the workplace and in the classroom) will be business-like and free of bias, prejudice and harassment.

Definitions of Harassment

a. Sexual harassment constitutes discrimination and is illegal under federal, state and local laws. For the purposes of this policy, sexual harassment is defined, as in the Equal Employment Opportunity Commission Guidelines, as unwelcome sexual advances, requests for sexual favors and other verbal or physical conduct of a sexual nature when, for example: (i) submission to such conduct is made either explicitly or implicitly a term or condition of an individual's employment or academic experience; (ii) submission to or rejection of such conduct by an individual

is used as the basis for academic or employment decisions affecting such individual; or (iii) such conduct has the purpose or effect of unreasonably interfering with an individual's academic or work performance or creating an intimidating, hostile or offensive working or learning environment.

Sexual harassment may include a range of subtle and not so subtle behaviors and may involve individuals of the same or different gender. Depending on the circumstances, these behaviors may include, but are not limited to: unwanted sexual advances or requests for sexual favors; sexual jokes and innuendo; verbal abuse of a sexual nature; commentary about an individual's body, sexual prowess or sexual deficiencies; leering, catcalls or touching; insulting or obscene comments or gestures; display or circulation in the workplace, or anywhere within the confines of the University, of sexually suggestive objects or pictures (including through e-mail); and other physical verbal or visual conduct of a sexual nature. Sex-based harassment — that is, harassment not involving sexual activity or language (e.g., male manager yells only at female employees and not males) — may also constitute discrimination if it is severe or pervasive and directed at employees (or students) because of their sex.

- b. Harassment on the basis of any other protected characteristic is also strictly prohibited. Under this policy, harassment is verbal or physical conduct that denigrates or shows hostility or aversion toward an individual because of his/her race, color, religion, national origin, age, disability, alienage or citizenship status, marital status, creed, genetic predisposition or carrier status, sexual orientation or any other characteristic protected by law or that of his/her relatives, friends, or associates, and that:
- (i) has the purpose or effect of creating an intimidating, hostile or offensive work or learning environment;
 - (ii) has the purpose or effect of unreasonably interfering with an individual's academic or work performance; or
 - (iii) otherwise adversely affects an individual's academic or employment opportunities.

vidual's academic or employment opportunities.

Harassing conduct includes, but is not limited to: epithets, slurs or negative stereotyping; threatening, intimidating or hostile acts; denigrating jokes and display or circulation in the workplace, or anywhere within the confines of the University, of written or graphic material that denigrates or shows hostility or aversion toward an individual or group (including through e-mail).

Individuals and Conduct Covered

These policies apply to all applicants, employees and students, and prohibit harassment, discrimination and retaliation whether engaged in by a faculty member, staff member or student, by a supervisor or manager, or by someone not directly connected to Polytechnic University (e.g., an outside vendor or consultant).

Conduct prohibited by these policies is unacceptable in the workplace, in the classroom, and in any work-related setting outside the workplace, such as during University trips, meetings, and social events.

Retaliation Is Prohibited

Polytechnic University prohibits retaliation against any individual who reports discrimination or harassment or participates in an investigation of such reports. Retaliation against an individual for reporting harassment or discrimination or for participating in an investigation of a claim of harassment or discrimination is a serious violation of this policy and, like harassment or discrimination itself, will be subject to disciplinary action.

Reporting an Incident of Harassment, Discrimination or Retaliation

Polytechnic University strongly urges the reporting of all incidents of discrimination, harassment or retaliation, regardless of the offender's identity or position. Individuals (including, but not limited to, students, faculty and staff) who believe they have experienced conduct that they believe is contrary to Polytechnic's policy or who have concerns about such matters should file their complaints with their immediate supervisor, a member of the Department of Human Resources (x3840) or the associate dean of student affairs (cmcnear@poly.edu)

and x3800). Individuals should not feel obligated to file their complaints with their immediate supervisor first before bringing the matter to the attention of one of the other Polytechnic-designated representatives identified above.

Early reporting and intervention have proven to be the most effective method of resolving actual or perceived incidents of harassment. Therefore, while no fixed reporting period has been established, Polytechnic strongly urges the prompt reporting of complaints or concerns so that rapid and constructive action can be taken. Polytechnic will make every effort to stop alleged harassment before it becomes severe or pervasive, but can only do so with the cooperation of its staff/employees and students.

The line between acceptable social conduct and harassment is not always clear. For that reason, Polytechnic encourages individuals who feel they are being or may have been harassed to communicate politely, clearly and firmly to the offending party that the conduct is unwelcome, offensive, intimidating or embarrassing; to explain how the offensive behavior affects the employee's work; and to ask that the conduct stop. If the individual is uncomfortable with making a direct approach to the offending party or has done so, but the perceived harassment has not stopped, the individual may use this complaint procedure to address and resolve the problem.

The Investigation

Any reported allegations of harassment, discrimination or retaliation will be investigated promptly, thoroughly and impartially. The investigation may include individual interviews with the parties involved and, where necessary, with individuals who may have observed the alleged conduct or may have other relevant knowledge. Confidentiality will be maintained throughout the investigatory process to the extent consistent with adequate investigation and appropriate corrective action.

Responsive Action

Misconduct constituting harassment, discrimination or retaliation will be dealt with promptly and appropriately. Responsive action may include, for example, training, referral to counseling, monitoring of the offender and/or disciplinary action such as warning, reprimand, expulsion or suspension from the University, withholding of a promotion or pay increase, reduction of wages, demotion, reassignment, temporary

suspension without pay or termination of employment, as Polytechnic believes appropriate (and subject to any applicable collective bargaining agreement or other contract) under the circumstances.

Individuals who have questions or concerns about these policies should talk with the affirmative action officer, the assistant director of human resources or the associate dean of student affairs.

Finally, these policies should not, and may not be used as a basis for excluding or separating individuals of a particular gender, or any other protected characteristic, from participating in business, student, or work-related social activities or discussions in order to avoid allegations of harassment. The law and the policies of Polytechnic University prohibit disparate treatment on the basis of sex or any other protected characteristic, with regard to the terms, conditions, privileges and prerequisites of employment and of being a student at the University.

FAMILY EDUCATIONAL RIGHTS AND PRIVACY ACT (FERPA)

The Family Educational Rights and Privacy Act (FERPA) (20 U.S.C. § 1232g; 34 CFR Part 99) is a federal law that protects the privacy of student education records. The law applies to all schools that receive funds under an applicable program of the U.S. Department of Education.

The following explains the procedures used by Polytechnic University for compliance with the Family Educational Rights and Privacy Act (FERPA), also known as the Buckley Amendment. Under FERPA, students at Polytechnic are afforded certain rights with respect to their education records. A student is defined as any individual who is or has been in attendance at Polytechnic and regarding whom Polytechnic maintains education records.

These rights include:

- The right to inspect and review the student's education records within 45 days of the day the University receives a written request for access. Students should submit the request to the Office of the Registrar that identifies the record they wish to inspect. The University official will make arrangements for access and notify the student of the time and place where the records may be inspected. If the records are not maintained by the University official to whom the request was submitted, that official shall advise the student of the

correct official to whom the request should be addressed. The University has the right to prohibit students from reviewing and inspecting education records that include the financial records of their parents, as well as those records consisting of confidential letters and statements of recommendation regarding their admission to the University, their application for employment or their receipt of an honor or honorary recognition.

- The right to request the amendment of education records that the student believes is inaccurate, misleading or in violation of his/her right to privacy. Students may ask the University to amend a record that they believe is inaccurate. They should write the University official responsible for the record, clearly identify the part of the record they want changed and specify why it is inaccurate. If the University is in agreement with the student's request to amend his/her record, the record in question will be amended accordingly and the student will be informed of the amendment in writing. If the University decides not to amend the record as requested by the student, the University will notify the student of the decision and advise the student of his/her right to a hearing regarding the request for amendment. Additional information regarding the hearing procedures will be provided to the student when notified of the right to a hearing.
- The right to consent to disclosures of personally identifiable information contained in the student's education records, except to the extent that FERPA authorizes the University to disclose without the student's consent. Consent to disclosures of personally identifiable information must be done by the students in a written request to the Office of the Registrar. The right to file a complaint with the U.S. Department of Education concerning alleged failures by the University to comply with the requirements of FERPA.

Release of Information

Polytechnic must have written permission from the student in order to release any personally identifiable information from his/her education records. In addition, the University may disclose personally identifiable information, without consent, to the following parties or under the following conditions (34 CFR § 99.31):

- School officials with legitimate educational interest in such information in order to fulfill their professional responsibility. (A school official is a person employed by the University in an administrative, supervisory, academic or research, or support staff position [including law enforcement unit personnel and health staff]; a person or company with whom the University has contracted [such as an attorney, auditor or collection agent]; a person serving on the Board of Trustees; or a student serving on an official committee, such as a disciplinary or grievance committee, or assisting another school official in performing his or her tasks.)
- Other schools to which a student seeks enrollment.
- Where disclosure is to certain federal, state and local authorities.
- Where disclosure is in connection with financial aid for which the student has applied or received.
- Where disclosure is in connection with studies being conducted for or on behalf of the University.
- Where disclosure is made to accrediting organizations.
- To comply with a judicial order or lawfully issued subpoena.
- Appropriate officials in cases of health and safety emergencies.
- Information designated as “directory information.”
- Where the information disclosed is the final results of a disciplinary hearing, and the disclosure is made to an alleged victim of a crime of violence or non-forcible sex offense.
- To parents or legal guardians regarding a violation of any federal, state, local law or University policy governing the use or possession of alcohol or a controlled substance if a student is under the age of 21 and if the University determines that the student has committed such violation.

FERPA permits the release of directory information to third parties outside Polytechnic without prior written consent, provided that students have been given the opportunity to withhold such disclosure. Polytechnic reserves the right to disclose the following directory information related to a student without consent:

- Student’s name
- Class year
- Major field of study, as well as similar information (e.g., title of master’s or doctoral dissertation, distinguished academic performance)
- Participation in recognized activities and sports
- Dates of attendance at Polytechnic
- Degrees, honors and awards
- Most recent previous educational institution attended

All requests for information must be supported by identifying and/or authenticating documents.

Polytechnic must inform students about directory information and allow them a reasonable amount of time to request that the University not disclose directory information to requesting parties.

Polytechnic must notify students annually of their rights under FERPA. The actual means of notification (such as, but not limited to, special letter, student handbook or newspaper article) is left to the discretion of Polytechnic.

Students can request that Polytechnic not disclose directory information about them through the Office of the Registrar.

STUDENT IDENTIFICATION

All students are required to carry and maintain at all times photo-identification cards issued by the Office of Facilities Management. ID cards must be presented and/or surrendered to any official of the University upon request.

A student ID number is used by the University to identify a student’s records (grades, accounts, etc.) from the time of the admission application process through the completion of his or her degree. This number is computer generated and used solely by Polytechnic.

STUDENTS WITH DISABILITIES

Polytechnic University supports Section 504 of the Rehabilitation Act of 1973 and the Americans with Disabilities Act. In this regard, it makes every effort to provide full and barrier-free program accessibility. Likewise, the University does not discriminate in its admissions practices and bases acceptance decisions primarily on academic records.

Polytechnic is committed to assisting students with disabilities in developing the personal, as well as academic, skills neces-

sary to fully participate in student programs. To that end, services are provided to students with disabilities based on their individual needs. The University is particularly interested in working with these students so they may become effective self-advocators.

Services for students with disabilities do not include the waiving of academic course requirements.

Although not every student with a disability requires services, registering with the Office of Student Development is advised.

ALCOHOL AND DRUGS

In compliance with New York State law, Polytechnic prohibits the unlawful possession, manufacture, use or distribution of illicit drugs and alcohol on its property or as part of any of its activities, unless otherwise noted. Violations of this policy will result in disciplinary actions pursuant to the University Code of Conduct. Furthermore, Polytechnic will not protect those who violate these laws, nor will it interfere with law enforcement agencies that may pursue violators of these laws.

All student organizations or groups wishing to hold events where alcohol is served must obtain permission from the Director of Student Development or designee, who will be solely responsible for making that decision and applying conditions and obligations to that permission.

GUIDELINES ON STUDENT RELIGIOUS OBSERVANCES

The faculty of the University has adopted the following guidelines on student religious observances, as recommended by the Commission on Independent Colleges and Universities. The intent of these guidelines is to encourage independent colleges and universities to reasonably accommodate individual students’ religious obligations and practices without penalty.

- Students will not be expelled or refused admission to the University because they are unable to participate in any examination, study or work requirement due to their religious obligations and practices.
- Students who are absent from school because of their religious obligations and practices will be given an equivalent opportunity to make up any examination, study or work requirement that was missed because of such absence on any particular day or days.

- Students must notify their instructors and The Office of Student Development in writing, no later than the fifteenth day after the first day of the semester, that they will be absent from a class scheduled on a day that conflicts with their religious obligations and practices.
- In effecting these provisions, the University's administration and faculty agree to exercise the fullest measure of good faith and agree that no adverse or prejudicial effects will happen to students who follow these guidelines on religious observances.

IMMUNIZATION

New York State law requires students to show proof of immunity to measles, mumps and rubella. Polytechnic complies fully with the provisions of this law. The law applies to all students (graduate and undergraduate) born on or after January 1, 1957.

Immunization status is checked as part of the registration process. Students who are not in compliance with the law (1) are barred from attending class (and are not entitled to any tuition refund); (2) do not receive grades; and (3) are denied further registration.

For forms or information on this requirement, or to submit the required proof, please contact the Office of Residence Life or the Office of Undergraduate Admissions.

HEALTH AND ACCIDENT INSURANCE

At Polytechnic, we are concerned about your health and protection against the high cost of medical care. Many students and their parents are just not prepared to meet the added expense associated with an unexpected injury or sickness. To ensure that all of our students are covered, the University requires that all students with 9 or more credits or those that are considered full-time students carry appropriate health insurance. If you do not have your own coverage, the University has set up a plan that will provide the necessary health insurance.

Our part-time students will also have the ability to enroll in accident and sickness coverage. If you are a part-time student, to insure that you are covered at the beginning of the semester, you must complete the online enrollment information and mail your confirmation statement with a check to Special Risk Consultants (SRC). SRC is our insurance broker and they will process your enrollment, and send you your insurance card.

Even if you have a private plan, you might want to consider supplementing that plan, as many policies exclude or limit coverage. However, if you are a domestic student and have comparable coverage you may elect to WAIVE the University-provided insurance plan by the designated deadlines. To do so you will need to provide us with information on your current coverage so that we can ensure that it is comparable and provides local care in all situations, not just emergencies. All international students are required to be enrolled in the University-sponsored plan as part of your enrollment at Polytechnic. You must complete the enrollment by the designated deadlines.

In addition, all full-time students (graduate and undergraduate) are covered by accident insurance.

PART 2

ACADEMIC DEPARTMENTS



OTHMER–JACOBS DEPARTMENT OF CHEMICAL AND BIOLOGICAL ENGINEERING

Head: Jovan Mijovic

Founded in 1905 as the Department of Chemical Engineering, our department has a long-standing tradition of excellence and innovation in teaching and research. Chemical engineering has traditionally focused on the chemical and physical transformation of raw materials into valuable and useful products. In recent years it has evolved to also encompass biological processes and biological systems ranging from enhanced drug delivery to the production of bulk chemicals from renewable bio-resources.

Chemical and biological engineers will be essential in meeting the challenges of the 21st century. In addition to their traditional roles in chemical processing, they will play important roles in emerging and new technologies including the development and production of alternative energy and alternative fuels, the production of commodity and specialty chemicals from renewable, biological sources and the development of new health-care systems and materials.

Chemical and biological engineering education at Polytechnic is focused on basic principles rather than specialization in the firm belief that this allows for the broadest range of opportunities. Graduates find employment in the petrochemical industry, food processing, bulk and fine chemical production and in the pharmaceutical industry. Still others find our broad and versatile education to be an excellent background for employment in the financial and banking industries and in patent law – there are almost no limits to the career paths and possibilities.

The department faculty members are leading educators and researchers in their fields. Research in our department spans a wide range of topics, from the dynamics of macromolecules to drug delivery and protein design and engineering, and is supported by both government and industrial grants. In order to meet the needs of industry, the department offers evening graduate courses and part-time study opportunities.

MISSION STATEMENT

The mission of the Othmer–Jacobs Department of Chemical and Biological Engineering is to develop graduates capable of contributing to the advancement of chemical and biological engineering. The department strives to be at the forefront in selected areas of research and its rigorous educational programs are designed to produce graduates who are well-grounded in the fundamentals of their chosen discipline, skilled in state-of-the-art techniques and able to understand the importance of new developments in their discipline in a global and societal context.

DEGREES OFFERED

Bachelor of Science

- Chemical and Biological Engineering

Master of Science

- Chemical Engineering

Doctor of Philosophy

- Chemical Engineering

CONTACT INFORMATION

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Six MetroTech Center
Brooklyn, NY 11201
Tel: (718) 260-3470
Fax: (718) 260-3125
E-mail: jmijovic@poly.edu
Web: cbe.poly.edu

UNDERGRADUATE PROGRAM

The undergraduate program in chemical and biological engineering provides a sound foundation in science and engineering. This foundation includes thorough instruction in physics, chemistry, biology and mathematics, which are essential to the understanding of physical, chemical and biological processes and operations. Built upon this foundation is a strong and integrated set of courses in chemical and biological engineering including engineering thermodynamics, reaction kinetics process dynamics and transport processes.

The undergraduate program leads to a Bachelor of Science in Chemical and Biological Engineering and is accredited by the Accreditation Board of Engineering and Technology (ABET). The undergraduate curriculum provides a background that enables graduates to select professional careers from an extremely broad spectrum of opportunities or to enroll in graduate or medical schools for advanced study.

GRADUATE PROGRAMS

The department offers programs leading to the MS and PhD in Chemical Engineering. Strong emphasis is placed on the processing and properties of synthetic and biological polymers, optimization of chemical and biological processes, alternative energy resources, and a variety of topics that combine engineering with biology and medical sciences, such as targeted drug delivery and metabolic engineering.

FACULTY**PROFESSORS**

Jovan Mijovic, Professor of Chemical Engineering and Department Head
PhD, University of Wisconsin at Madison

Relaxation dynamics in synthetic and biological complex systems, modeling of processing of polymers, in-situ monitoring of reactive processes, structural relaxation in the glassy state

ASSOCIATE PROFESSORS

Edward N. Ziegler, Associate Professor of Chemical Engineering

PhD, Northwestern University

Kinetics and reactor design, air pollution control, fluidization

Walter Zurawsky, Associate Professor of Chemical Engineering

PhD, University of Illinois

Plasma polymerization, mass transfer in membranes

ASSISTANT PROFESSORS

Jin Ryoum Kim, Joseph J. and Violet J. Jacobs Assistant Professor of Chemical Engineering

PhD, University of Wisconsin at Madison

Protein engineering, structure and properties of proteins

Rastislav Levicky, Donald F. Othmer Assistant Professor of Chemical Engineering

PhD, University of Minnesota

Biological polyelectrolytes, biosensors and bio-diagnostics

Stavroula Sofou, Assistant Professor of Chemical Engineering

PhD, Columbia University

Engineering principles of drug delivery for cancer cure

RESEARCH FACULTY

Leonard Stiel, Research Professor of Chemical Engineering

PhD, Northwestern University

FACULTY EMERITI

Robert C. Ackerman, Professor Emeritus of Chemical Engineering

PhD, Harvard University

Robert F. Benenati, Professor Emeritus of Chemical Engineering

PhD, Polytechnic University

William H. Kapfer, Professor Emeritus of Chemical Engineering

EngScD, New York University

AFFILIATED FACULTY

Stephen Arnold, University Professor and Thomas Potts Professor of Physics

PhD, City University of New York

Microparticle photophysics, optics

Bruce A. Garetz, Professor of Physical Chemistry

PhD, Massachusetts Institute of Technology

Laser spectroscopy, laser light scattering, non-linear optics, laser-induced nucleation and multiphoton processes

DEPARTMENT OF CHEMICAL AND BIOLOGICAL SCIENCES

Head: Bruce Garetz

The Department of Chemical and Biological Sciences was created in 2005, replacing the Department of Chemical and Biological Sciences and Engineering. The creation of the new department was motivated by the emergence of biology as the enabling science for the 21st century. To face the demands and challenges in modern industry, the department offers educational and research programs that focus on novel molecules and advanced materials properties. The undergraduate program in biomolecular science prepares students to enter the workforce in an array of fields that include tissue, genetic and metabolic engineering, drug delivery for cancer and AIDS cure, DNA on a chip, biological weapons and sensors, pharmaceuticals and cosmetics, biomaterials and biocatalysis, petroleum engineering, alternative energy sources, microelectronics and so on. Our graduate programs focus on advanced research in those areas. Job growth rates in these fields are the highest in the technical professions. The department's faculty comprises leading educators and active researchers in their fields. Research activities are supported by both government and industrial cooperation. To meet the needs of industry, the department offers evening courses, part-time study opportunities, on-site research in the industrial workplace and the possibility of classes via Internet as attractive options.

MISSION STATEMENT

The mission of the Department of Chemical and Biological Sciences is to develop graduates capable of contributing to the advancement of chemical and biological sciences. The department strives to be at the forefront in selected areas of research and its rigorous educational programs are designed to produce graduates who are well grounded in the fundamentals of their chosen discipline, skilled in state-of-the-art techniques and able to understand the importance of new developments in their discipline in a global and societal context.

DEGREES OFFERED

Bachelor of Science

- Biomolecular Science

Master of Science

- Biomedical Engineering
- Biotechnology
- Biotechnology and Entrepreneurship
- Chemistry

Doctor of Philosophy

- Materials Chemistry

Graduate Certificates

- Bioinstrumentation
- Biomedical Materials

CONTACT INFORMATION

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UNDERGRADUATE PROGRAMS

The BS in Biomolecular Science provides a modern exposure to both chemical and biological sciences. Students select their curriculum to prepare them for careers in medicine, dentistry, osteopathy, veterinary medicine, podiatry, optometry or biotechnology.

GRADUATE PROGRAMS

The MS in Chemistry and the PhD in Materials Chemistry are designed to provide students with a broad competence in the chemical sciences. The MS in Biomedical Engineering, the MS in Biotechnology and the MS in Biotechnology and Entrepreneurship offer students training in technologies at the interface between chemistry and biology. In addition to offering fundamental courses, the department offers a series of advanced specialized courses that focus on new materials and techniques. Students can focus on the synthesis of novel molecules, polymers and biomaterials, the characterization of these materials or the evaluation of the performance of products developed from these materials. On-site research and electives in other disciplines like

management are encouraged for part-time students.

FACULTY

PROFESSORS

Stephen Arnold, Thomas Potts Professor of Physics, University Professor of Physics PhD, City University of New York
Optics, microparticle photophysics, organic solid-state physics

Mary K. Cowman, Professor of Biochemistry PhD, Case Western Reserve University
Molecular biomechanics of connective, tissue polysaccharides. Solution conformation and interactions of hyaluronan, novel methods for structure characterization, connective tissue organization and function

Bruce A. Garetz, Professor of Physical Chemistry PhD, Massachusetts Institute of Technology
Laser spectroscopy, laser light scattering, non-linear optics, laser-induced nucleation and multiphoton processes

Mark M. Green, Professor of Organic Chemistry PhD, Princeton University
Macromolecular stereochemistry: synthesis and structure

Richard A. Gross, Herman F. Mark Professor of Polymer Science, Director of NSF Center on Biocatalysis and Bioprocessing of Macromolecules PhD, Polytechnic University
Interface between biology and polymer science, enzymes in organic media for regio- and enantioselective polymerizations, whole-cell systems for the generation of polymeric structures, bioresorbable polymers

Kalle M. Levon, Professor of Chemistry DrAgr, University of Tokyo (Japan)
Phase separation in polymer blends and solutions, conducting polymers

Abraham Ulman, Professor of Chemistry PhD, The Weizmann Institute (Israel)
Self-assembled monolayers and surface engineering, nanotechnology

ASSOCIATE PROFESSOR

Iwao Teraoka, Associate Professor of Polymer Chemistry
PhD, University of Tokyo (Japan)
Polymer solution dynamics, fractionation of polymers

ASSISTANT PROFESSOR

Jin Kim Montclare, Assistant Professor of Biological Chemistry
PhD, Yale University
Protein design and engineering

INDUSTRY PROFESSORS

Victor Barinov, Industry Associate Professor of Physics
PhD, Academy of Science of the Ukraine
Electroactive gels, mechanics of polymer networks, interface separation

Evgeny Vulfson, Industry Professor of Biotechnology
PhD, Moscow State University
Biotechnology

LECTURERS

Janice Aber, Lecturer of Chemistry,
PhD, Polytechnic University

Michael Joesten, Lecturer of Biology,
PhD, St. John's University

Charles P. Martucci, Lecturer of Chemistry, PhD, Columbia University

Myron I. Pollack, Lecturer of Chemistry,
PhD, New York University

RESEARCH FACULTY

Menachem Lewin, Research Professor of Polymer Science and Engineering
PhD, Hebrew University (Israel)
Science and technology of fibers

Yoshiyuki Okamoto, Research Professor and Director of the Polymer Research Institute
PhD, Purdue University
Organic and polymer synthesis, characterizations and applications

Eli M. Pearce, University Research Professor
PhD, Polytechnic University
Polymer synthesis and degradation

Arnost Reiser, Distinguished Research Professor of Chemistry
DrIng, University of Prague (Czech Republic)
Polymer photochemistry, photoresists, image science

Edward D. Weil, Research Professor in Polymer Research Institute
PhD, University of Illinois
Additives for polymers, flammability

FACULTY EMERITI

Ernest Loebel, Professor Emeritus of Physical Chemistry,
PhD, Columbia University

Herbert Morawetz, Institute Professor Emeritus of Polymer Chemistry,
PhD, Polytechnic University

Nancy M. Tooney, Associate Professor Emerita of Biochemistry,
PhD, Brandeis University

DEPARTMENT OF CIVIL ENGINEERING

Head: Dr. F. H. (Bud) Griffis

MISSION STATEMENT

The mission of the Department of Civil Engineering is to develop engineering graduates capable of contributing to and advancing the practice of civil engineering and its sub-disciplines.

THE DEPARTMENT

The Department of Civil Engineering mission involves its faculty in a wide variety of state-of-the-art research, and in the development of innovative curricula for the civil engineers of the 21st century.

Its research focuses on many aspects of urban infrastructure, playing a national leadership role in many areas, while at the same time, being integrally involved in a host of regional and local issues of great importance. Through its involvement in regional issues, students are exposed to a daily laboratory of infrastructure issues and projects all around them. The department is involved in four major interdisciplinary research centers: The Urban Infrastructure Institute, the Urban Utilities Institute, the Transportation Research Institute, and the Urban Security Initiative. Its research covers a broad range of topics: highway capacity and level of service, remote monitoring of infrastructure elements and use, management of urban utilities, intelligent transportation systems technologies, construction materials properties and monitoring, urban infrastructure security, and other topics.

All of the department's faculty members teach undergraduate as well as graduate students. Thus, the student is exposed to instructors who are in the forefront of their fields and who are frequently working on projects and topics of current interest, often within the region. The full-time faculty are augmented by an excellent group of adjunct faculty who teach specialty courses in areas of their expertise, bringing a strong practical application element to the classroom.

The department's programs are well-rounded and balanced, including all the necessary theoretical elements with emphasis on design and application. Its graduates will be versed in state-of-the-art techniques, and will develop the skills needed to become leaders in the profession. Among these skills are the ability to communicate effectively in

verbal and written form, and the ability to understand the context of civil engineering projects in a complex society.

CIVIL ENGINEERING PROFESSION

Civil engineers are responsible for the planning, design, construction, maintenance and operation of today's infrastructures. These areas cover a wide range of urban and regional systems and functions, including buildings, roads, bridges, airports, rail systems, dams, irrigation systems, water supply systems, environmental ecosystems, and solid and liquid waste treatment and disposal systems and processes. The civil engineer practices in a broad and exciting field that has a major impact on society in general and on its infrastructure environment in particular.

Modern civil engineering also deals with rapidly expanding information technologies. These technologies monitor, control, operate and manage complex infrastructure systems. From smart buildings to remote monitoring of transportation, water supply, sewage and other infrastructures, the modern civil engineer applies information technologies to improve the quality of the infrastructure environment.

DEGREE PROGRAMS

The department's undergraduate programs deliver a broad civil engineering background to the beginning engineer. Graduate programs are designed to allow students to specialize in particular areas or sub-disciplines, as well as to pursue general graduate work across several different areas. The department offers the following degree and certificate programs:

Bachelor of Science

- Civil Engineering
- Construction Management

Master of Science

- Civil Engineering
- Construction Management
- Environmental Engineering
- Environmental Science
- Transportation Management
- Transportation Planning and Engineering
- Urban Systems Engineering and Management

Doctor of Philosophy

- Civil Engineering
- Transportation Planning and Engineering

Advanced Certificates

- Construction Management*
- Executive Construction Management (Exec21)
- Hazardous Waste Management
- Traffic Engineering
- Transportation Management and Economics
- Transportation Planning

*Offered in conjunction with the Department of Management.

Specific information on each of these programs is found in the programs section of this catalogue.

OFFICE AND CONTACT INFORMATION

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Web: www.poly.edu/cee

FACULTY

PROFESSORS

George Bugliarello, University Professor, President Emeritus
ScD, Massachusetts Institute of Technology
Fluid mechanics, bio-socio-machine interactions, sustainable urban development, megacities, knowledge parks, infrastructure, science and technology policy.

John C. Falocchio, PE, Professor of Transportation Planning and Engineering, Executive Director of the Urban Intelligent Transportation Systems Center
PhD, Polytechnic University
Transportation planning, public transportation, travel demand, traffic engineering, transportation system evaluation, transportation systems management

Fletcher H. (Bud) Griffis, PE, Head, Professor of Civil Engineering, Provost and Dean of Engineering and Applied Sciences, Director of Center for Construction Management Technology
PhD, Oklahoma State University
Three-dimensional computer models and the fully integrated and automated project process, model-based simulation, applications of operations research principles to construction, dredging and dredged material disposal, infrastructure design, construction and management, engineering economics

Ilan Juran, Professor of Civil Engineering, Executive Director of Urban Infrastructure Institute
PhD, DSc, University of Paris IV, École Nationale de Ponts et Chaussées (France)
Geotechnical engineering, soil improvement technologies, geosynthesis engineering, in-situ soil testing, urban engineering

Roger P. Roess, Professor of Transportation Engineering
PhD, Polytechnic University
Highway capacity and level-of-service analysis, traffic control and operations, public transportation operations, transportation economics, engineering pedagogy

INDUSTRY PROFESSORS

Lawrence Chiarelli, PE, Esq., Industry Professor of Construction Management, Associate Director of the Center for Construction Management Technology.
JD, Brooklyn Law School
ME (Civil), The Cooper Union
Construction law, risk management, program management, and construction management; structural engineering and cost estimation

José M. Ulerio, Industry Associate Professor of Transportation Engineering
MSTP, Polytechnic University
Transportation and traffic engineering; collection, handling, and analysis of large-scale transportation data bases; highway capacity and quality of service analysis; travel demand forecasting; geometric design of highways

ASSOCIATE PROFESSORS

Masoud Ghandehari, Assistant Professor of Civil Engineering
PhD, Northwestern University
Mechanics of fracture, durability of concrete structures, structural materials

Magued G. Iskander, PE, Associate Professor of Civil Engineering
PhD, University of Texas at Austin
Foundation engineering, marine geo-technology, pile foundations, alternative foundations, geotechnical instrumentation and monitoring, transparent soils

Alan H. Molof, Associate Professor of Environmental Engineering
PhD, University of Michigan
Water and wastewater treatment processes, nutrient removal, river and stream pollution, industrial waste treatment

Elena S. Prassas, Associate Professor of Transportation Engineering
PhD, Polytechnic University
Traffic engineering, software systems and simulation for transportation applications, transportation economics, AI applications

LECTURER

Roula Maloof, Lecturer of Civil Engineering
PhD, Polytechnic University
Non-destructive evaluation, fracture mechanics, finite element analysis, stress analysis

ADJUNCT FACULTY

Construction Management and Engineering

Stylianos Aniftos, PE, Adjunct Lecturer in Civil Engineering
PhD, Polytechnic University
President, Technico Construction Services, Inc.

Hsiao-Hua (Eric) Chang, Adjunct Lecturer of Civil Engineering
PhD, Columbia University
Risk Management/Project Engineer, STV Incorporated, Construction Management

Robert Otruba, PE, Adjunct Lecturer of Civil Engineering
BS (Civil Engineering), Syracuse University
Associate Director, Navigant Consulting Inc.

Robert J. Pennella, Adjunct Lecturer in Civil Engineering
MS Polytechnic University
Project Executive, StructureTone Inc.

Jerome White, PE, Adjunct Professor of Civil Engineering
BS, Polytechnic University
President, Jerome B. White PC

Exec 21 Program in Construction Management

Albert DiBernardo, Adjunct Lecturer of Civil Engineering
MS, Polytechnic University
Principal, Weidlinger Associates

Joseph M. Giglio, Adjunct Professor of Civil Engineering
PhD, Northeastern University
Senior Academic Specialist; Executive Professor of General Management
Northeastern University
Vice-chairman, Hudson Institute

Jack Leibler, Adjunct Lecturer of Civil Engineering
LLB, Yale Law School
Leibler and Associates, LLC, President

Francis J. Lombardi, PE, Adjunct Lecturer of Civil Engineering
MS, Columbia University
Chief Engineer, The Port Authority of New York and New Jersey

John E. Osborne, Esq., Adjunct Lecturer of Civil Engineering
JD, University of South Carolina
Law Center
Partner, John E. Osborne, PC

Luis M. Tormenta, PE, Adjunct Lecturer of Civil Engineering
BCE, Manhattan College
Vice-chairman and Chief Operating Officer, LiRo Group

Louis A. Tucciarone, Adjunct Lecturer of Civil Engineering
MSCE, University of California at Berkeley
Senior Vice-President, URS Corporation

Environmental and Water Resource Engineering

Raoul Cardenas Jr., Adjunct Professor of Environmental Engineering
PhD, New York University

Structural and Geotechnical Engineering

J. Jong Lou, PE, Adjunct Professor of Civil Engineering
PhD, Northwestern University
President, J.J. Lou Associates LLPC

Khaled Mahmoud, PE, Adjunct Lecturer of Civil Engineering
PhD, City University of New York
Director of Research and Development,
URS Corporation

Patrick Princl, PE, Adjunct Lecturer of Civil Engineering
PhD, City University of New York
Project Engineer, New York State
Department of Transportation

Sri K. Sinha, PE, Adjunct Lecturer in Civil Engineering
MS, Polytechnic University
Director of Plant Improvements and Asset Management, Lucius Pitkin Inc.

Alfonso Whu, Adjunct Lecturer in Civil Engineering
MS, Polytechnic University

Transportation and Highway Engineering

Andrew Bata, Adjunct Professor in Civil Engineering
MS, Northwestern University
New York City Transit Authority

Philip A. Habib, PE, Adjunct Professor of Transportation Engineering
PhD, Polytechnic University
President, Philip A. Habib Associates

Michael Horodniceanu, PE, Adjunct Professor of Transportation Engineering
PhD, Polytechnic University
President, Urbitran Associates

Richard Malchow, Adjunct Professor of Transportation Engineering
MS, Union College
Vice President, Management and Budget,
Urbitran Associates

Ramon Patel, Adjunct Lecturer of Transportation Engineering
PhD Polytechnic University

Genaro Sansone, Adjunct Lecturer of Transportation Engineering
MBA, Iona College
New York City Transit Authority

FACULTY EMERITI

Paul R. DeCicco, PE, Professor Emeritus
MCE, Polytechnic University

Alvin S. Goodman, PE, Professor Emeritus
PhD, New York University

Albert H. Griswold, PE, Professor Emeritus
MSCE, Columbia University

Stephen T. Mikochik, Professor Emeritus
MS, Rutgers University

Robert C. Veit, Professor Emeritus
MSE, Polytechnic University

Ping-Chun Wang, PE, Professor Emeritus
PhD, University of Illinois

DEPARTMENT OF COMPUTER AND INFORMATION SCIENCE

Head: Stuart A. Steele

Computers are now used in practically every area of human endeavor and are radically changing both the way people live their lives and notions of the limits of human capabilities. Job opportunities in computer and information science are challenging and diverse. According to the U.S. Bureau of Labor Statistics, current job growth in computer science is among the highest of any technical profession.

Polytechnic's Department of Computer and Information Science offers programs of studies leading to the BS, MS and PhD in Computer Science and the MS in Information Systems Engineering. The department offers joint programs with the Department of Electrical and Computer Engineering, leading to the BS and MS in Computer Engineering and the MS in Telecommunication Networks. The department also offers an advanced certificate in software engineering and cyber security.

The department faculty is involved in research at the frontiers of many key areas of computer science. Current research includes the analysis and development of data mining, highly efficient Internet search engines, imaging, very large database systems, security with digital watermarking, advanced algorithms, interactive graphics and high-performance networks. Major research is done in data bases and information retrieval, visualization, software engineering, algorithms and complexity, cyber security and network centric software systems. Application of the research is in all business areas such as finance, transportation, education, government, entertainment and telecommunications. Software and the intelligence developed for these areas are growing rapidly and is a major challenge in computer science.

The faculty works closely with Polytechnic's Center for Advanced Technology in Telecommunications (CATT) and has relationships with various industries that support research and activity in their areas of special interest.

Polytechnic University has been designated as a Center of Excellence for Information Assurance Education by the National Security Agency (NSA) and operates the Scholarship for Service Program (SFS) in Information Assurance.

The department provides students with a wide variety of advanced computer and software systems. These support PC and UNIX technology along with highly distributed networks. The department has four dedicated computer science laboratories (virtual lab) for upper-level undergraduate students. They are the Software Engineering Laboratory, Parallel and Distributed Systems Laboratory, Visualization and Graphics Laboratory and Computer System and Security Integration Laboratory. Multimedia and web-based laboratories are also available.

MISSION STATEMENT

The Department of Computer and Information Science is committed to preparing its undergraduate and graduate students for leadership roles in professional and research activities in the information technology sector. The department fosters an environment that encourages lifelong learning in the information age. Graduates lead and grow in diverse working environments and apply the theories and skills of computer and information science to real-world problems. Toward this end, the department conducts state-of-the-art research in theoretical and applied computer science and maintains strong educational programs that emphasize on breadth and depth in technical knowledge, and proficiency in verbal and written communication skills.

DEGREES OFFERED

Bachelor of Science

- Computer Engineering*
- Computer Science

Master of Science

- Computer Science
- Information Systems Engineering
- Telecommunication Networks*

Master of Engineering

- Interdisciplinary Studies in Engineering (Wireless Innovation**)

Doctor of Philosophy

- Computer Science

Graduate Certificates

- Computer Engineering*
- Cyber Security
- Information Security Professional
- Information Systems Administration
- Software Engineering

* Offered in conjunction with the Department of Electrical and Computer Engineering.

** Offered in conjunction with the Department of Management and the Department of Electrical and Computer Engineering.

CONTACT INFORMATION

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E-mail: cis@poly.edu

Web: <http://cis.poly.edu>

UNDERGRADUATE PROGRAMS

COMPUTER SCIENCE

The undergraduate program in computer science is accredited by the Computing Accreditation Commission of the Accrediting Board for Engineering and Technology (ABET). The computer science program offers a curriculum that prepares students for professional careers as computer scientists or for graduate studies in computer science leading to research or teaching careers.

COMPUTER ENGINEERING

The computer engineering curriculum provides the fundamental knowledge and techniques that graduates need to design computer systems and work with computer hardware and software. The computer engineering program is accredited by the Accreditation Board for Engineering and Technology (ABET). The undergraduate program is a joint program and administered by the Department of Electrical and Computer Engineering. More details are available in that department's section as well as in the programs section of this catalogue.

GRADUATE PROGRAMS**COMPUTER SCIENCE**

The MS program in computer science develops graduate skills in a broad range of fundamental areas, including data structures and algorithms, programming languages, compilers, architecture, operating systems and artificial intelligence. This degree is offered on all three campuses.

The PhD program develops graduate skills in a broad range of areas as well as expertise in one or more specific areas and the ability to think critically and conduct independent research. Outstanding PhD students are advised to apply for financial aid in the form of teaching assistantships, research assistantships or partial-tuition remission.

TELECOMMUNICATION NETWORKS

The MS program in telecommunication networks prepares graduates for professional careers in designing, managing and operating telecommunication networks. This program includes a wide variety of courses ranging from fundamental topics to recent technological advances in the field of telecommunication networks.

INFORMATION SYSTEMS ENGINEERING

The information systems engineering program educates industry people who are faced with the challenges and opportunities of integrating computers and communication systems. The program combines courses from electrical engineering, computer science and management with an emphasis on information systems engineering. Polytechnic offers the program only at its Westchester campus, courses follow an executive format and classes meet every other weekend for two full days, Friday and Saturday.

SOFTWARE ENGINEERING

The advanced certificate in software engineering consists of a series of five graduate-level courses designed to give students the knowledge and skills they need to compete successfully in the software development arena. Students who want to continue in their studies can apply these courses to the MS program in computer science.

CYBER SECURITY

The graduate certificate allows technical professionals to obtain key bodies of knowledge and specialization in cyber security. Students will acquire an understanding of various technologies in emerging areas of security like computer and network security, digital forensics, cryptography, and biometrics. Students who want to continue in their studies can apply all courses taken toward the MS program in computer science.

FACULTY PROFESSORS

Boris Aronov, Professor of Computer Science
PhD Courant Institute, New York University
Algorithms, computational and combinatorial geometry

Phyllis G. Frankl, Professor of Computer Science
PhD, New York University
Software analysis and testing

K. Ming Leung, Professor of Computer Science
PhD, University of Wisconsin
Scientific Computing, computer simulation

Nasir Memon, Professor of Computer Science
PhD, University of Nebraska
data compression, image and video processing, computer security, multimedia computation and communication

Keith W. Ross, the Leonard J. Shustek Distinguished Professor of Computer Science
PhD, University of Michigan
computer networking, Internet research, multimedia networking, scholastic modeling

ASSOCIATE PROFESSORS

Hervé Brönnimann, Associate Professor of Computer Science
PhD, Princeton University
Design and analysis of algorithms, computational and combinatorial geometry, implementation of geometric algorithms, geometric computing

Yi-Jen Chiang, Associate Professor of Computer Science
PhD, Brown University
Computer graphics: out-of-core scientific visualization, isosurface extraction, surface simplification, virtual reality, air traffic control. Computer algorithms: I/O algorithms, computational geometry, graph algorithms, approximation algorithms, data structures

Lisa Hellerstein, Associate Professor of Computer Science
PhD, University of California at Berkeley
Computational learning theory, machine learning, complexity theory, discrete mathematics

John Iacono, Associate Professor of Computer Science
PhD, Rutgers–The State University of New Jersey
Computational geometry, data structures, algorithms

Torsten Suel, Associate Professor of Computer Science
PhD, University of Texas at Austin
Design and analysis of algorithms, database systems, parallel computation, experimental algorithmics

Joel Wein, Associate Professor of Computer Science
PhD, Massachusetts Institute of Technology
Scheduling, parallel and distributed computing, combinatorial optimization, data mining, algorithms

Edward K. Wong, Associate Professor of Computer Science
PhD, Purdue University
computer vision, image analysis, pattern recognition, computer graphics

Joshua Gluckman, Assistant Professor of Computer Science
PhD, Columbia University
Computer vision, image and video processing pattern

Nitesh Saxena, Assistant Professor of Computer Science
PhD University of California, Irvine
Computer and network security, applied cryptography

INDUSTRY FACULTY

David R. Doucette, Industry Professor
PhD, Polytechnic University
Systems integration, software engineering, operating systems

Robert J. Flynn, Industry Professor
PhD, Polytechnic University
Computer architecture, operating systems

Haldun Hadimioglu, Industry Professor of Computer Science
PhD, Polytechnic University
Computer architecture, parallel processing, reconfigurable systems, application specific processors and networking

Stuart A. Steele, Industry Professor of Computer Science, Department Head
PhD, Pennsylvania State University
Software engineering and management, programming languages, real-time systems

Fred J. Strauss, Industry Associate Professor and Director of CIS programs in Melville Campus—Long Island
MS, Polytechnic University
Software engineering, project management, distributed systems

RESEARCH FACULTY

Gad M. Landau, Research Professor of Computer Science
PhD, Tel-Aviv University (Israel)
Serial and parallel algorithms for problems related to strings, computation biology, pattern recognition, communication networks

LECTURER

John B. Sterling, Lecturer of Computer Science
MS, New York University

INSTRUCTORS

Evan Gallagher, Instructor of Computer Science
MS, New York University

Daniel Katz-Braunschweig, Instructor of Computer Science
MS, Iona College

FACULTY EMERITI

Arthur E. Laemmel, Professor Emeritus of Electrical Engineering and Computer Science
BEE, Polytechnic University

James T. LaTourrette, Professor Emeritus of Electrical Engineering and Computer Science
PhD, Harvard University

Stanley Preiser, Professor Emeritus of Mathematics and Computer Science
PhD, New York University

Henry Ruston, Professor Emeritus of Electrical Engineering and Computer Science
PhD, University of Michigan

Martin L. Shooman, Professor Emeritus of Electrical Engineering and Computer Science
DEE, Polytechnic University

Richard Van Slyke, Professor Emeritus of Electrical Engineering and Computer Science
PhD, University of California at Berkeley
Combinatorial optimization especially applied to telecommunications systems, distributed optimization

DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

Head: H. Jonathan Chao

Through innovations in telephones, electric power systems, rapid transit, radio, television, medical electronics, computers, microelectronics, the Internet and wireless communications, electrical and computer engineers contributed more to the quality of 20th century life than any other profession. The first half of the present century will be equally exciting.

The Department of Electrical and Computer Engineering is well respected throughout the world for its major contributions to the profession and its tradition of excellence in teaching and research. Polytechnic electrical and computer engineering graduates are prominent in university faculties, industrial labs and company boardrooms spanning the entire range of the electrical, electronic and information-technology industries.

The department enters the 21st century with strong teaching and research programs in the most exciting fields in the information age: the Internet, wireless communications, computers, multimedia signal processing, robotics, automatic control and electric power generation.

In the intimate Polytechnic environment, students benefit from frequent access to faculty members and laboratories at the forefront of innovation. Polytechnic provides infrastructure to encourage faculty and students to transfer their inventions to industry and even start up their own companies.

The department hosts the Center for Advanced Technologies in Telecommunications (CATT), a New York State sponsored research center, and the Wireless Internet Center of Advanced Technology (WICAT), a National Science Foundation Industry/University Cooperative Research Center. Together, they make the department particularly strong in telecommunication networks and wireless communications research and education.

MISSION STATEMENT

The mission of the Department of Electrical and Computer Engineering is to engage our students seeking educational achievement as our nation enters a new age with new demands and opportunities. Our goal is to provide undergraduate students with a broad-based education for a career in electrical and computer engineering with the skills necessary to become creative leaders in their future professional careers with the passion and desire to discover, invent, innovate, apply, and advance new science and technology to the world's most significant problems..

DEGREES OFFERED

The Department of Electrical and Computer Engineering offers the following degree and certificate programs. Separate sections of this catalogue present the objectives, requirements, advising resources and courses for the individual programs.

Bachelor of Science*

- Computer Engineering**
- Electrical Engineering
- Electrical and Computer Engineering (dual major)

Master of Science

- Computer Engineering**
- Electrical Engineering
- Electrophysics
- Systems Engineering
- Telecommunication Networks**

Master of Engineering

- Interdisciplinary Studies in Engineering (Wireless Innovation***)

Doctor of Philosophy

- Electrical Engineering

Graduate Certificates

- Computer Engineering**
- Image Processing
- Telecommunication Network Management
- Wireless Communications

**Accredited by the Accreditation Board for Engineering and Technology (ABET).*

***Offered in cooperation with the Department of Computer and Information Science.*

****Offered in cooperation with the Department of Management and the Department of Computer and Information Science.*

CONTACT INFORMATION

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Fax: (718) 260-3906
E-mail: eceinfo@poly.edu
Web: www.poly.edu/ece

GRADUATE CERTIFICATE PROGRAMS

The department offers advanced certificate programs on themes of current interest. The programs recognize students for successful completion of four graduate courses (12 credits) focused in areas of interest to working engineers. More details about these programs are available below in the sections about related degree programs. Courses completed for an advanced certificate are applicable toward a master's degree in a related field. The department's graduate manual and web site should be consulted for the latest list of these programs that follow current trends in technology.

SPECIAL UNDERGRADUATE OPTIONS

The BS/MS Accelerated Honors Option:

This program is available to exceptional undergraduate students, enabling them to earn both the bachelor's and master's degrees in as little as four years of study. Possible BS/MS combinations include BS in Electrical or Computer Engineering with a MS in Electrical Engineering, Telecommunications Networks, Computer Engineering or Computer Science.

Dual Major: A student can earn a Bachelor of Science degree in Electrical and Computer Engineering by completing a total of 142 credits.

Minors: A student can earn a minor in Electrical or Computer Engineering. See the relevant program description.

STUDENT ORGANIZATIONS

Institute of Electrical and Electronics Engineers (IEEE), Professional Organization, Student Chapter. Eta Kappa Nu, Electrical Engineering Honor Society.

SPECIALTY LABS

Keeping pace with the dynamic advances in electrical and computer engineering, the department maintains state-of-the-art laboratories for student instruction and experimentation. Laboratory courses combine lectures, experiments and project work. They provide students with a rich set of elective choices, opportunity to work on senior projects with faculty researchers, valuable hands-on experience to enhance and supplement material they learn in their lecture classes, and forums to practice their oral and written communication skills. Technologies developed in these labs include multimedia information communications and processing, local area networks, wireless information networks, electrical machinery, very large-scale integrated circuits, control/robotics and microwaves.

The Wireless Lab provides formal experiments, lectures and project work on state-of-the-art commercial spread spectrum wireless access systems, including bit error rate analysis and UHF channel propagation measurements.

The Multimedia Lab is equipped with PC-based multimedia workstations, providing students with hands-on experience to acquire, process and communicate voice, image and video as well as create multimedia documents.

The Local Area Networks Lab includes a set of weekly experiments using X-terminals, Ethernet LANs, routers and bridges and associated software to conduct a variety of LAN/WAN experiments and projects.

The VLSI Design Lab treats Very Large-Scale Integrated circuit design, performance analysis and circuit characterization using modern VLSI CAD tools such as VHDL. Students study the design of MOS, CMOS and BiCMOS logic, standard cells and gate arrays and mixed (analog/digital) circuits.

The Machinery Lab provides projects and structured experiments on electrical machinery and power-related laboratory measurements. These include transformers, induction motors, synchronous machines, dc machines, DC/DC converters and AC/AC cycloconverters.

The Control/Robotics Lab provides a variety of experiments and project work focusing on feedback control, data acquisition and computer control.

The Microwave Lab treats the design, fabrication and testing of passive and active circuits and antennas using modern CAD and measurement software and hardware.

CENTER FOR ADVANCED TECHNOLOGY IN TELECOMMUNICATIONS

Through the New York State Center for Advanced Technology in Telecommunications (CATT), electrical and computer engineering faculty collaborate with industry in research, education and technology transfer in telecommunications and information systems. CATT is distinguished for its innovations in many fast-moving areas, including broadband networks, peer-to-peer networking, switch design and implementation, security hardware, ad hoc wireless networks, cellular networks, wireless local area networks, software design and reliability, search engine technology, network design tools, traffic planning and capacity engineering, image and video coding and transport.

WIRELESS INTERNET CENTER FOR ADVANCED TECHNOLOGY

The Wireless Internet Center for Advanced Technology (WICAT) is a National Science Foundation Industry/University Cooperative Research Center based at Polytechnic University, with programs at Columbia University, University of Virginia and Auburn University. WICAT collaborates with many industry partners to overcome technical challenges and create new applications for the future Internet in which the majority of devices will be mobile and portable. University research gives companies a crystal ball with a view of the future. Industry collaboration maximizes the practical value of the new knowledge created at the WICAT universities.

FACULTY PROFESSORS

Steve Arnold, University & Thomas Potts Professor of Physics
(Joint appointment with Dept of Physics)
PhD, City University of NY
Microparticle photophysics, photonic atom bio-sensors

Frank A. Cassara, Professor of Electrical and Computer Engineering, Director of Long Island Graduate Center
PhD, Polytechnic University
Electronic circuits, wireless communication systems

David C. Chang, Professor of Electrical and Computer Engineering
PhD, Harvard University
Electromagnetics, microwave integrated circuits

H. Jonathan Chao, Professor of Electrical and Computer Engineering, Department Head
PhD, Ohio State University
Network security, and high-performance routers/switches

David J. Goodman, Professor of Electrical and Computer Engineering, Director of the NSF Wireless Internet Center for Advanced Technology (WICAT)
PhD, Imperial College, University of London (England)
Communications systems

Zhong-Ping Jiang, Professor of Electrical and Computer Engineering
PhD, École des Mines de Paris (France)
Control systems

Farshad Khorrami, Professor of Electrical and Computer Engineering
PhD, Ohio State University
Robotics, control systems

Spencer P. Kuo, Professor of Electrical and Computer Engineering and Electrophysics
PhD, Polytechnic University
Plasmas and electromagnetics

I-Tai Lu, Professor of Electrical and Computer Engineering
PhD, Polytechnic University
Electromagnetics, acoustics, wireless communication

Shivendra S. Panwar, Professor of Electrical and Computer Engineering, Director of the New York State Center for Advanced Technology in Telecommunications
PhD, University of Massachusetts, Amherst
Communication networks

S. Unnikrishna Pillai, Professor of Electrical and Computer Engineering
PhD, University of Pennsylvania
Signal processing and communications

Yao Wang, Professor of Electrical and Computer Engineering
PhD, University of California, Santa Barbara
Image and video processing and communications, pattern recognition

Zivan Zabar, Professor of Electrical and Computer Engineering
ScD, Technion (Israel)
Power electronics, electric drives, power systems

ASSOCIATE PROFESSORS

Dariusz Czarkowski, Associate Professor of Electrical and Computer Engineering
PhD, University of Florida
Power electronics, power quality

Nirod K. Das, Associate Professor of Electrical and Computer Engineering
PhD, University of Massachusetts
Electromagnetics, antennas, microwave integrated circuits

Francisco de Leon, Associate Professor of Electrical and Computer Engineering
PhD, University of Toronto, Canada
Power system analysis, distributed generation systems

Elza Erkip, Associate Professor of Electrical and Computer Engineering
PhD, Stanford University
Wireless communication, communication theory, information theory

Ramesh Karri, Associate Professor of Electrical and Computer Engineering
PhD, University of California, San Diego
VLSI, CAD, computer engineering

Ivan W. Selesnick, Associate Professor of Electrical and Computer Engineering
PhD, Rice University
Signal processing

Peter Voltz, Associate Professor of Electrical and Computer Engineering
PhD, Polytechnic University
Communications and signal processing

ASSISTANT PROFESSORS

Yong Liu, Assistant Professor of Electrical and Computer Engineering
PhD, University of Massachusetts, Amherst
Communication networks

Garret S. Rose, Assistant Professor of Electrical and Computer Engineering
PhD, University of Virginia
VLSI, Nanoelectronics, low power circuit design

Andrej Stefanov, Assistant Professor of Electrical and Computer Engineering
PhD, Arizona State University
Communication theory, wireless

INDUSTRY FACULTY

Michael Knox, Industry Associate Professor of Electrical and Computer Engineering
MSEE, Polytechnic University
Wireless communications, RF and microwave components, analog circuit design

Kang Xi, Industry Assistant Professor of Electrical and Computer Engineering
PhD, Tsinghua University (China)
High-speed networking

Yang Xu, Visiting Assistant Professor of Electrical and Computer Engineering
PhD, Tsinghua University (China)
High-speed networking

RESEARCH FACULTY

Onur G. Guleryuz, Research Professor
PhD, University of Illinois at Urbana Champaign

Thanasis Korakis, Research Assistant Professor
PhD, University of Thessaly, Greece
Communication networks

ADJUNCT FACULTY

Andrew Bach, Adjunct Lecturer
BS, Pratt University

Mehran Bagheri, Adjunct Lecturer
PhD, Columbia University

Tushar Bhattacharjee, Adjunct Lecturer
PhD, Jadavpur University (India)

Paul Bocheck, Adjunct Lecturer
PhD, Columbia University

Matthew Campisi, Adjunct Lecturer
MS, Polytechnic University

Edward Chen, Adjunct Lecturer
MSc, Yale University

Robert DiFazio, Adjunct Lecturer
PhD, Polytechnic University

Monisha Ghosh, Adjunct Lecturer
PhD, University of Southern California

Robert Gordon, Adjunct Lecturer
PhD, Polytechnic University

Ian Harris, Adjunct Lecturer
PhD, Herriot-Watt University (Scotland)

Howard Hausman, Adjunct Lecturer
MS, Polytechnic University

Zhu Liu, Adjunct lecturer
PhD, Polytechnic University

Schuyler Quackenbush, Adjunct Lecturer
PhD, Georgia Institute of Technology

Ben Spherling, Adjunct Lecturer
PhD, Leningrad Polytechnic University (Russia)

George Sullivan, Adjunct Lecturer
MS, Polytechnic University

Fred Winter, Adjunct Lecturer
PhD, Polytechnic University

Mike Yang, Adjunct Lecturer
PhD, Harvard University

Tao Zhang, Adjunct Lecturer
PhD, University of Massachusetts, Amherst

Zhenqxue Zhao, Adjunct Lecturer
PhD, Polytechnic University

FACULTY EMERITI

Leonard Bergstein, Professor Emeritus of Electrical Engineering
PhD, Polytechnic University

Henry L. Bertoni, Professor Emeritus of Electrical Engineering
PhD, Polytechnic University

Leo Birenbaum, Associate Professor Emeritus of Electrical Engineering and Electrophysics
MS, Polytechnic University

Donald Bolle, Professor Emeritus of Electrical Engineering, Emeritus Provost
PhD, Purdue University

Joseph J. Bongiorno Jr., Professor
Emeritus of Electrical Engineering
DEE, Polytechnic University

Robert Boorstyn, Professor Emeritus of
Electrical Engineering
PhD, Polytechnic University

Edward S. Cassedy, Professor Emeritus
of Electrical Engineering
DrEng, Johns Hopkins University

Bernard R. S. Cheo, Professor Emeritus
of Electrical Engineering
PhD, University of California at Berkeley

Douglas A. Davids, Associate Professor
Emeritus of Electrical Engineering
PhD, Johns Hopkins University

Rudolf F. Drenick, Professor Emeritus of
Electrical Engineering
PhD, University of Vienna (Austria)

Herman Farber, Associate Emeritus
Professor of Electrophysics
MEE, Polytechnic University

Leopold B. Felsen, University Professor
Emeritus
DEE, Polytechnic University

Richard A. Haddad, Professor Emeritus
of Electrical Engineering
PhD, Polytechnic University

Donald F. Hunt, Professor Emeritus of
Electrical Engineering
BS, University of Pennsylvania

Ludwik Kurz, Professor Emeritus of
Electrical Engineering
EngScD, New York University

James T. LaTourette, Professor Emeritus
of Electrophysics
PhD, Harvard University

Nathan Marcuvitz, University Professor
Emeritus
DEE, Polytechnic University

Maurice C. Newstein, Professor
Emeritus of Electrophysics
PhD, Massachusetts Institute of Technology

Arthur A. Oliner, Professor Emeritus of
Electrophysics
PhD, Cornell University

Istvan Palocz, Professor Emeritus of
Electrical Engineering and Electrophysics
PhD, Polytechnic University

Philip E. Sarachik, Professor Emeritus of
Electrical Engineering
PhD, Columbia University

Harry Schachter, Professor Emeritus of
Electrical Engineering
PhD, Polytechnic University

Benjamin Senitzky, Professor Emeritus
of Electrophysics
PhD, Polytechnic University

Sidney S. Shamis, Professor Emeritus of
Electrical Engineering
MS, Stevens Institute of Technology

Leonard G. Shaw, Professor Emeritus of
Electrical Engineering
PhD, Stanford University

Jerry Shmoys, Professor Emeritus of
Electrical Engineering
PhD, New York University

Theodore Tamir, University Professor
Emeritus
PhD, Polytechnic University

Wen-Chung Wang, Professor Emeritus
of Electrical Engineering and Electro-
physics
PhD, Northwestern University

Gerald Weiss, Professor Emeritus of Elec-
trical Engineering
DEE, Polytechnic University

Dante C. Youla, University Professor
Emeritus
MS, New York University

UNDERGRADUATE ADVISER
Ellen Daniels
MS, Polytechnic University

GRADUATE ADVISER
Xiaokang Chen
PhD, Polytechnic University

DEPARTMENT OF FINANCE AND RISK ENGINEERING

Head: Charles S. Tapiero

Department of Finance and Risk Engineering (FRE) is a diversified degree granting department - the second in the U.S. to provide the MS degree in Financial Engineering - providing a broadly based education in finance, risk engineering and management. The department's programs, research and extracurricular activities are designed to meet future challenges, and to provide the talent needed by financial services industries and to assume employment positions as traders, hedge fund managers, quantitative professionals as well as financial and specialized risk managers in a broad set of professions. The department's curriculum is designed to combine a rigorous vision of economics, finance and management with a practical appreciation of evolving global markets and the unfolding technological and financial changes that currently occur in world markets. In addition, the department provides interdisciplinary certificates and opportunities to combine studies, such as computer science, mathematics, and engineering with financial management and risk engineering.

The department is based in both Brooklyn at MetroTech Center and in Wall Street, in the midst of the world's leading financial center. Our MS degrees and certificates span topics such as corporate and financial markets, computational finance and financial technology.

The department is staffed by a number of leading academics and practitioners, both nationally and internationally, and boasts a number of outstanding affiliated professors and cutting-edge traders, hedge funds managers and academics turned practitioners by the lure of Wall Street. This combination of talent, theoretically and practically based, national and international, provides a first-rate education embedded in answering the real needs of the financial services sector that recognizes the continuous growth of finance, risk engineering, technology, financial engineering and management in an increasingly global world.

GOALS AND OBJECTIVES

The goals of the financial engineering program are to educate financial market professionals, technology managers and computational finance engineers for fast-

moving, highly rewarding careers that create value enabled by finance, technology and computational mathematics

DEGREES OFFERED

Master of Science

- Financial Engineering

Graduate Certificates

- Financial Engineering
- Financial Information Services and Technology Management
- Risk Management

CONTACT INFORMATION

Administrative and Faculty Offices

Brooklyn Campus

Rogers Hall 517
Polytechnic University
Six MetroTech Center
Brooklyn, NY 11201
Tel: (718) 260-3279
Fax: (718) 260-3355
Web: www.poly.edu/fe

Classrooms

Manhattan Location

55 Broad Street
New York, NY 10004

GRADUATE AND CERTIFICATE PROGRAMS

THE MASTER OF SCIENCE PROGRAM

The Master of Science in Financial Engineering (FE) is a 36-credit program designed to provide the skills required to operate at the cutting-edge of financial engineering in today's financial services industry. Separate tracks make it possible to pursue careers in financial markets and corporate finance, in financial technology or computational finance. The program is rigorous, demanding and selective. Graduates of the Financial Markets and Corporate Finance Track are expected to seek positions in financial management groups, on trading and arbitrage desks, in product structuring groups, in derivatives groups, in investment banking departments and in the information-technology firms that support the trading operations of financial institutions. Graduates of the Financial Information Services and Technology Track are best viewed as information technologists who

are actively involved in the development and implementation of the entire spectrum of software applications, databases and networks used in modern financial services firms.

The Computational Finance Track emphasizes both theory and practice, bridging the two using both quantitative and software finance. This track is meant for those individuals with a strong desire to become Quant finance managers, pursue applied finance research interests in cutting-edge investment science and finance. Techniques such as quantitative finance, financial econometrics, stochastic modeling, simulation and optimization are part of a set of financial tools applied to the many problems of algorithmic trading, asset pricing, developing derivative product and the many areas where quant finance has a contribution to make. Graduates of the Computational Finance Track will be qualified to work in financial risk management, in derivatives pricing, in cutting-edge institutions, in quant hedge funds and in research and advanced product development departments of financial and consulting firms.

Graduates are expected to seek positions in commercial banks, investment banks, thrifts, insurance companies, investment companies, pension funds, finance companies, consulting firms, energy marketing firms, accounting firms with consultancy practices and similar industries. Polytechnic's Master of Science in Financial Engineering brings together three key areas: finance and related business disciplines, quantitative analysis (mathematics and statistics) and information technology (telecommunications and computer science). In addition, it provides an opportunity to attend to the many areas of business and management where finance is an essential element. Polytechnic has long been recognized as a leader in both advanced mathematics and information technology. Now, through its FRE department and associated research and curriculum development, Polytechnic has positioned itself to be a leader in the financial technology, risk engineering and financial management on which financial institutions increasingly depend for their revenue streams. The financial component has been further strengthened by developing a large and versatile body of adjunct faculty consisting of

leading financial market practitioners from major Wall Street firms and international professors affiliates. This adjunct faculty work closely with Polytechnics fulltime faculty emphasizing both applied and theoretical research in bringing to financial engineering students a greater sensitivity to the needs and the demands of financial markets and in-situations.

ADMISSIONS

The Master of Science in financial engineering at Polytechnic University is very highly selective. All applicants must present transcripts from all colleges and universities they have attended as well as either GRE (Graduate Record Exam) or GMAT (Graduate Management Admission Test) test scores; there are no exceptions to this rule. Applicants who have undergraduate marks averaging above a 3.0 or a master's degree and also have a GRE or GMAT quantitative percentile score above 80 are considered for admission. Completed applications must be received by Polytechnic by April 1 for consideration for the fall semester or by October 15 for consideration for the spring semester.

For the GRE or GMAT, the institution code is 2668, a department code is not necessary. Additionally, the applicant must have sufficient proficiency and aptitude in mathematics. This may be demonstrated by grades earned in relevant course work and/or standardized examinations. This criterion is not entirely objective and will be established by the Academic Director.

Applicants who meet the above criteria are by no means guaranteed admission. Each fall, 75 new students begin study in our department; 25 begin each spring. This number of applicants is accepted into the MS FE and certificate programs while other qualified applicants are placed on a waiting list. If admitted students do not decide to submit deposits to hold their places in a timely manner, their class seats will be forfeited and students from the waiting list selected to take their places.

Two letters of recommendation are also required for admission. The student also must demonstrate a proficiency in the English language as measured by verbal scores on the GRE or GMAT or successfully complete a series of ESL courses in order to commence formal study.

The Graduate Certificates associated with Financial Engineering Program have the same application requirements and prerequisites as the Master of Science Degree.

Applicants requesting admission for study only in a particular course or group of courses are given Special or Visiting Student Status status, which permits registration, generally for a limited duration, in those courses indicated by the approval of admission. Registration is limited to six credits per semester. If additional courses are desired after the end of the specified period, a new admission request must be filed through the admissions office. Special Status students who later apply for and are accepted to the Master's or certificate program may transfer up to nine credits taken while on Special Status. Special Status students are expected to complete the GRE or GMAT exam before applying for admission to MS FE or any associated Graduate Certificate. The GPA earned as a Special Status student will be used as part of the admissions decision in place of the undergraduate GPA.

Individuals interested in applying for admissions to either the Master of Science in Financial Engineering or the Graduate Certificate Program please visit the Graduate Admissions web page at www.poly.edu/graduate. The site has a downloadable application and information on tuition and financial aid.

ACCELERATED HONORS PROGRAM

BS MATHEMATICS/ MS FINANCIAL ENGINEERING

Jointly offered by the Department of Finance and Risk Engineering and the Departments of Mathematics a new accelerated Bachelor of Science in Mathematics and a Bachelor of Science in Computer Science and a Master of Science in Financial Engineering Honors Program are offered, addressing educational and professional needs within the financial services industry. This program is geared to attract outstanding high school students interested in pursuing careers in mathematics and computer science, in general, and job opportunities in the financial services industry, in particular. Students receive both degrees at the end of either a four-year or a five-year track.

Students in the BS Mathematics/MS Financial Engineering Honors Program must meet all University requirements to complete each degree. Both degrees are awarded at the end of either four or five years.

For more information on the BS in mathematics, contact Erwin Lutwak department head, at (718) 260-3366 or lutwak@poly.edu.

For more information on the MS in Financial Engineering, contact Barry Blecherman at (718) 260-3398 or blecherman@poly.edu.

ADMISSIONS POLICY

The admission policy for the BS Mathematics/MS Financial Engineering Honors Program is similar to that used by the Othmer Institute for Interdisciplinary Studies Honors College (more information on the Othmer Institutes Honors College is included in Part I Polytechnic University Profile). Admission to the program includes the following:

- Essay(s) submitted with application
- Two letters of recommendation
- SAT score of at least 1350
- High school diploma with a minimum 90 grade average (or equivalent letter grade)*
- Results of Regent and Advanced Placement (AP) exams are taken into consideration
- Personal interview will be considered with advisers from the Departments of Mathematics and Finance and Risk Engineering

Students who take AP calculus courses equivalent in subject matter to MA 1012 and MA 1022 will be considered for the four-year track. For high school juniors, a minimum 90 grade average is required.

CENTER FOR FINANCE AND TECHNOLOGY (CFT)

The Center for Finance and Technology (CFT), under the auspices of the Department of Finance and Risk Engineering, is a unique resource, addressing the evolving financial risk, quant and technology enabled innovation needs of the financial services industry. CFT is a research hub as well as a laboratory for generating new ideas and tools for the industry. CFT also undertakes collaborative research projects to provide ideas, methods and tools with scholarly and practical applications. For more information, contact Charles S. Tapiero at (718) 260-3653 or ctapiero@poly.edu, or visit <http://www.poly.edu/fe>.

FACULTY

PROFESSORS

Charles S. Tapiero, the Morton and Angela Topfer Distinguished Professor in Financial Engineering and Technology Management

PhD, New York University

Financial engineering, risk technology and management, supply-chain management

K. Ming Leung, Professor of Financial Engineering and Computer Science

PhD, University of Wisconsin

Computer programming, computer simulation

ASSISTANT PROFESSOR

Stanley Peterburgsky, Assistant Professor of Financial Engineering

PhD, Columbia University

Corporate finance

INDUSTRY FACULTY

Barry S. Blecherman, Industry Associate Professor of Financial Engineering,

PhD, Wharton School, University of Pennsylvania

Information economics and strategy, decision theory, business negotiations

Fredrick Novomestky, Industry

Professor of Financial Engineering
PhD, Polytechnic University

Asset/liability modeling and management, technologies for interactive management education, evolutionary computational algorithms for business optimization, systems with distributed objects, quantitative investment strategy

RESEARCH FELLOWS

Anne Zissu, Research Fellow

PhD, The Graduate School and University Center of the City University of New York

Corporate finance, risk management, securitization

ADJUNCT FACULTY

Sassan Alizadeh, Adjunct Associate

Professor of Financial Engineering

PhD, University of Pennsylvania

Term-structure model, quantitative trading strategies

Lucas Bernard, Adjunct Associate

Professor of Financial Engineering

PhD, The New School for Social Research

Credit derivatives, corporate finance

Paul Biederman, Adjunct Associate

Professor of Financial Engineering

PhD, New School University

Financial market regulation, industry economic analysis

Robert Biolsi, Adjunct Associate

Professor of Management

PhD, Graduate Center, College University of New York

Innovation, equity prices, and commodity diversification, electricity deregulation

Jean-Carlo Bonilla, Adjunct Associate

Professor of Financial Engineering

MA, Polytechnic University

Quantitative methods in finance

Rohan Douglas, Adjunct Associate

Professor of Financial Engineering

BSc, Sydney University (Australia)

Market theory, credit derivatives

Roy Freedman, Adjunct Associate

Professor of Financial Engineering

PhD, Polytechnic University

Evolutionary information technology, quantitative methods in finance, artificial intelligence

Barry Guttenplan, Adjunct Associate

Professor of Financial Engineering

MPhil, Yale University

Taxation and finance; credit derivatives

Thomas Hutchinson, Adjunct Associate

Professor of Financial Engineering and

Management

MA, McMaster University (Canada)

Investment banking, financial economics

Maureen Koetz, Adjunct Associate

Professor of Financial Engineering

Principal

Koetz and Duncan LLC

Environmental finance

Andrew Kalokatay, Adjunct Associate

Professor of Financial Engineering

PhD, University of Toronto

Debt management, valuation of bonds, interest-rate derivatives, and mortgage-backed securities

Steven Mandel, Adjunct Associate

Professor of Financial Engineering

PhD, New York University

Risk management, portfolio optimization, return attribution

Ingrid Marshall, CPA, Adjunct Associate

Professor of Financial Engineering

MBA, St. Johns University

Corporate financial accounting

Jerzy Pawlowski, Adjunct Associate

Professor of Financial Engineering

PhD, State University of New York

Credit derivatives, energy derivatives

Ronald T. Slivka, Adjunct Associate

Professor of Financial Engineering

PhD, University of Pennsylvania

Quantitative approaches to derivative securities valuation and applications, quantitative investment strategies

Richard Van Slyke, Adjunct Associate

Professor of Financial Engineering

PhD, University of California, Berkeley

Financial risk optimization

Edward Weinberger, Adjunct Associate

Professor of Financial Engineering

PhD, Courant Institute, New York

University

Credit risk measurement and management

Edward Zimmer, Adjunct Associate

Professor of Financial Engineering

Corporate finance

INTERNATIONAL PROFESSORS ASSOCIATES

Konstantin Kogan

Affiliation: Bar Ilan University, Israel

Bertrand Munier

Affiliation: ESAM, France

Aim Scannavino

Affiliation: University of Paris II,

France

Pierre Vallois

Affiliation: University of Nancy, France

DEPARTMENT OF HUMANITIES AND SOCIAL SCIENCES

Chair: Richard E. Wener

MISSION STATEMENT

The Department of Humanities and Social Sciences is an interdisciplinary department that focuses on critical engagement with technology through research and teaching. This mission is fulfilled in part by our degree programs, such as undergraduate programs in digital media, technical communications, science and technology studies, sustainable urban environments, and liberal studies, and graduate programs in digital media, Specialized Journalism, History of Science and technology and environment-behavior studies. The Department of Humanities and Social Sciences is also responsible for the Polytechnic core curriculum, including writing, communications, and general education requirements of engineering programs, designed to give our students a breadth of knowledge and perspective necessary for careers in technology and the sciences.

DEGREES OFFERED

Bachelor of Science

- Integrated Digital Media
- Liberal Studies (Concentrations in Philosophy, Literature, Psychology, History and History of Science)
- Science and Technology Studies
- Sustainable Urban Environments
- Technical Communication

Accelerated BS/MS Program

- Technical Communication/
Specialized Journalism
- Liberal Studies/Psychology,
Organizational Behavior

The Department of Humanities and Social Sciences offers BS/MS honors programs for exceptional first-year students and advanced undergraduates. Through these unique programs, students can earn both a Bachelor of Science and a Master of Science in Technical Communication/Specialized Journalism or a Bachelor of Science in Liberal Studies with a Concentration in Psychology and a Master of Science in Organizational Behavior in just four to five years.

The accelerated programs allow students to take up to 9 credits that fulfill both undergraduate and graduate degree requirements. In addition, credit may be granted

for high school advanced placement courses where a student earns a 4 or 5 on the AP test. Students accepted into the program may also earn up to 18 credits through one or more undergraduate and graduate internship opportunities.

All candidates for the program must pass an entrance examination administered by the department and be interviewed by a program adviser. Once enrolled in the program, students are expected to maintain a 3.0 GPA.

Graduate Certificate

Awarded for successful completion of a 15 credit sequence at the graduate level. Students must take two core courses, and three electives.

- Environment–Behavior Studies
- History of Science and Technology
- Integrated Digital Media
- Technical Communication
(also available online)

Master of Science

- Environment–Behavior Studies
- History of Science
- Integrated Digital Media
- Specialized Journalism

MINORS

A 15-credit sequence, approved by the department, in any one of the subjects listed below:

- AH Art History
- AN Anthropology
- DM Digital Media
- EC Economics
- EN English/Literature
- HI History
- LW Law and Technology
- MU Music
- PO Political Science
- PS Psychology
- SO Sociology
- TC Technical Communication/
Specialized Journalism

GENERAL EDUCATION REQUIRED COURSES

All humanities and social science courses used to fulfill the graduation requirement are organized according to principles of breadth and depth into three categories:

1. Level I Basic Courses required of all students
2. Level II Elective Courses
3. Level III Elective Courses

To fulfill the general education requirement, students must complete the following:

- Three basic courses (EN 1014 / EN 1034, EN 1204 and HI 2104, taken in order)
- Two Level II Elective Courses
- One Level III Elective Course cognate with at least one Level II Course (i.e., which has a Level II Elective Course as a prerequisite)

Courses that carry the following prefixes may be used to fulfill the general humanities/social science requirements:

AH Art History
AN Anthropology
EC Economics
EN English/Literature
HI History
MU Music
PL Philosophy
PO Political Science
PS Psychology
SO Sociology

Courses that carry the following prefixes may NOT be used to fulfill the general humanities/social science requirements:

DM Digital Media
LA Liberal Arts
LW Law
TC Technical Communications

ELECTIVES

All of our courses may be taken as free electives, as provided for in a student's BS or MS degree program, subject to prerequisites for advanced courses. DM and TC courses may also be used to fulfill a "technical elective" requirement. Consult your home department's academic adviser for details.

RESEARCH CENTERS**CENTER FOR HISTORY AND PHILOSOPHY OF SCIENCE STUDIES**

The center was established to encourage discussion among philosophers, engineers, computer scientists and other practitioners from the scientific and technological professions on the ethical, political and general cultural connotations of contemporary technological activity, as well as straightforward research in the traditional philosophical questions concerning technology. The center also fosters various types of interdisciplinary education.

By bringing the humanities, communications and social science disciplines closer together and reaching out to other academic departments in the University, the center helps facilitate the exploration of intellectual common ground.

INTEGRATED DIGITAL MEDIA INSTITUTE

The Integrated Digital Media Institute has been established to set up and support creative partnerships:

- Between our students and faculty
- Between Polytechnic University and leading individuals, organizations, and enterprises in electronic media
- Between the most advanced thinkers and practitioners in the humanities, arts, social sciences, and communications technologies

FACULTY PROFESSORS

Myles W. Jackson, Dibner Family Professor of History of Science and Technology
Ph.D., Cambridge University
History of science and technology

ASSOCIATE PROFESSORS

Jonathan Bain, Assistant Professor of Philosophy of Science
PhD, University of Pittsburgh
Quantum theory, philosophy of space and time

Teresa Feroli, Assistant Professor of English
PhD, Cornell University
Renaissance literature, Shakespeare, women's studies

Jean Gallagher, Associate Professor of English
PhD, City University of New York Graduate Center
Feminist theory, 19th- and 20th-century American literature, composition and rhetoric

Sylvia Kasey Marks, Associate Professor of English
PhD, Princeton University
Shakespeare, Samuel Richardson, the 18th- and 19th-century British novel, public speaking, expository writing

Francis David Mulcahy, Associate Professor of Anthropology
PhD, University of Massachusetts
Language and culture of China and Spain

Lowell L. Scheiner, Associate Professor of Humanities and Communications
MS, Columbia University Graduate School of Journalism
MA, Columbia University
Technical writing, journalism

Jonathan Soffer, Associate Professor of History
PhD, Columbia University
JD, University of Denver
Twentieth-century American political and foreign relations history, urban history with a specialization in the history of New York City since 1945

Romualdas Sviedrys, Associate Professor of History of Technology
PhD, Johns Hopkins University
Technology forecasting and technology assessment, history of technology and science

Richard E. Wener, Associate Professor of Environmental Psychology, Head of Department of Humanities and Social Sciences
PhD, University of Illinois at Chicago
Environmental psychology

ASSISTANT PROFESSORS

Nancy H. Kwak, Assistant Professor of History
PhD, Columbia University
Urban history

Tara Pauliny, Assistant Professor of Rhetoric and Composition
PhD, Ohio State University
Rhetoric and composition

Carl Skelton, Assistant Professor of Digital Media, Director of Integrated Digital Media Institute
MVA, University of Alberta (Canada)
Digital media

INDUSTRY FACULTY

Jerry MacArthur Hultin, Industry Professor of Law, Management and Public Policy; President of Polytechnic University
JD, Yale University
Innovation management, global development, modern university education, technology policy

Noel N. Kriftcher, Industry Professor of Humanities, Executive Director of David Packard Center for Technology and Educational Alliances
EdD, Hofstra University
Teacher development in math and science

Ann Lubrano, Industry Associate Professor of Sociology, Associate Director of Othmer Institute for Interdisciplinary Studies, Director of Honors College
PhD, City University of New York
Technology and social change, organizations

Harold P. Sjursen, Industry Professor of Philosophy
PhD, New School University
History of philosophy, ethics, philosophy of science and technology

LECTURERS

Donald S. Phillips, Lecturer of Psychology
BS, Polytechnic University
Experimental and physiological psychology, physical anthropology, paleontology

INSTRUCTORS

Alph Edwards, Instructor of English
MA, Hunter College
Developmental writing

Alan Goldstein, Instructor of English
BA, University of Denver
English as a second language

Sadrul A. Khan, Instructor of History
PhD, Ludwig Maximilian University
(Germany)
World history, Asian history, political science

Christopher Leslie
PhD, City University of New York
Graduate Center
English, technical communications, media studies

James P. Lewis, Instructor of Psychology
MA, Stony Brook University
Humanistic psychology

Elisa Linsky, Instructor of Technical
Communications
BA, Wittenberg University
Technical writing, technical presentations, writing across the curriculum

Alan M. Nadler, Instructor of English
MFA, Columbia University
Contemporary poetry, the European novel

Meredith Schuman, Instructor of English
MFA, Brooklyn College

ADJUNCT FACULTY

Kenseth Armstead
BFA Corcoran School of Art, Whitney
Museum of American Art (Independent
Study Program)
MS Polytechnic University

Mary Ann Benedetto
MS, Polytechnic University

Asya Blue, Adjunct Instructor of Techni-
cal and Professional Communication
BFA, Parsons School of Design

Keith Bunin
MA, Columbia University

Joshua Goldberg
MPS, New York University

Erin Hayes
MA, City University of New York

John Klima
MS, Polytechnic University

Michael Laderman
DMA, Stony Brook University

Frank Meola
B.A., Columbia University

David Mermelstein
PhD, Columbia University

Andrew Miller
BA, Columbia University

Naomi Nemptow
MFA, American University

Michael Schumacher
DMA, Juilliard School

Daniel Vatsky
MS, Polytechnic University

James Waller
MA, Columbia University

Shannon Welch
MFA, University of Iowa

FACULTY EMERITUS

Lester Bumás
John G. Cavanna
Wolhee Choe
Duane DeVries
Anne Eisenberg
Marvin Gettleman
Helmut Gruber
Louis Menashe
David Mermelstein
Bernard Rechtschaffen
Thomas B. Settle

DEPARTMENT OF MATHEMATICS

Head: Erwin Lutwak

The Department of Mathematics is committed to excellence and innovation in the teaching and research of mathematics. Current active areas of research include geometric analysis, partial differential equations, mathematical physics, sports science and mathematics education. The bachelor's, master's and doctoral degree programs provide both a solid foundation in mathematics and extensive exposure to how mathematics is used in practice. Half of a mathematics major's courses are taken in other departments. The department also offers a complete spectrum of undergraduate and graduate courses.

MISSION STATEMENT

The mission of the Department of Mathematics is to develop and implement innovative teaching strategies designed to help each student understand fundamental mathematical concepts and to use these concepts to excel in subsequent science and engineering courses.

Students taking departmental courses become confident in their abilities to reason rigorously, use the language of mathematics properly, write and speak about mathematical ideas precisely and concisely and appreciate the amazing power of mathematics to describe phenomena in the world. Students learn how to use mathematical software appropriately as a tool in the study and application of mathematics.

The department also has degree programs in its own discipline, with a strong interdisciplinary focus. The BS in Mathematics, for instance, has an optional concentration in physics. The MS in Mathematics focuses on strong abstract and quantitative reasoning abilities. The PhD in Mathematics encourages work applying advanced mathematics in other disciplines, with the major adviser from those disciplines.

To support its academic quality and to strengthen interdisciplinary work, the department's research excels in the areas of convex geometry and the analysis of nonlinear partial differential equations arising from gauge field theory.

DEGREES OFFERED

Bachelor of Science

- Mathematics

Master of Science

- Mathematics

Doctor of Philosophy

- Mathematics

OFFICE

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Polytechnic University
Six MetroTech Center
Brooklyn, NY 11201
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Fax: (718) 260-3660
E-mail: chair@math.poly.edu
Web: www.math.poly.edu

FACULTY

PROFESSORS

Monika Ludwig, Professor of Mathematics
PhD, Technische Universität Wien
Convex geometry, valuations, geometric and analytic inequalities

Erwin Lutwak, Professor of Mathematics,
Department Head
PhD, Polytechnic University
Geometric analysis

Edward Y. Miller, Professor of
Mathematics
PhD, Harvard University
Differential topology

Deane Yang, Professor of Mathematics
PhD, Harvard University
Geometric analysis

Yisong Yang, Professor of Mathematics
PhD, University of Massachusetts at
Amherst
Partial differential equations, mathematical physics

Gaoyong Zhang, Professor of Mathematics
PhD, Temple University
Geometric analysis

ASSOCIATE PROFESSORS

Kathryn Kuiken, Associate Professor of
Mathematics
PhD, Polytechnic University
Complex analysis, group theory

Joel C. W. Rogers, Associate Professor of
Mathematics
PhD, Massachusetts Institute of Technology
Partial differential equations, fluid mechanics, numerical methods

INDUSTRY FACULTY

David V. Chudnovsky, Distinguished Industry
Professor of Mathematics
PhD, Institute of Mathematics, Ukrainian
Academy of Science
Theoretical mathematics: number theory, partial differential equations, Hamiltonian systems. Mathematical physics: field theories, quantum systems. Computer science: computer algebra and complexity, large-scale numerical mathematics, parallel computing and digital signal processing

Gregory V. Chudnovsky, Distinguished
Industry Professor of Mathematics
PhD, Institute of Mathematics, Ukrainian
Academy of Science
Number theory: analytic number theory, diophantine approximations and transcendence theory. Mathematical physics: nonlinear equations, quantum and classical fields. Computer science: computer algebra and complexity, large-scale numerical mathematics, parallel computing and digital signal processing

ASSISTANT PROFESSORS

Franziska Berger
PhD, Munich University of Technology
Discrete mathematics

TEACHING FACULTY

Carolyn D. King, Lecturer of Mathematics
MA, New York University
Mathematics education

Lindsey Van Wagenen, Lecturer of
Mathematics
PhD, Columbia University
Applied physics

Dorjan Puleri
MS Mathematics, Polytechnic University

ADJUNCT PROFESSORS

Michel Lobenberg
PhD, Columbia University
*Banach spaces, probability and stochastic
processes, mathematical physics*

Harvansh Manocha
PhD, Panjab University
Lie groups and special functions

Stanley Rabinowitz
PhD, City University of New York
Number theory

Jiazuo Zhou
Research Professor
Convex geometry, integral geometry

ADJUNCT INSTRUCTORS

Margarita Amchislavska
BS Mathematics, Polytechnic University

Orval Crawford
BS Mathematics, Polytechnic University

Boris Ganelin
BS Mathematics, Polytechnic University

Amakoe Gbedemah
MA Applied Mathematics
BA Pure Mathematics

Mirela Ivan
BS Mathematics/Physics, Dunarea de Jos,
Romania
MS Financial Engineering, Polytechnic
University

Rachel Jacobovits
MS, Polytechnic University

Liana Lazarashvili
MS Computational Mathematics,
Georgian Academy of Science

Luciano Medina
BS Mathematics, Polytechnic University

Tom Pranayanuntana
PhD, Polytechnic University

Abraham Sher
ME, City College of New York; MA
Brooklyn College

Andy Tsang
BS Mathematics, Polytechnic University

Hanna Ulman
BA, Hebrew University

Fang Zhao
MS Mathematics, Polytechnic University

EMERITI FACULTY
George Bachman
Heinrich Guggenheimer
Leon Herbach
Harry Hochstadt
Burton Lieberman
Clifford W. Marshall
Lesley Sibner
Andrew J. Terzuoli
Hermann Waldinger
Georges Weill
Erich Zauderer

DEPARTMENT OF MECHANICAL AND AEROSPACE ENGINEERING

Head: George Uradis

Mechanical and aerospace engineers design and build the modern products and processes that society needs. The wide range of dynamic and continually evolving areas where such engineers are the prime movers of innovation and change include bioengineering, energy systems, aircraft, aerospace, environmental engineering, controls for mechanical systems, mechanical-electrical devices, automobiles, materials engineering, automated manufacturing, structural engineering, robotic systems, fluid systems and devices, production planning and control and combustion processes and systems.

MISSION STATEMENT

The mission of the Department of Mechanical and Aerospace Engineering is to prepare students for careers in mechanical and related engineering disciplines for professional development, life-long learning, and contributions to society. Furthermore, the department will add value to the student's market/career potential by an emphasis on (a) understanding the physical world through projects, tools, and practice, and (b) providing the foundation tools for innovation, invention and entrepreneurship.

DEGREES OFFERED

Bachelor of Science

- Mechanical Engineering (concentration in aerospace engineering available)

Master of Science

- Mechanical Engineering (concentrations in mechanical analysis/design, systems/controls/robotics and thermal/fluids systems)

Doctor of Philosophy

- Mechanical Engineering (concentrations in aerodynamics, materials science, mechanical analysis/design, systems/controls/robotics and thermal/fluid systems)

OFFICE

Rogers Hall, Room 502
Tel: (718) 260-3160
Fax: (718) 260-3532
E-mail: MAE@poly.edu
Web: <http://mechanical.poly.edu>

THE DEPARTMENT

The Department of Mechanical and Aerospace Engineering stresses creativity and innovation while providing students with a program that emphasizes fundamental understanding of the underlying sciences, design methodologies, and economic and social impact of engineered products. The undergraduate degree is accredited by the Engineering Accreditation Commission (AEC) of the Accreditation Board of Engineering and Technology (ABET). The doctoral degree is approved by the New York State Doctoral Program Review.

DEGREE PROGRAMS

The department offers programs in mechanical engineering and an option in aerospace engineering. The undergraduate program in mechanical engineering allows students to: (1) acquire the fundamental principles in mechanical engineering, mathematics and the sciences, which provide a foundation for and inspire professional development; (2) understand the interrelationship of technology and social and ethical issues; (3) formulate, analyze and design thermal and mechanical components and systems; (4) skillfully use modern engineering tools; (5) work in and lead multidisciplinary teams; and (6) communicate effectively.

Students are encouraged to join Polytechnic's student chapters of the American Society of Mechanical Engineers (ASME), American Institute of Aeronautics (AIAA), National Society of Black Engineers (NSBE), Society of Women Engineers (SWE) and Society of Automotive Engineers (SAE), as well as honor societies (Pi Tau Sigma for mechanical engineers and Tau Beta Pi for engineers in general).

The department offers MS and PhD graduate programs in mechanical engineering. Specific information about these programs may be found in the programs section of the catalogue.

FACULTY

PROFESSORS

Sunil Kumar, Professor of Mechanical Engineering
PhD, University of California at Berkeley
Thermal fluid sciences, applied mathematics

Said Nourbakhsh, Professor of Materials Science, Department Head
PhD, Leeds University (England)
Phase transformation, electron microscopy, mechanical behavior, composite materials, smart materials, ferroelectric thin films

Richard S. Thorsen,
PhD, New York University
Heat transfer, nuclear reactor safety, solar energy

Richard S. Thorsen,
PhD, New York University
Heat transfer, nuclear reactor safety, solar energy

Sung H. Whang, Professor of Materials Science
DEngSc, Columbia University
Mechanical properties and microstructure of nanostructured materials, titanium aluminides, intermetallic compounds, processing and properties of rapidly solidified materials, characterization of electronic materials and ceramic superconductors

ASSOCIATE PROFESSORS

Iraj M. Kalkhoran, Associate Professor of Aerospace Engineering
PhD, University of Texas at Arlington
Gas dynamics, high-speed flows, wind tunnel testing, shock tubes

Vikram Kapila, Associate Professor of Mechanical Engineering
PhD, Georgia Institute of Technology
Linear/nonlinear control with applications to robust control, saturation control, closed-loop input shaping, distributed spacecraft formation flying, spacecraft attitude control and mechatronics

George C. Vradis, Associate Professor of Mechanical Engineering and Department Head

JD, Brooklyn Law School
PhD, Polytechnic University

Computational fluid dynamics and heat transfer, non-Newtonian flows, flow measurement, combustion, energy systems

ASSISTANT PROFESSORS

Nikhil Gupta, Assistant Professor of Mechanical Engineering

PhD, Louisiana State University

Micro- and nano-composite materials/mechanics

Maurizio Porfiri, Assistant Professor of Mechanical Engineering

PhD, Virginia Polytechnic Institute and State University

Dynamics, vibrations, computational mechanics, robotics

ADJUNCT FACULTY

T. David Bomzer

MSME, Polytechnic University

Statics, dynamics, thermodynamics

Joseph Borowicz

PhD, Polytechnic University

Finite elements, numerical methods

Ali Vedavarz

PhD, Polytechnic University

HVAC

Iskender Sahin

PhD, Virginia Polytechnic Institute and State University

Thermal and fluid systems

FACULTY EMERITI

Philip Abrami, Professor Emeritus
MS, Polytechnic University

Vito D. Agosta, Professor Emeritus
PhD, Columbia University

Anthony E. Armenakas, PE, Professor Emeritus
PhD, Columbia University

William B. Blesser, Professor Emeritus
MEE, Polytechnic University

Martin H. Bloom, Institute Professor
PhD, Polytechnic University

Irving B. Cadoff, Professor Emeritus
DEngSc, New York University

Louis S. Castleman, Professor Emeritus
ScD, Massachusetts Institute of Technology

John R. Curreri, Professor Emeritus
MEE, Polytechnic University

Carmine D'Antonio, Professor Emeritus
MMetE, Polytechnic University

George J. Fischer, Professor Emeritus
MMetE, Polytechnic University

Joseph Kempner, PE, Professor Emeritus
PhD, Polytechnic University

Jerome M. Klosner, PE, Professor Emeritus
PhD, Polytechnic University

Harold Margolin, Professor Emeritus
DEngSc, Yale University

William R. McShane, PE Professor Emeritus
PhD, Polytechnic University

Gino Moretti, Professor Emeritus
PhD, University of Turin (Italy)

Wheeler K. Mueller Jr., Professor Emeritus
PhD, University of Illinois

Sharad A. Patel, Professor Emeritus
PhD, Polytechnic University

Bernard W. Shafer, PE, Professor Emeritus
PhD, Brown University

William P. Vafakos, PE, Professor Emeritus
JD, Brooklyn Law School
PhD, Polytechnic University

DEPARTMENT OF PHYSICS

Head: Lorcan M. Folan

Physics is the science devoted to the study and understanding of nature. It traces its history back to Aristotle and derives its name from the Greek words for nature and natural. Physics deals with the constituents, properties and evolution of the entire universe, on all length and time scales, and so is often said to be the most fundamental science. Other branches of science focus on smaller domains, but physics provides the foundation for all of them.

MISSION STATEMENT

The physics department at Polytechnic is committed to providing high-quality introductory-, intermediate-, and advanced-level physics courses as services to the engineering and science departments of the University; through an undergraduate major, training new generations of physicists capable of applying the tools of physics to contemporary problems, for the benefit of all; and through close collaborations with other departments, enabling engineering research and education with physics knowledge and techniques, and serving as a catalyst for research in other scientific and engineering fields.

CONTACT INFORMATION

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FACULTY

PROFESSORS

Stephen Arnold, University Professor of Physics
PhD, City University of New York

Edward L. Wolf, Professor of Physics
PhD, Cornell University

ASSOCIATE PROFESSORS

Lorcan M. Folan, Associate Professor of Physics, Department Head
PhD, Polytechnic University

INDUSTRY PROFESSORS

Victor Y. Barinov, Industry Associate Professor of Physics
PhD, Academy of Science of the Ukraine

David R. Doucette, Industry Professor of Engineering and Computer Science
PhD, Polytechnic University

Gunter W. Georgi, PE, Industry Professor of Engineering and Computer Science
MS, Columbia University

Valery A. Sheverev, Industry Associate Professor of Physics, Director of Physics Laboratory Program
PhD, Saint-Petersburg State University (Russia)

LECTURERS

S. John DiBartolo, Lecturer of Physics
PhD, University of Virginia

David T. Mugglin, Lecturer of Physics
PhD, Lehigh University

Vladimir I. Tsifrinovich, Lecturer of Physics
DSc, Academy of Science of the USSR

INSTRUCTORS

Vladimir Ostrovsky, Instructor of Physics
DSc, Academy of Science of the Ukraine

ADJUNCT FACULTY

D. James Cordista, Adjunct Professor of General Engineering
BS, Polytechnic University

Akhil Lal, Adjunct Professor of Physics
PhD, Polytechnic University

EMERITUS FACULTY

Deo C. Choudhury
Professor Emeritus of Physics
PhD University of California

Hellmut J. Juretschke
Professor Emeritus of Physics
PhD Harvard University

DEPARTMENT OF TECHNOLOGY MANAGEMENT

Chair: Professor Mel Horwitch

Effective technology and innovation management and entrepreneurship increasingly determine success in business today. The Department of Technology Management is an acknowledged pioneer and leader in the New York City/tri-state region in offering courses and programs dealing with these increasingly critical arenas. The department serves a diverse and broad range of professionals, and its faculty and students comprise a vital and forward-thinking research and learning community. The department's research and educational offerings deal with a broad range of sectors, including financial and professional services; retailing and logistics; bio-medical and pharma sustainability; media and entertainment; IT and telecom, and modern electronic business; and non-for-profits and government—the areas of greatest growth and opportunity in the modern economy, especially in New York, the nation's foremost global city.

MISSION STATEMENT

The mission of the Department of Technology Management is to act as a major educational gateway and premier learning, and research hub explicitly devoted to broadly defined innovation and technology management and entrepreneurship. As such, all its carefully tailored learning programs and the scholarly intellectual capital it produces enable the department to provide unique and valuable opportunities for students, other professionals and scholars. The department is unequivocally committed to upgrade and revise continually its learning programs and courses to meet fast-changing demands of a dynamic, innovation-driven and competitive environment, and to be an academic leader in technology management.

DEGREES OFFERED

Bachelor of Science

- Business and Technology Management

Master of Science

- Management (MSM)
- Management of Technology (MOT)***

- Master of Business Administration (MBA)
- Organizational Behavior (MSOB)
- Telecommunications and Information Management (TIM)

Master of Engineering

- Interdisciplinary Studies in Engineering (Wireless Innovation*)

Doctor of Philosophy

- Technology Management

Graduate Certificates

- Construction Management**
- Electronic Business Management
- Entrepreneurship
- Human Resource Management
- Information Management
- Organizational Behavior
- Project Management
- Technology Management
- Telecommunications Management

*Offered in conjunction with the Department of Electrical and Computer Engineering and the Department of Computer and Information Science.

**Offered in conjunction with the Department of Civil Engineering.

***Offered in both the MOT and AMOT Programs.

RESEARCH AND DEVELOPMENT

The department has achieved its preeminent position with a continuous stream of high-quality and relevant research, development and pacesetter learning programs. With its outstanding faculty, the department contributes to theory and practice in an increasingly knowledge-intensive age. The department's research and development work is varied, including scholarly books and articles in the most respected journals and timely case studies. Some of this material (especially cases, which are in print or web-based digital formats) forms part of the content in the department's educational programs, helping to keep its programs up to date and distinctive. The department is also committed to integrating wisely technology into all of its educational programs to enhance learning.

UNDERGRADUATE PROGRAM

The Department of Technology Management offers a Bachelor of Science in Business and Technology Management (BTM). This program prepares students to be the next generation of managers in fields dominated by technological innovation and information intensity. Students completing this program are prepared to succeed in positions such as technology project leaders, new economy entrepreneurs, technology and IT analysts, customer relationship managers and in other cross-functional roles.

MINOR IN MANAGEMENT

Undergraduate Students may obtain an undergraduate minor in management by completing 14 credits of management courses. An overall GPA of at least 2.0 must be maintained in these classes. At least 8 of the 14 credits must be taken by students while enrolled at Polytechnic.

GRADUATE AND CERTIFICATE PROGRAMS

Because all managers must now understand how technology and innovation are essential for delivering value to organizations and the market, the department offers a portfolio of redesigned and modernized educational programs, all dealing in some fashion with the broad spectrum of innovation, technology management and entrepreneurship in the modern economy, including the Internet.

The department offers seven graduate and professional programs, two of which are earned in executive management programs (meeting every other week on Thursday evening and all day Saturday or Wednesday), four evening graduate programs, and one offered in both formats.

- Accelerated Management of Technology Master's Program (AMOT)
- Master in Business Administration (MBA)- Innovations & Technology Management Program
- Master of Science in Management Program (MSM)
- Management of Technology Executive Master's Program (MOT in Executive Format)

- Master of Science in Organizational Behavior (MSOB)
- Telecommunications and Information Management Executive Master's Program (TIM in Executive Format)
- PhD Technology Management

The AMOT, MSM, MSOB Programs may be pursued either part time or full time with an evening schedule. Each has concentrations that allow students to specialize in selected areas.

The department also offers advanced graduate certificates from the MSM and MSOB Programs, which consist of sequences of selected courses leading to advanced knowledge in a desired area of specialization.

MASTER IN BUSINESS ADMINISTRATION (MBA) - INNOVATION & TECHNOLOGY MANAGEMENT

The Poly MBA program is designed for professionals who aim to innovate at the nexus of business and technology. The program aims to educate professionals for whom managing technology, nurturing innovation, and fostering entrepreneurship are paramount concerns. At Poly MBA students have direct access to the latest technological developments. Poly's NYC location and close ties with premier firms also mean that MBA students are exposed to state-of-the-art and sophisticated managerial practices. The Poly MBA reflects and is informed by modern value creation as practiced in the nation's most advanced global city.

Other distinctive features of the MBA Program include:

- An emphasis on managing technology, nurturing innovation and promoting entrepreneurship
- A unique MBA curricula design that comprises foundational, techno-innovation, and immersion courses, diverse electives, learning links with Poly's incubator and entrepreneurial firms, and co-created flexible MBA tracks
- Integration of local, regional and global perspectives
- Active involvement of highly respected faculty in management and engineering and applied science
- A focus on leadership
- A holistic educational approach that connects the worlds of technology and business
- Modern learning methods, e.g., individualized and team-based coaching, experiential project-based education, and advanced learning platforms

• A priority on serving one's community

- Close involvement with leading companies, entrepreneurial ventures, and professional services firms

Entrance requirements for the MBA program include possessing a four-year bachelor's degree from an accredited college or university; and submitting official GMAT examination scores, a completed application, a résumé and two letters of recommendation.

DOCTOR OF PHILOSOPHY IN TECHNOLOGY MANAGEMENT

Modern technologies increasingly and profoundly affect management of products, services, processes, organizational forms, business models, the shape of industry structures and modern business environments, the kinds of the technology enabled innovation available, and the capability of integrating technology and management to create value for customers and organizations. The ability to conduct research on and to educate on the managerial implications of such topics—all comprising technology management—is a highly sought-after and important arena for business scholarship and education. The PhD in Technology Management is designed for this increasingly significant set of scholarly and educational opportunities.

This degree program is designed for research-oriented students. Both full-time and part-time students are accepted. Admission criteria include academic record, professional experience, research potential, GMAT or GRE scores and references.

Visit www.phd-tim.poly.edu for more information.

All management undergraduate and graduate degree programs, as well as certificate programs, are further described in this Catalogue under the appropriate entries.

STUDENT PROFESSIONAL SOCIETIES, ASSOCIATIONS AND ORGANIZATIONS

The Management of Technology and the Telecommunications and Information Management Executive Programs Alumni Association actively seek to continue and expand shared professional experience gained during and after the programs. Members meet face-to-face or electronically to share insights obtained in their work experiences and to debate issues broadly relevant to technology management.

The Organizational Behavior Program sponsors an award-winning student chapter of the Society for Human Resources Management (SHRM). The chapter sponsors forums with experts and provides an excellent means for professional networking to further enhance the student's education and overall career.

The student club associated with the Bachelor of Science in Business and Technology Management degree program is a strong and valued component of the social fabric of undergraduate life at Polytechnic. This organization works to create professional knowledge and opportunities for its members.

INSTITUTE FOR TECHNOLOGY AND ENTERPRISE

The Institute for Technology and Enterprise (ITE) is supported by the Department of Technology Management at Polytechnic University. Located at 55 Broad Street in Manhattan, ITE is New York City's premier research and education hub for the management of technology and innovation management and entrepreneurship. Located in the heart of high-technology New York City, ITE is a focal point and R&D engine for building managerial knowledge and developing learning programs suited particularly to technology-intensive and "hybrid"—i.e., digital and physical—settings.

ITE is also a gathering place for a unique, diverse and interdisciplinary community, comprising faculty members from the Department of Technology Management and other Polytechnic departments, industry leaders, and participating professionals in the department's MBA and executive master's programs. These highly committed professionals and scholars take part in ITE round tables and workshops in New York City and around the world, and, working together, develop relevant research and learning materials that are used in learning programs and other international events.

ITE activities include:

- Roundtables and executive workshops on such subjects as Silicon Alley 2.0, global e-Business (held in Taiwan), the Intelligent Communities Forum (held annually), wireless innovation, media management, mobile business, e-business decision making and new business models, managerial challenges in the biotechnology industry in Israel, services innovation, sustainability innovation and new dimensions in global innovation.

- Research and curriculum development on modern innovation management, mobile social networking, sustainability innovation, the transformation of the print media industry, value creation in financial services, global innovation strategy, homeland security's impact on the shape of U.S. innovation, venture capital and entrepreneurship.

ITE is closely aligned with the activities of the Department of Technology Management; in particular, ITE has a strong and mutually reinforcing relationship with Polytechnic's new MBA - Innovation & Technology Management Program and Executive Master's Programs in Management of Technology (MOT) and Telecommunications and Information Management (TIM), which are also held at 55 Broad Street in Manhattan.

For further information, call (718) 260-3610, fax: (212) 547-7029, e-mail ite@poly.edu, or visit www.ite.poly.edu.

EXTENSION IN ISRAEL

The Department of Technology Management offers its management programs at its extension in Israel. The program is identical to the MSM evening curriculum in New York, with selected concentrations specifically designed for professionals and managers working in Israeli business and industry. The MSM program brings cutting-edge technology management approaches taught by Polytechnic professors together with Israeli faculty to address the advanced state of technology in Israel. A Master of Science in Organizational Behavior (OB) is also planned to be offered at the Israel extension.

For further information about the Department of Management extension in Israel, contact Academic Director Harold Kaufman at (718) 260-3485 in New York and 08-939-0520 in Israel, or by e-mail at hkaufman@poly.edu.

OFFICES

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E-mail: mgt-dept@poly.edu
Web: www.managementdept.poly.edu

Manhattan Location

Poly MBA Program
MOT and TIM Executive Master's Programs, AMOT
Institute for Technology and Enterprise
55 Broad Street, Suite 13B
New York, NY 10004
Tel: (718) 260-4014
Fax: (212) 547-7029
E-mail: mba@poly.edu; mot-tim@poly.edu; ite@poly.edu
Web: www.poly.edu/mba;
www.mot-tim.poly.edu;
www.ite.poly.edu

Departmental representatives are available for student advising on the Long Island and Westchester campuses.

FACULTY

PROFESSORS

Mel Horwitch, Professor of Technology Management, Chair, Department of Technology Management, Director of Institute for Technology and Enterprise MBA, DBA, Harvard University, AB Princeton
Innovation management, global technology strategy, technology policy

Harold G. Kaufman, Professor of Management, Academic Director of Organizational Behavior Program, Academic Director of Department of Management Extension in Israel
MIE, PhD, New York University, BME, Cooper University
Managing professional and technical workers, career management, obsolescence of knowledge and skills, research methods

ASSOCIATE PROFESSOR

Bharat P. Rao, Associate Professor of Management, Director, PhD Technology Management Program
PhD, University of Georgia, Brooklyn Tech, National Institute of Technology, California Institute of Technology, India
Managing emerging technologies; broadband, wireless & digital business; global innovation; strategic marketing; IT in the supply chain; alliances, networks and collaborative enterprises

ASSISTANT PROFESSORS

Anne-Laure Fayard, Assistant Professor of Management
PhD, Ecole Des Hautes Etudes en Sciences Sociales, MA, Ecole Polytechnique, BA, MA, University La Sorbonne, Paris
Discourse analysis, communication, online communities, social-material practices, space and culture

Oded Nov, Assistant Professor of Management

PhD, University of Cambridge, UK, MSC, London School of Economic, UK
BA, Tel Aviv University, Israel
Technology management, behavioral aspects of information systems, knowledge management, motivations of open source and user-generated content contributors

INDUSTRY FACULTY

Jerry MacArthur Hultin, Industry Professor of Law, Management and Public Policy; University President
JD, Yale University, BA, Ohio State University
Innovation management, global development, modern university education, technology policy

Nina D. Ziv, Industry Associate Professor of Management, Co-director of Executive Master's Programs
BA, PhD, New York University
Content innovation, social networks, global entrepreneurship, media management, wireless innovation, e-business

HUMANITIES AND SOCIAL SCIENCES

Richard. C. Wener, Associate Professor of Psychology
PhD, University of Illinois at Chicago
Environmental psychology, crowding, assessment of the built environment

FACULTY EMERITI

Seymour Kaplan, Associate Professor Emeritus of Operations Management and Management Science
PhD, New York University
Operations research and management

A. George Schillinger, Research Professor and Professor Emeritus of Technology Management
Eng ScD, Columbia University
BEE, City College of New York
Management of innovation, technology management, science and technology policy

ADJUNCT FACULTY

John Artise, Global Human Resource Management
MA, New York University

Yair Berson, Adjunct Associate Professor of Management
PhD, SUNY Binghamton
Organizational behavior, leadership of high technology firms, strategic leadership

Robert Biolsi, Adjunct Associate Professor of Management
PhD, Graduate Center, College University of New York
Inflation, equity prices, and commodity diversification, electricity deregulation

Howard Bruck, Adjunct Associate Professor of Management
MBA, Fordham University
Project Management

Srimat T. Chakradhar, Adjunct Associate Professor of Management
PhD, Rutgers University
Design/test distributed, networked computing systems, embedded systems

Joe Chizmarik, Adjunct Associate Professor of Management
MS, Stevens Institute of Technology
Telecommunications management and MIS

Arnold Cohen, Adjunct Associate Professor of Management
MBA, City College of New York
Marketing

Lance Cohen, Adjunct Associate Professor of Management
PhD, Columbia University
MIS

Robert Cohen, Adjunct Associate Professor of Management
MBA, New York Institute of Technology
Management information systems, quality control and systems

Alejandro Crawford, Adjunct Associate Professor of Management
MBA, Tuck School, Dartmouth
Entrepreneurial Marketing and Sales

Michael Cortegiano, Adjunct Associate Professor of Management
BS, Fairfield University
Accounting and finance

Jan Damsgaard, Adjunct Associate Professor of Management
PhD, Copenhagen Business School (Denmark)
e-Business, MIS

Anthony Deak, Adjunct Associate Professor of Management
MS, Polytechnic University
Foundations of management, global perspectives in management

Matthew J. DeLuca, Adjunct Associate Professor of Management
MPA, University of Pittsburgh
Labor relations, performance appraisal, compensation management

Michael D'Emic, Adjunct Associate Professor of Management
M.Litt. and MBA, Trinity College, Dublin, Ireland
Accounting, finance

Philip Dorin, Adjunct Associate Professor of Management, Management Department Adviser for Long Island Campus
PhD, University of Connecticut
Organizational behavior, human resource management, training and development

Noha S. El-Ghobashy, Adjunct Associate Professor of Management
MS., Mechanical Engineering, Columbia University
Project management

James Fazio, Adjunct Associate Professor of Management
MA and MBA, St. John's University
Operations management

Philip Ferrara, Adjunct Associate Professor of Management
PhD, Hofstra University
Organizational staffing, job design

Roy Freedman, Adjunct Associate Professor of Financial Engineering
PhD, Polytechnic University
Evolutionary information technology, quantitative methods in finance, artificial intelligence

Sanjay Ghandi, Adjunct Associate Professor of Management
BS, Clarkson University
Marketing, entrepreneurship

Marv Golland, Adjunct Associate Professor of Management
MBA, New York University
MIS

Robert R. Goodman, Adjunct Associate Professor of Management
MBA, Harvard University
Corporate and government management

Sara Grant, Adjunct Associate Professor of Management
PhD, New York University
Organizational theory and design, human resource management, conflict management, organizational behavior, research methods

Edward Greenbaum, Adjunct Associate Professor of Management
MS, Cornell University
Industrial and labor relations

Bohdan Hoshovsky, Adjunct Associate Professor of Management
PhD, Pacifica Graduate Institute
Organizational behavior, project management, general management, transhumanism

Howard Kupferman, Adjunct Associate Professor of Management
MS-OB, Polytechnic University;
MBA, Finance, Fordham University
Organizational behavior, business ethics

David Lefferts, Adjunct Associate Professor of Management
MBA, Columbia University
Emerging financial technologies, financial products, e-Business

Gary Levanti, Adjunct Associate Professor of Management
MBA, Binghamton University
Entrepreneurship

Peter Lubell, Adjunct Associate Professor of Management
MS, Polytechnic University
Data-communications management

Thomas Mazzone, Adjunct Associate Professor of Management
MBA, Theseus Institute (France)
Operations management, supply chain management, project management

Pavlos Mourdoukoutas, Adjunct Associate Professor of Management
PhD, University of Connecticut
Economics

Carl Nelson, Adjunct Associate Professor of Management
MIE, New York University
Operations management

Bruce Niswander, Adjunct Associate Professor of Management
JD, Ohio State University
Entrepreneurship, entrepreneurial finance, managing intellectual property and intellectual capital

Jim Paguagua, Adjunct Associate Professor of Management
MBA, Pace University
New product development, marketing

John Reilly, Adjunct Assistant Professor of Management
MA, Columbia University
Human resource information systems

Timothy W. Reinig, Adjunct Associate Professor of Management
JD, State University of New York at Buffalo
e-Business, e-Commerce marketing, Internet law and intellectual property

David Rosensaft, Adjunct Associate Professor of Management
MS, Polytechnic University
Managerial decision making, finance, supply chain

Fred Schlissel, Adjunct Associate Professor of Management
MBA, Columbia University
Entrepreneurship

Sandor Schweiger, Adjunct Associate Professor of Management
JD, School of Law, New York University

Wendy Stahl, Adjunct Associate Professor of Management
MBA, Harvard University
Marketing new product development

Thomas Stiles, Adjunct Associate Professor of Management
MBA, New York University
Telecommunications management

John Thomas, Adjunct Associate Professor of Management
MBA, University of Rochester
Operations, quality and project management

Carla Visser, Adjunct Associate Professor of Management
MBA, University of Rochester
Operations, quality and project management

Richard Walton, Adjunct Associate Professor of Management
MBA, New York University
Management

Anthony Zinsser, Adjunct Associate Professor of Management
PhD, Stevens Institute of Technology
Organizational development

ADVISORY BOARDS: CORPORATE AND ACADEMIC

The Department of Management maintains close and deep ties with a wide range of firms in a host of knowledge- and innovation-intensive sectors. The department is honored to have a distinguished and active Corporate Advisory Board. The department also works closely with high quality academic institutions and colleagues throughout the world and is honored to have an active and highly respected Academic Advisory Board. Both boards meet regularly to discuss and review the department's learning programs, research and plans for the future. In this manner, the department stays informed, meets the pragmatic and scholarly needs and critical challenges confronting technology and innovation executives and entrepreneurs, and makes certain that its courses and programs are at the state-of-the-art and are relevant.

CORPORATE ADVISORY BOARD MEMBERS

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Stevens Institute of Technology

Professor Raymond-Alain Thietart
University of Paris-Dauphine
Paris, France

Professor N. Venkatraman
Boston University School of Management

PROGRAM ADMINISTRATION
AND PROFESSIONAL STAFF

Bohdan Hoshovsky
Administrative Director, BS-BTM and
MSM Programs
PhD, Pacifica Graduate Institute

Janelle Meehan
Program Coordinator
BA, Lycoming College

Paul Sunda
Administrative Director
Poly MBA Program and MOT-TIM
Executive Master's Programs
MSEd, Baruch College, CUNY

PART 3

ACADEMIC PROGRAMS



A BRIEF GUIDE TO COURSE DESCRIPTIONS

Each program described in this catalogue contains detailed descriptions of the courses offered within the program. A sample course description follows:

MA1234 Experimental Design 2½:1½:0:4

Principles of modern statistical experimentation, including practice using basic designs for scientific and industrial experiments and testing. Single factor experiments, randomized block design, Latin squares, Graeco-Latin squares; factorial and fractional factorial experiments; surface-fitting designs. *Prerequisite: MA 2244 Co-requisite: MA 1534* Also listed under IE 1234

The first line gives the official course number for which you must register the official course title, and the breakdown of periods for the course. In the sample description, the courses meet for 2½ lecture periods, 1½ laboratory periods and no recitation periods per week. If successfully completed, 4 credits are earned.

The paragraph description briefly indicates the contents and coverage of the course. A detailed course syllabus may be available on request from the office of the offering department.

“Prerequisites” are courses (or their equivalent) that must have been completed before registering for the described course. “Co-requisites” are courses taken concurrently with the described course.

The notation “Also listed...” indicates that the course is also given under the number shown. This means that two or more departments or programs are sponsoring the described course, and that you may register under either number, usually the one representing your major program. The classes are jointly given and held.

ACCELERATED MANAGEMENT OF TECHNOLOGY PROGRAM

Program Director: Nina Ziv

The Accelerated Management of Technology (AMOT) Program is a part-time intensive program in the management of technology, designed for participants who are recent college graduates or those who are in the early stages of their careers and want to pursue a degree in technology management. The aim of the AMOT program is to develop managers who are able to integrate their knowledge of technology and management and assume leadership positions in established firms as well as new ventures. The curriculum emphasizes innovation in various settings, new business models, strategic management issues and global management issues.

PROGRAM STRUCTURE AND CURRICULUM

The AMOT Program is composed of 10 courses (see listing below) for a total of 30 credits. Courses for the AMOT program are held during the evening at 55 Broad Street in Lower Manhattan and at the Brooklyn campus of Polytechnic. Participants must take at least 2 courses a semester and can finish the AMOT program in three semesters. Participants in the AMOT program receive a Master of Science in Management of Technology (MOT).

COURSES

The AMOT program has a series of required courses which provide participants with a deep understanding of the foundations of managerial competencies needed for managing innovation in the evolving business environment. In addition, participants can choose an elective from the Department of Technology Management or from other areas of the University which can enhance their understanding of a particular area of interest in the broadly defined arena of technology management.

CAPSTONE PROJECT

An important aspect of the AMOT curriculum is the capstone project in which participants integrate the themes and ideas learned during the course of the program into a final project. Participants work in a small group setting on in-depth case studies and research related to technology management. In fulfillment of the Capstone course, participants may also work with a faculty member and write a thesis on a topic of his or her choice.

A COMMUNITY PERSPECTIVE

One of the major goals of the AMOT program is to develop a community of learners that extends to strategic partners, faculty, participants, colleagues around the world, industry leaders and networks of people who can be called upon to enrich the experiences of the participants as well as of others in the community. The Institute for Technology and Enterprise (ITE), located at 55 Broad Street, which has served as a focal point for building managerial knowledge and developing learning programs particularly suited to technology-intensive settings is a major partner in developing this community. ITE is already committed to the Executive Master's programs and has a strong and mutually reinforcing relationship with these programs.

FACULTY

The faculty for the AMOT program includes full-time faculty from the Department of Technology Management, and faculty from other Departments at Polytechnic who give specialized courses in their field. In addition, practitioners from the field are regularly invited to participate in seminars and other events designed to enrich the participants' experiences.

ADMISSIONS CRITERIA

The AMOT program is selective. Candidates must have an undergraduate degree from an institution of higher learning either in the United States or abroad. Candidates are required to have a minimum of a 3.0 grade-point average or equivalent in their undergraduate degree. Candidates are required to take the Graduate Management Admission Test (GMAT) or Graduate Record Examination (GRE). International students are required to take the TOEFL exam.

AMOT CURRICULUM

Please see the Master's Management (MSM) Program in this catalog for course descriptions.

Required Courses

Course Title	Credits
MG 6093 Managerial Accounting and Finance	3
MG 8653 Managing Innovation	3
MG 6033 Organizational Behavior	3
MG 6503 Management of Information & Information Systems*	3
MG 6083 Managerial Economics	3
MG 6303 Operations Management	3
MG 6073 Marketing	3
MG 8203 Project Management	3
MG 9703 AMOT Capstone Project or equivalent	3
MG XX Elective**	3

**Note: To fulfill a requirement for a technology related course, participants can substitute other courses given by the Department of Technology Management in this field, e.g., MG 6603 Management of New and Emerging Technologies; MG 7503 Electronic Business Management; or another technology-related course with permission of the Program Director.*

**Electives

Note: Below are a list of selected electives given by the Department of Technology Management. Participants can also choose an elective given in other Departments of the University.

MG 7743 Advanced Topics in Technology Management
MG 8763 Knowledge Management
MG 6153 Leadership and Team Development
MG 8773 Managing Intellectual Property and Intellectual Capital
MG 7703 Entrepreneurship
MG 6143 Conflict Management

For more information on the program, please contact AMOT Administrative Program Director, Department of Technology Management, 55 Broad Street, Suite 13B, New York, NY 10004; mot-tim@poly.edu; 718-260-4014.



BIOINFORMATICS PROGRAM

Academic Director: Kalle M. Levon
Program Manager: Bhavin Vaishnav

Bioinformatics is a relatively new branch of science that organizes and interprets the overwhelming amount of data recently available on living organisms as a result of the human genome project and follow-up projects. The need for this branch of science is very real; while it is becoming increasingly simple to obtain experimental information on DNA, RNA and protein sequences and expression levels, the interpretation of this information is far from straightforward. There is a critical scarcity of individuals with the training in biology, chemistry, computer science and the specific methods of bioinformatics to interpret this data. The need is very real in academia and especially in industry. The need for individuals with a focused expertise in bioinformatics emerged a few years ago and is growing rapidly.

Polytechnic's MS in Bioinformatics is designed to provide a solid, carefully tailored program of study. It is responsive to the needs of (1) persons with BS degrees seeking entry into the field and (2) persons with advanced degrees who may be employed in sectors that now value and require such expertise. The latter typically have primary (PhD level) expertise in chemistry, molecular biology or chemical modeling, and may be employed in the biotechnology or pharmaceutical sectors. A master's program, with flexible on-site requirements and extensive use of Web-based or other remote-access training concepts, such as multimedia instruction, addresses the needs of both groups.

The curriculum is flexible, allowing sufficient exposure to and mastery of computer science skills to enable students to be effective in their home environments or competitive in the job market. In addition to traditional computer science, students gain expertise with such commercial databases as Oracle and Psibase, in addition to theory and hands-on experience with widely used methods in bioinformatics, including dynamic programming, profiles, hidden Markov chains and neural nets to predict protein secondary structure.

GOALS AND OBJECTIVES

The master of science program in bioinformatics is a crucial component in offering a mechanism to train individuals seeking reassignment to fast growing bioinformatics positions within the pharmaceutical or

biotechnological industries. The goal of the MS program is to fill the present educational needs with flexible on-site requirements and extensive use of web-based or other remote-access training concepts such as multimedia instruction. In addition to the traditional computer science components, the program entails training in commercial databases and exposure to theory and to hands-on experience with widely used methods in bioinformatics such as dynamic programming, profiles, hidden Markov chains and neural nets to predict protein secondary structure. Thus, the basic understanding of sequence analysis, protein structure prediction and the structure/function relationship are the core educational goals.

REQUIREMENTS FOR THE MASTER OF SCIENCE

The master of science degree is intended for students from various backgrounds seeking in-depth knowledge in informatics in chemical and biological sciences. Admission to the master's program requires a bachelor's degree from an accredited institution, with superior undergraduate academic record with completion of all prerequisite courses. Students not meeting all these requirements will be considered for admission on an individual basis and may be admitted subject to completing appropriate undergraduate courses to remove deficiencies.

Applicants who are otherwise sufficiently prepared for admission without undergraduate deficiencies may nevertheless be required to take specified undergraduate and introductory-level graduate courses. Such courses count towards a master's degree.

To satisfy the requirement for the degree Master of Science, students must complete a total of 30 units and hold an overall B grade in all graduate courses. Students must take all five of the required core courses and at least two of the basic core courses. The knowledge in all basic core courses is required, thus all of these courses are required unless such knowledge can be proven. Computational proficiency is expected.

Students may elect research and a thesis (9 units). An oral defense of the thesis is held after the typed written thesis has been submitted. A grade of A or B is required. Students not electing to write a thesis may elect to take from 3 to 6 units of guided studies (BI 7583, BI 7593) with submission of a written report. Electives can be selected from the existing courses.

Main Courses for the MS degree:

Basic Course courses	Units
BI 7513 Chemical Foundation for Bioinformatics	3
BI 7523 Biological Foundation for Bioinformatics	3
MA 5413 Stringology: Mathematics of String Comparisons in Computational Biology	3
CM 5713 Molecular Modeling and Simulation	3
CS 5303 Introduction to Programming and Problem Solving	3

Required Core Courses	Units
BI 7533 Bioinformatics I: Sequence Analysis	3
BI 7543 Bioinformatics II: Protein Structure	3
BI 7553 Bioinformatics III: Functional Prediction	3
BI 7563 Chemoinformatics	3
BI 7613 Systems Biology: Modeling of Biological Networks	3

GRADUATE COURSES

BI 7513 Chemical Foundation for Bioinformatics 3:0:0:3

An intensive review of those aspects of organic chemistry and biochemistry necessary to begin research in bioinformatics and to enter graduate courses in biology. Covalent bonding, quantum mechanical basis of bond formation, three-dimensional structure of molecules, reaction mechanisms, catalysis, polymers, enzymes, thermodynamic and kinetic foundations, metabolic pathways, sequence and structure of macromolecules. This course makes extensive use of computer approaches to convey the essential computational and visual nature of material to be covered. *Prerequisites:* CM102, general chemistry, general physics, organic chemistry and calculus.

BI 7523 Biological Foundation for Bioinformatics 3:0:0:3

An intensive review of those aspects of biochemistry, molecular biology and cell biology necessary to begin research in bioinformatics and to enter graduate courses in biology. Areas covered include cell structure, intracellular sorting, cellular signaling (receptors), Cytoskeleton, cell cycle, DNA replication, transcription and translation. This course makes extensive use of computer approaches to convey the essential computational and visual nature of the material to be covered. *Prerequisites:* CM102, general chemistry, general physics, organic chemistry, calculus or instructor's permission.

BI 7533 Bioinformatics I: Sequence Analysis 3:0:0:3

Computer representations of nucleic acid and protein sequences, pairwise and multiple alignment methods, available databases of nucleic acid and protein sequences, database search methods, scoring functions for assessment of alignments, nucleic acid to protein sequence translation and codon usage, genomic organization and gene structure in prokaryotes and eukaryotes, introns and exons, prediction of open reading frames, alternative splicing, existing databases of mRNA, DNA protein and genomic information. An overview of available programs and of resources on the web. Lab is an integral part of this course. *Prerequisites: None.*

BI 7543 Bioinformatics II: Protein Structure 3:0:0:3

Protein folding representations, databases of protein folding classes, secondary structure prediction, tertiary structure prediction via computer folding experiments threading, and homology model building, prediction of post-translation modification sites, active and binding sites in proteins, representations of contiguous and non-contiguous epitopes on protein surfaces at the sequence level, representations of functional motifs at the three dimensional and at the sequence level. Lab is an integral part of this course. *Prerequisite: BI 7533.*

BI 7553 Bioinformatics III: Functional Prediction 3:0:0:3

Functional classifications of proteins, prediction of function from sequence and structure, Orthologs and paralogs, representations of biological pathways, available systems for the analysis of whole genomes and for human-assisted and automatic functional prediction. Lab is an integral part of this course. *Prerequisite: BI 7543.*

BI 7563 Chemoinformatics 3:0:0:3

Review of database theory, chemical structure representation; connection tables, line notations, structure diagrams, representations of chemical reactions, structure manipulation: graph theory, structure analysis: ring perception, structural fingerprints, symmetry perception, molecular modeling algorithms, genetic algorithms, simulated annealing, QSAR historical approaches, structural search of chemical databases, commercial chemical information databases, combinatorial chemistry and diversity assessment.

BI 7573 Special Topics in Bioinformatics: Presentation at intervals of various advanced or specialized topics in chemo- or bioinformatics.

BI7583/-93 Guided Studies in Bioinformatics

As arranged.

BI 7603 Research in Bioinformatics

As arranged

Original research, which serves as basis for master's degree. Minimum research registration requirements for the master's thesis: 12 units. Registration for research required each semester consecutively until students have completed adequate research projects and acceptable theses and have passed required oral examinations. Research credits registered for each semester realistically reflect time devoted to research. *Prerequisites for MS candidates: Degree status and consent of graduate adviser and thesis director.*

BI 7613 Systems Biology: Modeling of Biological Networks 3:0:0:3

This course explains the functioning of basic circuit elements in transcription regulation, signal transduction, and developmental networks of living cells, using simplified mathematical models. The course focuses on design principles and information processing in biological circuits. It discusses network motifs, modularity, robustness, evolutionary optimization and error minimization by kinetic proof-reading in specific applications to bacterial chemotaxis, developmental patterning, neuronal circuits, and immune recognition in several well-studied biological systems. *Prerequisites: Undergraduate courses in elementary calculus and physical chemistry.*

CM 5713 Molecular Modeling and Simulation 3:0:0:3

Introduces students to principles and applications of modern molecular modeling and simulations methods, using commercially available software packages on powerful computer workstations. Algorithms for visualization and prediction of structural and physical properties of molecules and molecular aggregates are taught, based on the principles of quantum, classical and statistical mechanics, which will be reviewed in a mathematically simplified form. The accompanying laboratory part focuses on acquiring practical skills in application of commercial software packages to illustrative problems in physical chemistry, chemical engineering, biology and medicine. *Prerequisites: Completion of core undergraduate courses in mathematics and science (grade C or better) in CM, CH, ME, EE, CS, PH, CE or equivalent.*

MA 5413 Stringology: Mathematics of String Comparisons in Computational Biology 3:0:0:3

Addresses basic combinatorial problems of string manipulation—string matching, string editing, string distance computations, arising from areas of text processing, computational biology and genomics. Classical, modern and entirely new approaches to these problems will be presented with all necessary mathematical and computer science backgrounds. Emphasis is on practical and effective algorithm implementations.

THE MASTER OF SCIENCE IN BIOMEDICAL ENGINEERING

Academic Director: Richard A. Gross
Program Manager: Bhavin Vaishnar

GOALS AND OBJECTIVES

The primary goal of the MS in biomedical engineering program is to provide students with an in-depth, advanced education that gives them the tools needed to perform fundamental and applied research in biomedical engineering. Alternatively, students gain the requisite technical knowledge that they may wish to apply to management, marketing, sales and other entrepreneurial activities related to biomedical engineering. Specific objectives include:

- To enroll students who come from a wide array of disciplines and bring different skill sets to solve a broad range of biomedical engineering problems. The program is constructed to accommodate students that have a BS or a more advanced degree in: i) chemical engineering, ii) mechanical engineering, iii) electrical engineering, iv) computer science engineering, v) physics, vi) chemistry, vii) biology, viii) premedical, ix) bioengineering and x) biotechnology.
- To provide students with a cutting-edge program that integrates engineering, biological and medical sciences. Students will acquire the skills to participate in technological innovations that provide people with longer, healthier and more productive lives.
- To merge the leadership and talents found at Polytechnic in chemistry, biology, engineering, computer science, management, humanities with the expertise in medical sciences at SUNY Downstate Medical Center.
- To give students an opportunity to focus on a wide range of contemporary topics that are all important to various aspects of biomedical engineering. Students can choose courses in topics that include biomedical instrumentation, biomaterials, drug delivery, orthopedic devices, protein engineering, anatomy, biochemistry, immunology, bioinformatics and material science.
- To give students the option of doing research in the laboratories at Polytechnic and/or SUNY Downstate Medical Center. Students may also substitute research credits with course electives.

In the years ahead, health and human productivity can be vastly improved through major advances in medicine. These advances will happen through the successful, seamless

integration of biology and modern engineering. Scientists anticipate future breakthroughs ranging from the design of drugs customized to an individual's genome to the perfection of artificial implantable organs. Aggressive and intelligent integration of engineering and the biological and medical sciences will hasten the realization of these and other innovations, leading to longer, healthier and more productive lives. Scientists can now visualize structures inside the body with a level of clarity thought impossible only a decade ago. With the improved diagnosis that comes from these advances and those that will follow, further discoveries in the area of treatment will be added. Today, miniature devices can be manipulated through endoscopes, making it possible to perform surgical procedures with minimal invasion and thus minimal trauma to the patient. In the future, the microfabrication of biomedical devices at Polytechnic and elsewhere will further enable surgery and increase the functionality of the physically impaired in applications ranging from congenital defects to improving the function of major organs, such as the heart, kidneys and liver. Other areas show similar promise-breakthroughs in human tissue research point to the possibilities of replacing damaged or diseased bone, cartilage, and other tissues with newly engineered materials. Bioresorbable materials will substitute for permanent implants allowing recovery of tissues with subsequent clearance from the system of the degraded implant material. New imaging systems are emerging that provide new information and monitoring possibilities. Wireless technology will integrate into medical devices and home-care systems. There is little doubt that these and other extraordinary developments will dramatically impact lives over the next few decades. By merging the leadership and talents found at Polytechnic in engineering, chemistry, biology, computer science, management, humanities with the expertise in medical sciences at SUNY Downstate Medical Center, the Biomedical Engineering Program provides its students a broad range of opportunities. The partnership between Polytechnic and SUNY Downstate is dedicated to this new mode of biomedical education, and to the development of students with both practical and fundamental knowledge. Students in the program move freely between the Polytechnic University and SUNY Downstate, taking advantage of both facilities, their faculty and associated research programs. Polytechnic's goal is to provide

students with the best in classroom and laboratory education, to give them the skills to succeed in the wide range of opportunities that will be open to them upon graduation.

A Perfect Formula for a Successful Biomedical Engineering Program

The strategic alliance between SUNY Downstate Medical Center and Polytechnic University created the framework that has resulted in Downstate's important contribution to Polytechnic's Master of Science in Biomedical Engineering Program. The two institutions have coextensive research interests with complementary technological expertise. Noteworthy common areas of scientific investigation include:

- Biosensors
- Telemetry
- Neurorobotics
- Optical imaging
- Bioresorbable Biomedical Materials
- Drug Delivery
- Protein and Glycolipid Therapeutics
- Tissue Engineering
- Microchip Sensors

FULL-AND PART-TIME STUDENTS

Students entering this master's program may wish to complete their degree rapidly by taking a full course load, or proceed at a slower pace if they are working professionals with other full-or part-time commitments. The curriculum structure and class schedule for this program accommodates both part-time and full-time students. Thus, most 3-credit courses offered are given as two and-a-half hour lectures one evening per week during a 15-week semester. Evening research opportunities are also available.

ADMISSION AND DEGREE REQUIREMENTS

The Master of Science degree is intended for students from various backgrounds seeking in-depth knowledge in biomedical engineering. Students may apply to the master's program if they have one or more of the following: (1) BS or a more advanced degree in any engineering discipline, (2) BS or more advanced degree in mathematics, or (3) BS or more advanced degree in any of the natural sciences. Students entering the program should have a minimum of two-semester of college-level calculus (see POLY course descriptions for mathematics, MA 1024, and MA 1124), two semesters of college-level physics (see POLY course descriptions for physics, PH 1004 and PH 2004, 2-semester

of college-level chemistry (see POLY course descriptions for Chemistry, CM 1014 and CM 1024). For students choosing to focus on the biomaterials and polymer therapeutics track, additional background in organic chemistry is desirable. For students choosing to focus on the bioimaging and neuroengineering track, additional advanced courses in mathematics (e.g., POLY courses MA 2132, ordinary differential equations; and MA 2112/2122 in multi-variable calculus). Students that lack undergraduate courses described above may be admitted to the program contingent upon the student satisfying certain course work deemed necessary for the student's success in the MS in biomedical engineering program. To help students in the program raise their level of knowledge in chemical and biochemical concepts specific to advanced courses in the bioimaging and neuroengineering track, BE 6653, principles of Chemical and Biochemical Systems for Engineers, was developed and is offered. A program adviser will review with successful applicants what undergraduate courses, if any, must be taken. Such courses will not count towards the master's degree.

THE CURRICULUM

Requirements for the Master of Science

Biomedical Engineering – Biomaterials and Polymer Therapeutics track

To meet graduation requirements, students must have an overall B average in all courses (including MS thesis, research or guided studies) and must not obtain more than two grades of C in required (core) subjects.

Required (core) courses for all students in the Biomaterials and Polymer Therapeutics Track who are fulfilling their requirements for an MS in biomedical engineering.

Core required courses (3 credits each)

- Choose one of the following:
 - BE 6003 Principles of Biological Systems (co-listed as CM 9503)
 - BE 6023 Cellular and Molecular Neuroscience
 - CM 9413 Biochemistry I
 - CM 9423 Biochemistry II
- BE 6703 Materials in Medicine
- Choose one of the following:
 - CM 7723 Synthesis of Macromolecules
 - CM 7813 Characterization of Macromolecules
 - CBE 7263 Engineering Properties of Polymers
 - BE 6723 Natural Polymers and Materials (co-listed as CM 7923)
 - CBE 7283 Polymer Composites
- Choose one of the following:
 - BE 6603 Drug Delivery
 - CBE 8373 Engineering Principles of Drug Delivery
- Choose one of the following:
 - BE 6253 Biosensors
 - BE 9433 Protein engineering

- 6. BE 9443 Tissue Engineering
- 7. BE 6753 Biomechanics and Biomaterials in Orthopedics

In addition, during at least two semesters, biomedical engineering MS students are required to register for Colloquium in Biomedical Engineering (BE 8730, 0-credits) and attend seminars.

For all students in the Biomaterials and Polymer Therapeutics Track, remaining credits (9) must be selected from the following list of electives unless permission is granted by the biomedical engineering graduate adviser to substitute a course not on the list below. The student may also choose to take the remaining 9 credits to do research and complete a master's thesis (see below). This requires that students take 9-credits of BE 997x and then write/defend their master's thesis according to University guidelines. Students may also elect to take research in biomedical engineering courses (873x, 3 to 6 credits) without writing a thesis.

9 credits selected from the following courses or research credit options:

- BE 6003 Principles of Biological Systems (co-listed as CM 9503)
- BE 6013 Molecular Immunology
- BE 6023 Cellular and Molecular Neuroscience
- BE 6203 Biomedical Imaging I
- BE 6213 Biomedical Imaging II
- BE 6253 Biosensors
- BE 6503 Biomedical Instrumentation
- BE 6603 Drug Delivery
- BE 6653 Principles of Chemical & Biological Systems
- BE 9433 Protein Engineering
- BE 9503 Enzyme-Catalysis in Organic Synthesis (co-listed as CM 9053)
- BE 6723 Natural Polymers and Materials (co-listed as CM 7923)
- BE 6303 Bio-optics
- BE 871x Guided Studies in Biomedical Engineering
- BE 6353 Special Topics in Biomedical Engineering
- CBE 8373 Engineering Principles of Drug Delivery
- CBE 8313 Biointerfacial Engineering
- CBE 8813 Biochemical Engineering
- CBE 7263 Engineering Properties of Polymers
- CBE 7283 Polymer Composites
- BT 6013 Biotechnology and the Pharmaceutical Industry (3 credits)
- BT 6023 Biotechnology & Health Care (3 credits)
- BT 7013 Special Topics in Biotechnology (3 credits)
- CM 7723 Synthesis of Macromolecules
- CM 7813 Characterization of Macromolecules
- CM 7533 Bioinformatics I: Sequence Analysis
- CM 7543 Bioinformatics II: Protein Structure
- CM 8213 Bioanalytical Chemistry (3 credits)
- CM 7043 Statistical Thermodynamics and Kinetics
- CM 9033 Physical Organic Chemistry
- CM 8023 Principles of Spectroscopy
- CM 8073 Organic Spectroscopy
- CM 6013 Advanced Inorganic Chemistry
- CM 9413 Biochemistry I
- CM 9423 Biochemistry II
- MT 6003 Structure-Property Relationships in Materials (3credits)
- BE 873x Research in Biomedical Engineering
- BE 875x Thesis for Degree of Master of Science in Biomedical Engineering

Students who choose the master's thesis option must register for at least 9-credits of BE 997x, and then write/defend a master's thesis according to University guidelines. Alternatively, students may choose to take up to six credits in Biomedical Engineering Research (BE 873x) without writing/defending a masters thesis.

Total: 30 credits

BIOMEDICAL ENGINEERING – BIOIMAGING AND NEUROENGINEERING TRACK

Requirements for the Master of Science

To meet graduation requirements, students must have an overall B average in all courses (including MS thesis, research or guided studies) and must not obtain more than two grades of C in required (core) subjects.

Required (core) courses for students in the Bioimaging and Neuroengineering Track fulfilling their requirements for an MS in biomedical engineering are listed below.

Required courses (3 credits each)

- Choose one of the following:
- BE 6003 Principles of Biological Systems (co-listed as CM 9503)
 - CM 9413 Biochemistry I
 - BE 6023 Cellular and Molecular Neuroscience
 - BE 6703 Materials in Medicine
 - BE 6203 Biomedical Imaging I
 - BE 6253 Biosensors
 - BE 6503 Biomedical Instrumentation (co-listed with EL 9123)
 - Choose one of the following:
 - BE 6603 Drug Delivery
 - CBE 8373 Engineering Principles of Drug Delivery
 - Choose one of the following:
 - BE 6213 Biomedical Imaging II
 - BE 6353 Image Processing (co-listed as EL 5123)
 - BE 6403 Signals and Systems (co-listed as EL 6113)
 - BE 6453 Probability (co-listed as EL 6303)
 - BE 6483 DSP laboratory (co-listed as EL 6183)

In addition, during at least two semesters, biomedical engineering MS students are required to register for Colloquium in Biomedical Engineering (BE 8730, 0-credits) and attend seminars.

For all students in the Bioimaging and Neuroengineering Track, remaining credits (9) must be selected from the following list of electives unless permission is granted by the biomedical engineering graduate adviser to substitute a course not on the list below. The student may also choose to take all 9 of the remaining credits to do research and complete a master's thesis (see below). This requires that students take 9-credits of BE 875x and then write/defend their master's thesis according to University guidelines. Students may also elect to take one or two research in biomedical engineering courses (873x) without writing a thesis.

Choose 3 courses or a total of 9-credits from the following list:

BE 6003	Principles of Biological Systems (co-listed as CM 9503)
BE 6023	Cellular and Molecular Neuroscience
BE 6013	Molecular Immunology
BE 6653	Principles of Chemical and Biochemical Systems
BE 6213	Biomedical Imaging II
BE 6503	Biomedical Instrumentation
BE 6603	Drug Delivery
BE 9433	Protein Engineering
BE 9503	Enzyme-Catalysis in Organic Synthesis (co-listed as CM 9053)
BE 6723	Natural Polymers and Materials (co-listed as CM 7923)
BE 6303	Bio-optics
BE 871x	Guided Studies in Biomedical Engineering
BE 6353	Image Processing (co-listed as EL 5123)
BE 6403	Signals and Systems (co-listed as EL 6113)
BE 6453	Probability (co-listed as EL 6303)
BE 6483	DSP laboratory (co-listed as EL 6183)
BE 6353	Special Topics in Biomedical Engineering
EL 5223	Sensor Based Robotics
CBE 8373	Engineering Principles of Drug Delivery
BT 6013	Biotechnology and the Pharmaceutical Industry (3 credits)
BT 6023	Biotechnology & Health Care
BT 7013	Special Topics in Biotechnology
CM 7533	Bioinformatics I: Sequence Analysis
CM 7543	Bioinformatics II: Protein Structure
CM 7713	Introduction to Polymer Science
CM 7823	Macromolecules in the Solid State
CM 8213	Bioanalytical Chemistry
CM 8023	Principles of Spectroscopy
CM 8073	Organic Spectroscopy
CM 9413	Biochemistry I
CM 9423	Biochemistry II

MT 6003 Structure-Property Relationships in Materials

BE 873x Research in Biomedical Engineering
BE 997x Thesis for Degree of Master of Science in Biomedical Engineering

Students who choose the master's thesis option must register for at least 9-credits of BE 997x, and then write/defend a master's thesis according to University guidelines. Alternatively, students may choose to take up to six credits in Biomedical Engineering Research (BE 873x) without writing/defending a masters thesis.

Total: 30 credits

ADVANCED CERTIFICATE PROGRAMS

The Biomedical Engineering Program administers two certificate programs: (1) Biomedical Materials and (2) Bioinstrumentation. The Advanced Certificates in Biomedical Materials and Bioinstrumentation are intended for students from various backgrounds seeking in-depth knowledge in a specialty area within biomedical engineering. Students may apply to the certificate program if they have one or more of the following:

(1) BS or a more advanced degree in any engineering discipline, (2) BS or more advanced degree in mathematics and/or (3) BS or more advanced degree in any of the natural sciences. The program adviser reviews with successful applicants prerequisites that may be required for successful completion of certificate courses. A certificate program requires four courses (12 credits), designed for working professionals who seek advanced training in a specific subject area within the Biomedical Engineering Program. Students must have an average of B or better in all graduate courses. Upon completion of a sequence with an average grade of B or better, students are issued Advanced Certificates. Those who choose to work towards the master's degree in biomedical engineering are able, upon admission, to apply all courses taken toward a certificate toward fulfilling the degree program. Additional information may be obtained from the department. To satisfy the requirement for the Advanced Certificate in Biomedical Materials, students must complete a minimum of 12 credits.

1. Certificate Requirements for an Advanced Certificate in Biomedical Materials

Required:

1. BE 6703 Materials in Medicine
2. BE 6723 Natural Polymers and Materials
3. One of the following courses:
 - CM 7723 Synthesis of Macromolecules
 - CM 7813 Characterization of Macromolecules
 - CBE 7263 Engineering Properties of Polymers
4. One of the following courses:
 - BE 6603 Drug Delivery
 - BE 6253 Biosensors
 - BE 9433 Protein engineering
 - BE 9443 Tissue Engineering
 - BE 6753 Biomechanics and Biomaterials in Orthopedics

2. Certificate Requirements for an Advanced Certificate in Bioinstrumentation

Required:

1. BE 6703 Materials in Medicine
2. BE 6203 Biomedical Imaging I
3. BE 6253 Biosensors
4. BE 6503 Biomedical Instrumentation

GRADUATE COURSES

Course descriptions of biomedical engineering courses as well as CM and CBE courses associated with the MS in Biomedical Engineering Program are given below. Other courses that are not described below, but are listed in the biomedical engineering program can be found in the description of courses from their respective departments in other sections of this catalogue.

BE 6013 Molecular Immunology 3:0:0:3

Familiarizes students with the body of research that forms the foundation of our present understanding of the molecular basis and the cellular interactions that regulate the immune responses. The principal tool of learning is the reading and discussion of research papers in immunology by a small group of students supervised by a faculty member who is active in the specific research area. The topics to be covered include antibody structure, B-cell development, T-cell structure and development, T-cell-MHC interaction, MHC structure and antigen processing, complement chemistry, complement and Fc receptor structure and function, transplantation immunogenetics, mucosal immunology and allergic reactions. *Prerequisite: undergraduate biochemistry.*

BE 6023 Cellular and Molecular Neuroscience 3:0:0:3

A comprehensive overview of cellular neuroscience that consists of 20 lectures and two exams. Course is roughly divided into three parts: (1) the physiology and biophysics of neurons; (2) neuronal signal transduction, gene expression and transport of RNA and protein; and (3) synaptic transmission and plasticity. The textbook is *Fundamental Neuroscience* by Zigmond, Bloom, Landis, Roberts and Squire with supplementary readings provided from other textbooks as well as relevant journal articles. *Prerequisites:* CM 9506 or its equivalent and undergraduate biochemistry.

BE 6203 Biomedical Imaging I 3:0:0:3

This course introduces the physics, instrumentation, and signal processing methods used in X-ray imaging (projection radiography), X-ray computed tomography, nuclear medicine (SPECT/PET), ultrasound imaging, and magnetic resonance imaging. Co-listed as EL582. *Prerequisite:* Multivariable calculus (MA2112, MA2122), physics (PH2004), probability (MA3012)-open to graduate students and upper-level UG students. *Co-requisite:* Signals and systems (EE3054, preferred but not required).

BE 6213 Biomedical Imaging II 3:0:0:3

This course introduces the mechanisms and concepts related to image acquisition and subsequent image processing and image formation in various biomedical imaging modalities. Building on material covered in Biomedical Imaging I, these courses focus on advanced topics such as functional magnetic resonance imaging (MRI), ultrasound imaging, biomagnetic imaging and optical tomographic imaging (OTI). Co-listed as EL682. *Prerequisite:* BE 6203 (Biomedical Imaging I, B).

BE 6253 Biosensors 3:0:0:3

Discussion of various biosensors, which consist of bio-recognition systems, typically enzymes or binding proteins such as antibodies, immobilized onto the surface of physicochemical transducers. Immuno-sensors, which use antibodies as their biorecognition system, are also discussed. Other bio-recognition systems discussed are nucleic acids, bacteria, and whole tissues of higher organisms. Specific interactions between the target analyte and the complementary bio-recognition layer that undergoes a physicochemical change is ultimately detected and measured by the transducer. Various transducers, which

can take many forms depending upon the parameters being measured-electrochemical, optical, mass and thermal changes are also part of the course. *Prerequisite:* CM 1004, CM 2214, CM 2614 and CM 9413.

BE 6303 Bio-optics 3:0:0:3

Recent growth in the use of optics technology for biomedical research and health care has been explosive. New applications are made possible by emerging technologies in lasers, optoelectronic devices, fiber optics, physical and chemical sensors and imaging-all of which are being applied to medical research, diagnostics, and therapy. This sequence course on optics for biomedical students combines fundamental knowledge of the generation and interaction of electromagnetic waves with applications to the biomedical field. It is hoped that this approach will not only provide tools for researchers in bio-physics, but also familiarize researchers, technologists and premed students with cutting-edge approaches. *Prerequisite:* an undergraduate course in physics that includes electricity, magnetism and waves such as PH 2004. Multivariable Calculus CMA 2112, MA 2122.

BE 6353 Special Topics in Biomedical Engineering 3:0:0:3

Topics of special interest in Biomedical Engineering are announced in advance of each semester in which they are offered. *Prerequisite:* adviser's approval.

BE 6503 Biomedical Instrumentation 3:0:0:3

This course, intended for graduate students in the Bioengineering Program, introduces them to the principles of some of the most commonly used instruments in neuroscience research, particularly in electrophysiology and imaging. Theoretical considerations in choice of appropriate techniques as well as practical issues in choice of materials and design of experiments will be discussed. *Prerequisite:* adviser's approval.

BE 6603 Drug Delivery 3:0:0:3

Provides an integrated approach to the basic and clinical science of drug delivery. This course discusses the following: highlights of the historical development of drug delivery; kinds of drugs to be delivered, including genes and proteins; various targeting mechanisms; pharmacokinetics and pharmacodynamics of drug delivery systems, polymeric drug delivery systems; various devices developed for controlled delivery. *Prerequisite:* In-

troductory undergraduate courses in biology, chemistry and physiology (minimum grade C).

BE 6653 Principles of Chemical and Biochemical Systems 3:0:0:3

Introductory course for graduate engineering students that focuses on providing fundamental knowledge of chemical and biochemical reactions. Students learn structure and function of biological molecules such as proteins, carbohydrates, DNA. They master basic concepts of structure-property relationships of macromolecules. Chemistries critical to biosensor technologies such as, linking biological molecules to various supports, is described. Students gain an appreciation and understanding of the wide-range of chemical and biological molecules that are critical to living systems. *Prerequisite:* Instructor's permission.

BE 6703 Materials in Medicine 3:0:0:3

Focuses on the following: the basic principles behind human tissue response to artificial surfaces and materials; the general types of polymeric and metallic materials used in soft and hard tissue replacements; tissue engineering and drug delivery devices; current approaches directed toward the engineering of cell based replacement for various tissues; techniques utilized to control the physiologic response to artificial surfaces; critical review of the current biomaterials literature; current research in the field; and evaluation of the design criteria which a material must meet for a given biological application and what is required for "biocompatibility." *Prerequisites:* Introductory undergraduate courses in biology, chemistry, and physiology. Courses in polymers, biochemistry, molecular/cellular biology and immunology are helpful but are not essential.

BE 6753 Biomechanics and Biomaterials in Orthopedics 3:0:0:3

Provides students with fundamental knowledge of the relevant background science, theory, practice, and materials required to provide modern orthopedic and trauma care. Students learn about biomaterials used in orthopedics and how they have become increasingly sophisticated through materials engineering. The course covers important clinical applications as well as fundamental concepts in biomechanics of bone and other tissues, materials used, wear and corrosion during use, dental implants, joint replacement devices and more. *Prerequisite:* BE 6703 Materials in Medicine.

BE 871x Guided Studies in Biomedical Engineering

Selections, analyses, solutions, and presentations of biomedical engineering reports for problems in products, processes or equipment design, or other fields of biomedical engineering practices under supervision of a faculty member. Conferences scheduled. Master's degree candidates are required to submit three unbound copies of their reports to advisers one week before the last day of classes. Credits: 6 total, each 3 credits. *Prerequisite: degree status.*

BE 9433 Protein Engineering 3:0:0:3

This course will introduce students to the modern protein engineering techniques available to researchers to understand protein structure and function and to create entirely new proteins for a variety of purposes. This is a new field that lies on the interface of chemistry, biology and engineering. The first part of the course will discuss the protein composition and structure, various genetic, biochemical and chemical techniques required to engineer proteins, which then will be followed by specific topics. Topics will include designing proteins that are highly structured; active at high temperatures and in non-aqueous solvents; that selectively interact with other proteins, small molecules and nucleic acids for therapeutic purposes; and that catalyze new reactions. *Prerequisite: CM9413 or adviser's approval.*

BE 9443 Tissue Engineering 3:0:0:3

This course instructs students in the following: i) basic biological processes that occur during blood contact with artificial surfaces, ii) how to critically read and review the literature in the field of tissue engineering, iii) how to anticipate biocompatibility issues relevant to a variety of implant devices that the student may encounter in future endeavors, iv) current approaches directed toward the engineering of cell-based replacements for various tissue types. *Prerequisite: Adviser's approval.*

BE 6723 Natural Polymers and Materials 3:0:0:3

Introduction to natural and biomimetic polymers taught with an interdisciplinary view of biology, chemistry and macromolecular science. Topics covered in this course include: natural building blocks and methods by which nature carries out polymer synthesis and modification reactions; DNA; structural proteins; plant proteins; polysac-

charides; polyesters; biosurfactants; polymers built from natural monomers and a wide variety of renewable resources; uses of these polymers as fibers, films, rheological modifiers, flocculants, foams, adhesives and membranes; special applications of natural polymers in medicine and as biodegradable plastics. Co-listed as CM 7923. *Prerequisite: CM 1004 and LC 1004.*

BE 9503 Enzyme-Catalysis in Organic Synthesis 3:0:0:3

Provides students with a working knowledge of how to use biotransformations as a tool in organic chemistry. Students will learn about general enzymatic reaction types that carry out the cleavage and formation of C-O bonds, P-O bonds, C-N bonds, C-C bonds, reduction reactions, oxidation reactions and isomerizations. In addition, students will be taught about advanced principles that are currently being applied to the engineering of catalytic proteins. Co-listed as CM 9053. *Prerequisite: CM 2214, CM 2614 and CM 3314.*

BE 6003 Principles of Biological Systems 3:0:0:3

Physiology is defined as the science that deals with the functions of the body. It logically follows, therefore, that a sound, comprehensive knowledge of human physiology should occupy a significant part of the academic training of personnel in medicine and related fields. The emphasis is on normal functions, but also considers the consequences of disease and injury, and deal with the body's potential for recovery and for compensation.

Behavioral responses to environmental conditions are considered, but in this area our chief concern will be with the regulation and control of fundamental reflexes or neuro-endocrine mechanisms. *Prerequisite: None, although some background of biochemistry and gross and cellular anatomy would be helpful. Co-listed as CM 9503. Prerequisite: None.*

BE 6403 Image Processing 3:0:0:3

Image formation and perception; image acquisition, representation and display; image sampling and resizing; contrast enhancement; two-dimensional Fourier transform and other unitary transforms; frequency domain and spatial domain linear filtering; median and morphological filtering; image smoothing, sharpening, and edge detection through linear and nonlinear filtering; color image representation and processing; lossless and lossy-image coding techniques and stan-

dards, image deblurring; imaging geometry, image registration and geometric transformation. C- or MATLAB implementation of selected imaging processing algorithms. Co-listed as EL5123. *Prerequisites: Graduate student status or EE3054 and MA3012.*

BE 6403 Signals, Systems and Transforms 3:0:0:3

Continuous and discrete linear systems, system function. Fourier transforms, periodic functions, Z transforms, discrete Fourier series, fast Fourier transforms. Magnitude Characteristics of LTI systems, All-pass Systems and Properties. Analog and digital filters, finite order system functions. Digital processing of analog signals. Sampling theorems. Co-listed as EL6113. *Prerequisite: Graduate status.*

BE 6453 Probability Theory 3:0:0:3

The axiomatic definition of experiment and probability. Conditional probability. Bayes' Theorem, Notion of independence. Repeated trials. Bernoulli trials and their limiting forms. The concept of a random variable. Probability distribution and density functions. Probability mass functions. Examples of random variables: Normal(Gaussian), Poisson, Gamma, Exponential, Laplace, Cauchy, Rayleigh, etc. Bayes' Theorem revisited. Functions of one random variable and their density functions. Expected value of a random variable: mean, variance, moments, and characteristic functions. Two random variables: Joint distribution and joint density functions of two random variables, independence. One function of two random variables. Two functions of two random variables. Order statistics. Joint moments, Uncorrelatedness, orthogonality, joint characteristic function. Jointly Gaussian random variables. Conditional distribution and conditional expected values. The central limit theorem. The principle of maximum likelihood. Elements of parameter estimation. Maximum likelihood estimation for unknown parameters. Unbiased estimators and their variances. Co-listed as EL 6303. *Prerequisites: Graduate status and MA 3012.*

BE 6483 Digital Signal Processing Laboratory 1.5:1.5:0:3

This course includes hands-on experience with a set of laboratory experiments, lectures and projects relating to real-time digital signal processing (DSP) systems using a DSP microprocessor. Students will gain experience in the implementation of common algorithms used in a variety of applications, and will learn tools and functions important for the design of DSP-based systems. Students are required to complete a project and provide an oral presentation. This course is suitable for students interested in DSP and Embedded Systems. Co-listed with EL 6183. *Prerequisites: EL 6113 or Equivalent, C/C++.*

PROJECTS, THESES AND SEMINARS

BE 873x Research in Biomedical Engineering

Fundamental or applied research in biomedical engineering that is performed under supervision of a faculty member. Conferences scheduled. Master's degree candidates are required to submit three unbound copies of their reports to advisers one week before the last day of classes. Credits: 6 total, each 3 credits. *Prerequisite: Degree status.*

BE9730 Colloquium in Biomedical Engineering

Recent developments in biomedical engineering are presented by engineers and scientists from industry and academia. Two and four semesters are required for master's and PhD students, respectively. Credits: 0. *Prerequisite: None.*

BE997x Thesis for Degree of Master of Science in Biomedical Engineering

Thesis for the master's degree in biomedical engineering should give results of original investigation of problems in biomedical engineering or application of physical, chemical or other scientific principles to biomedical engineering. Thesis may involve experimental research, theoretical analyses or process designs, or combinations thereof. Master's degree candidates are required to submit four unbound copies to advisers before the seventh Wednesday prior to commencement. Registration of at least 9 credits required. Credits: 9 total, each 3 credits. *Prerequisite: Degree status.*

FACULTY

PARTICIPATING FACULTY FROM SUNY DOWNSTATE MEDICAL CENTER

Randall Barbour, Professor of Pathology, SUNY Downstate; Research Professor of Electrical Engineering, Polytechnic University PhD, Syracuse University
Development of optical tomographic imaging methods for the evaluation of tissue function

Martin H. Bluth, MD, PhD, Director of Research, Assistant Professor of Surgery, Medicine and Pathology, SUNY Downstate Medical Center
Peripheral blood mononuclear cell and immunoglobulin regulation in inflammatory disease; intracellular adhesion and selection mediated leukocyte circulation and migration patterns in inflammation; biomarker development and novel therapeutics in inflammatory disease.

John K. Chapin, Professor, Department of Physiology and Pharmacology PhD, University of Rochester, School of Medicine and Dentistry
Emerging computer and electronic technologies are used to establish real-time control of a robotic prosthesis using signals derived from neuronal population recordings in motor cortex. The goal is to restore motor functions to paralysis patients by extracting "motor" commands from their brains, and using the "motor" commands to control robots, or their own limbs. A long-range goal is to combine motor prostheses with somatosensory prostheses that could substitute for the information normally provided by the skin. Similarly technology will make it possible to remotely control the navigational goals of animals that can carry sensors into otherwise inaccessible areas.

Miriam H. Feuerman, Associate Professor, Department of Biochemistry PhD, University of California at Irvine
Molecular mechanisms that separate controlled normal growth from carcinogenesis; regulation of gene expression in liver regeneration and tumorigenesis

Brehon C. Laurent, Assistant Professor, Department of Microbiology and Immunology PhD, Massachusetts Institute of Technology
The control of two cellular processes in the context of chromatin structure: transcriptional initiation and progression through the mitotic cell division cycle

Josef Michl, Associate Professor, Department of Pathology; Associate Professor, Department of Anatomy and Cell Biology; Associate Professor, Department of Microbiology and Immunology MD, Johannes Gutenberg Universitaet Mainz (Germany)

Cells involved in host defense mechanisms against infectious agents and tumors; the process of carcinogenesis in the exocrine pancreas in animals and humans using tissue culture and cell cloning, immunological, ultrastructural and biochemical as well as cell and molecular biological approaches and techniques

André A. Fenton, Assistant Professor, Department of Physiology and Pharmacology PhD, State University of New York Downstate Medical Center.

Neural coordination: The brain stores memories, associations between stimuli and between stimuli and responses in neural representations of experience and knowledge. We study the physiology of the hippocampus to understand how memory is stored and how neural activity is coordinated to selectively activate and suppress these representations.

BIOMOLECULAR SCIENCE PROGRAM

Program Director: Michael Joesten

Advances in biology, particularly at the cellular and molecular level, are changing the world that we live in. The basic knowledge of the way nature functions to create and sustain life on earth is increasingly applied to the health care industry, to feeding an expanding world population, to producing cheap energy from renewable sources, to cleaning up the environment. Biology is the enabling science of the 21st century and will create numerous opportunities in the job market in the years to come. The BS in biomolecular science lies at the interface between biology and chemistry and is designed to build upon the understanding of biology at the molecular level. The curriculum also provides a strong foundation in both mathematics and physics. This broadly based science education is a prerequisite for successful careers in industry and governmental laboratories, and for professional or graduate studies in the biological sciences, medicine and other health-related fields.

The BS in biomolecular science has three options to meet the diverse needs of our students. The option in biomedical science is designed to provide students with the fundamental knowledge and skills needed for employment in the rapidly changing bio-related industries or to pursue advanced professional or graduate degrees. The curriculum is highly innovative, spans the boundaries between biology and chemistry and involves considerable exposure to research. The option in biotechnology is oriented towards the need of students who plan to work for the fast-growing biotechnology industry. The nature of the industry has dramatically changed in the last decade, with technologies based on human gene therapy taking their place alongside the production of antibiotics, vaccines, hormones in technologies based on genetic engineering. This option provides a large choice of elective courses that would meet both the specific needs and interests of individual students. The option in chemistry inherits the rich traditions of Polytechnic in providing excellent education in chemistry, now combined with a fundamental knowledge of biology, to prepare students for employment in pharmaceutical and related companies. Graduates will also be prepared for positions at educational and/or research institutions and governmental laboratories. The research opportunities provided by this option will prepare students for pursuing graduate de-

grees in chemistry as well as degrees that border on biology.

GOALS AND OBJECTIVES

The goal of the BS in biomolecular science is to provide students with the fundamental knowledge and skills needed to advance to work in the rapidly changing bio-related industries or to pursue advanced professional or graduate degrees. This is accomplished through an innovative curriculum that spans the boundaries between biology and chemistry and through exposure to research. In this way, the program is designed to attract and train students who are adaptable and active learners.

The BS in biomolecular science, option in chemistry, with an appropriate selection of electives, is certified by the American Chemistry Society (ACS) to be a rigorous academic program, which is valued by both potential employers and graduate schools. ACS-certified graduates are immediately eligible for society membership.

BS/MS ACCELERATED HONORS OPTION

The BS/MS Accelerated Honors Option leads to the simultaneous awarding of bachelor's and master's degrees. Depending on the student's preparation and objective, the two degrees may be completed in as few as four years of study. Each program is individually designed in cooperation with the departmental BS/MS adviser to allow varied transfer and AP credits, professional summer jobs, and other goals consistent with the honors option. Possible BS/MS combinations include a BS in biomolecular science with an MS in chemistry, bioinformatics, biotechnology or biomedical engineering. Incoming freshman with superior admissions qualifications are invited to participate in the Accelerated Honors Program. Later admission may be considered after students complete no more than one year at Polytechnic. Students must complete 16 to 20 credits each semester, maintain a 3.5 GPA average, and display a record free of course repetitions. The required courses for the two degrees include all courses required for individual BS and MS degrees, except for Senior Research Project II (either BMS 4924 or CM 4924), and all curriculum footnotes apply. Required credits are the sum of the credits for the two degrees minus the 4 credits for Senior Research Project II. Students in this program must complete a Master's Thesis. (No Bachelor's Thesis is required.)

Acceleration may be achieved through summer course work, extra course loads, careful sequencing or credit by examination. Students may also achieve acceleration through advanced placement credit in such courses as biology, calculus, chemistry, computer science or physics.

MEDICAL SCHOOL EARLY ASSURANCE GUARANTEED ADMISSIONS PROGRAM

Polytechnic and SUNY Downstate Medical Center have created the Medical School Early Assurance Guaranteed Admissions Program. Through the program, five slots are reserved in the first-year medical school class for graduating Polytechnic students. Students majoring in biomolecular science who satisfy certain requirements are eligible for this program. Contact the department of Chemical and Biological Sciences Department for further information.

REQUIREMENTS FOR THE BACHELOR OF SCIENCE

Subject	OPTION		
	Biomedical Science	Biotechnology	Chemistry
Chemistry	33cr	33cr	36cr
Biology	26	18	8
Research*	8	8	8
Chemical & Biological Engineering	0	0	4
Computer Science	4	4	4
Humanities/Social Sciences	26	26	28
Mathematics	8	8	12
Physics	8	8	8
Technical electives	15	23	20
Total	128	128	128

A minimum of 128 credits is required for the BS in Biomolecular Science.

**Students registering for research are required to submit a written report prior to graduation. Students may elect to write an undergraduate thesis.*

UNDERGRADUATE COURSES

BMS 1004 Introduction to Cell and Molecular Biology 3:3:0:4

Fundamentals of biology. Physical, chemical and biochemical bases of life on various organizational levels, cellular morphology, complementarity of form and function, including reproduction, development and genetics.

BMS 2004 Introduction to Physiology 3:3:0:4

Fundamentals of biology, continued. Emphasis on evolutionary theory, phylogeny and comparative physiology including homeostasis, regulation, integration and coordination of organisms at the systems level. *Prerequisite: BMS 1004 or instructor's permission.*

BMS 2512 Biostatistics 2:0:0:2

Concise introduction to statistical methods used in biology, including probability, statistical distributions, regression, correlation and tests.

BMS 3114 Genetics 3:3:0:4

The genetics of bacteria, viruses and high organisms. Emphasis is placed on both the genetic and biochemical analyses of gene replication, heredity, mutation, recombination and gene expression. Comparisons of prokaryotic and eukaryotic genetics and regulation. Laboratory techniques used in the study of genetic phenomena in prokaryotes, eukaryotes and viruses. Emphasis placed on modern approaches to genetic research. Lab fee required. *Prerequisite: BMS 1004. Corequisite: CM 2214.*

BMS 3214 Microbiology 3:3:0:4

Study of microbial organisms, especially bacteria and viruses. Microbial relationship to disease, infections and immunological processes. Mutation, transformation, transduction, induction and bioenergetic processes. Laboratory work includes experimental analysis of microbial structure and physiology by biochemical and cytochemical means.

Influence of environment on nutrition, enzymes and metabolism of representative microbial species. Lab fee required. *Prerequisites: BMS 2004 and CM 1014 or instructor's permission.*

BMS 3314 Advanced Cell and Molecular Biology I 3:3:0:4

This course is designed as the first semester of a year-long course in which the molecular basis of cell function and current trends in molecular biology are explored. The lab component consists of a year-long project to locate, characterize, clone and express a gene. Lab fee required. *Prerequisites: CM 3314 and CM 2224 (see BMS 4324 for second semester).*

BMS 4011 Senior Seminar 1:0:0:1

Students present seminars based on current literature.

BMS 4314 Advanced Cell Physiology 3:3:0:4

Analysis of chemical and physical mechanisms of cellular function. Molecular constituents of biological systems, enzymes and reaction rates, energetic and regulation of metabolic processes, membrane transport, contractility and irritability. Laboratory studies include examination of cellular components in terms of their functional activities (enzymes, oxidative-phosphorylation, photosynthesis), kinetics of soluble and membrane-bound enzymes and membrane transport. Lab fee required. *Prerequisites: BMS 2004 and CM 2614.*

BMS 4414 Biophysics 4:0:0:4

Molecular basis of complex biochemical functions, membrane transport, intercellular and extracellular signaling, metabolism and energy transduction, DNA, RNA and protein synthesis and control, macromolecular assemblies, special topics in biochemistry.

BMS 4324 Advanced Cell and Molecular Biology II 3:3:0:4

This course is for the second semester of a year-long course in which the molecular basis of cell function and current trends in molecular biology are explored. The lab component consists of a year-long project to locate, characterize, clone and express a gene. Lab fee required. *Prerequisite: BMS 3314.*

BMS 4814/4824/4834/4844 Topics in Biology 4 credits each as arranged

BMS 4914/4924 Undergraduate Research in Biomolecular Science 4 credits each

Investigations of problems in biology under supervision of faculty members. Library research, experimental studies and written reports required. Lab fee required. *Prerequisites: senior status or adviser's approval, CM 5010, CM 5040.*

BMS 4934 Life Science Internship 4 credits

Supervised projects carried out in hospital, community or industrial settings. Evaluated on basis of written and oral reports presented to faculty and outside project co-sponsors. Faculty conferences and visits required. Open to senior students on approval of departmental adviser. Pre-planned experiences provide students with significant exposure to relationships between theoretical information and practical applications. *Prerequisite: senior status or adviser's approval.*

Typical Course of Study for the Bachelor of Science in Biomolecular Science Option in Biomedical Science

FRESHMAN YEAR

Fall Semester

Course No.	Course Title	Hours/Week			
		Class	Lab.	Rec.	Cr.
MA 1054	Calculus I with Precalculus I	4	0	0	4
CM 1014	General Chemistry I	3	2	1	4
BMS 1004	Biology I (Intro Cell & Molecular Bio)	3	3	0	4
EN 1014	Writing & Humanities I ²	4	0	0	4
SL 1010	Freshman Seminar	1	0	0	0
					16

Spring Semester

Course No.	Course Title	Hours/Week			
		Class	Lab.	Rec.	Cr.
MA 1154	Calculus II with Precalculus	4	0	0	4
BMS 2004	Biology II (Intro Physiology)	3	3	0	4
CM 1024	General Chemistry II	3	2	1	4
EN 1204	Writing & Humanities	4	0	0	4
					16

SOPHOMORE YEAR

Fall Semester

CM 2214	Organic Chemistry I	3	3	0	4
PH 1004	Introductory Physics I	4	1½	1	4
CS 2113	Programming with VBA/Excel	3	0	0	3
HU 2104	Modern World History	4	0	0	4
					15

Spring Semester

CM 2224	Organic Chemistry II	3	3	0	4
PL 2072	Bioethics	2	0	0	2
BMS 2512	Biostatistics	2	0	0	2
CM 2614	Physical Chemistry I	4	0	0	4
PH 2004	Introductory Physics II	4	1½	1	4
					16

JUNIOR YEAR

Fall Semester

BMS 3114	Genetics	3	3	0	4
CM 3314	Biochemistry I	4	0	0	4
	HU/SS Elective ³	4	0	0	4
	Elective	4	0	0	4
					16

Spring Semester

BMS 4924	Senior Project Research	0	12	0	4
BMS 48xx	Topics in Biology	4	0	0	4
	HU/SS Elective ³	4	0	0	4
	Elective ⁴	4	0	0	4
					16

SENIOR YEAR

Fall Semester

BMS 4324	Adv Cell & Molecular Bio II	3	3	0	4
BMS 4914	Senior Project Research	0	12	0	4
	HU/SS Elective ³	4	0	0	4
	Elective ⁴	4	0	0	4
					16

Spring Semester

BMS 3314	Adv Cell & Molecular Bio I	3	3	0	4
CM 3324	Biochemistry II	4	0	0	4
CM 3514	Analytical Chemistry	3	3	0	4
CM 5011	Information Sources	1	0	0	1
	Elective ⁴	4	0	0	4
					17

Total credits required for graduation:

128

See page 118 for footnotes.

Typical Course of Study for the Bachelor of Science in Biomolecular Science Option in Biotechnology

*FRESHMAN YEAR***Fall Semester**

Course No.	Course Title	Hours/Week			
		Class	Lab.	Rec.	Cr.
MA 1054	Calculus I with Pre-calculus I	4	0	0	4
CM 1014	General Chemistry I	3	2	1	4
BMS 1004	Biology I (Intro Cell & Molecular Bio)	3	3	0	4
EN 1014	Writing & Humanities I ²	4	0	0	4
SL 1010	Freshman Seminar	1	0	0	0
					16

Spring Semester

Course No.	Course Title	Hours/Week			
		Class	Lab.	Rec.	Cr.
MA 1154	Calculus II with Pre-calculus	4	0	0	4
BMS 2004	Biology II (Intro Physiology)	3	3	0	4
CM 1024	General Chemistry II	3	2	1	4
EN 1204	Writing & Humanities	4	0	0	4
					16

*SOPHOMORE YEAR***Fall Semester**

CM 2214	Organic Chemistry I	3	3	0	4
PH 1004	Introductory Physics I	4	1½	1	4
CS 2113	Programming with VBA/Excel	3	0	0	3
HU 2104	Modern World History	4	0	0	4
CM 5040	Laboratory Safety	1	0	0	0
					15

Spring Semester

CM 2224	Organic Chemistry II	3	3	0	4
PL 2072	Bioethics	2	0	0	2
BMS 2512	Biostatistics	2	0	0	2
CM 2614	Physical Chemistry I	4	0	0	4
PH 2004	Introductory Physics II	4	1½	1	4
					16

*JUNIOR YEAR***Fall Semester**

BMS 3114	Genetics	3	3	0	4
CM 3314	Biochemistry I	4	0	0	4
	HU/SS Elective ³	4	0	0	4
	Elective ⁵	4	0	0	4
					16

Spring Semester

BMS 3314	Advanced Cell & Molecular Biology I	3	3	0	4
CM 3324	Biochemistry II	4	0	0	4
CM 3514	Analytical Chemistry	3	3	0	4
CM 5011	Information Sources	1	0	0	1
	Elective ⁵	4	0	0	4
					17

*SENIOR YEAR***Fall Semester**

BMS 4914	Senior Project Research	0	12	0	4
	HU/SS Elective ₃	4	0	0	4
	Elective ⁵	4	0	0	4
	Elective ⁵	4	0	0	4
					16

Spring Semester

BMS 4924	Senior Project Research	0	12	0	4
	HU/SS Elective ₃	4	0	0	4
	Elective ⁵	4	0	0	4
	Elective ⁵	4	0	0	4
					16

Total credits required for graduation:**128**

See page 118 for footnotes.

Typical Course of Study for the Bachelor of Science in Biomolecular Science Option in Chemistry

FRESHMAN YEAR**Fall Semester**

Course No.	Course Title	Hours/Week			Cr.
		Class	Lab.	Rec.	
MA 1024	Calculus I ₁	2	0	0	4
CM 1014	General Chemistry I	3	2	1	4
BMS 1004	Biology I (Intro Cell & Molecular Bio)	3	3	0	4
EN 1014	Writing & Humanities I ²	4	0	0	4
SL 1010	Freshman Seminar	1	0	0	0
					16

SOPHOMORE YEAR**Fall Semester**

CM 2214	Organic Chemistry I	3	3	0	4
PH 1004	Introductory Physics I	4	1½	1	4
CS 1114	Intro Progr & Problem Solving	3	3	0	4
HU 2104	Modern World History	4	0	0	4
CM 5040	Laboratory Safety	1	0	0	0
					16

JUNIOR YEAR**Fall Semester**

CM 3314	Biochemistry I	4	0	0	4
CM 4413	Polymer Science	3	0	0	3
CBE 2124	Chemical & Biological Processes	4	0	0	4
	HU/SS Elective ₃	4	0	0	4
					15

SENIOR YEAR**Fall Semester**

CM 4914	Senior Project Research	0	12	0	4
	HU/SS Elective ³	4	0	0	4
	Elective ⁶	4	0	0	4
	Elective ⁶	4	0	0	4
					16

Spring Semester

Course No.	Course Title	Hours/Week			Cr.
		Class	Lab.	Rec.	
MA 1124	Calculus II	2	0	0	4
BMS 2004	Biology II (Intro Physiology)	3	3	0	4
CM 1024	General Chemistry II	3	2	1	4
EN 1204	Writing & Humanities	4	0	0	4
					16

Spring Semester

CM 2224	Organic Chemistry II	3	3	0	4
MA 2012	Linear Algebra I (½ semester)	4	0	0	2
MA 2132	Ordinary Differential Equations (½ semester)	4	0	0	2
CM 2614	Physical Chemistry I	4	0	0	4
PH 2004	Introductory Physics II	4	1½	1	4
					16

Spring Semester

CM 3324	Biochemistry II	4	0	0	4
CM 3514	Analytical Chemistry	3	3	0	4
CM 5011	Information Sources	1	0	0	1
	HU/SS Elective ³	4	0	0	4
	Elective ⁶	4	0	0	4
					17

Spring Semester

CM 4924	Senior Project Research	0	12	0	4
	HU/SS Elective ³	4	0	0	4
	Elective ⁶	4	0	0	4
	Elective ⁶	4	0	0	4
					16

Total credits required for graduation:**128**

See page 118 for footnotes.

Footnotes for Typical Course of Studies for the Bachelor of Science in Biomolecular Science Options in Biomedical Science, Biotechnology and Chemistry

1. Students who are placed by examination or by an adviser into MA 914 must defer registration for MA 1054 or MA 1024.

2. Students who are placed by examination or by an adviser into EN 1080 must subsequently register for EN 1034, rather than EN 1014.

3. Approved HU/SS electives are courses with the following prefixes: AH, AN, EC, EN, HI, MU, PL and PS. Two courses must be from Level II Elective courses in different disciplines, and one from Level III Advanced Elective courses.

4. Electives for the Option in Biomedical Sciences: Two courses must be chosen from the following list or must be approved by an adviser, subject to the courses being offered in a given semester. Graduate courses may only be taken by students with junior standing and a C+ average or better, unless otherwise approved by the adviser. The remaining courses are free electives.

CBE 2124	Chemical & Biological Processes	4 cr
BMS 2314	Physiology	4 cr
BMS 3214	Microbiology	4 cr
BMS 4414	Bio-physics	4 cr
BMS 48XX	Topics in Biology	4 cr
CM 9443	Tissue Engineering	3 cr
BE 6603	Drug Delivery	3 cr
BE 6703	Materials in Medicine	3 cr

5. Electives for the Option in Biotechnology: Three courses must be chosen from the following list or must be approved by an adviser, subject to the courses being offered in a given semester. Graduate courses may only be taken by students with junior standing and a C+ average or better, unless otherwise approved by the adviser. The remaining courses are free electives.

CBE 2124	Chemical & Biological Processes	4 cr
BMS 4324	Advanced Cell and Molecular Biology II	4 cr
BMS 48XX	Topics in Biology	4 cr
CM 4314	Biomaterials	4 cr
CM 4413	Polymer Science	3 cr
CM 9463	Recombinant DNA Technology	3 cr
CM 6253	Biosensors	3 cr
CM 9053	Enzyme Catalysis in Organic Synthesis	3 cr
BI 7513	Chemical Foundations of Bioinformatics	3 cr
BI 7533	Bioinformatics I: Sequence Analysis	3 cr
BI 7543	Bioinformatics II: Protein Structure	3 cr

6. Electives for the Option in Chemistry: Two courses must be advanced undergraduate CM, BMS or CBE courses, or graduate CM courses, or must be approved by an adviser, subject to the courses being offered in a given semester. Graduate courses may only be taken by students with junior standing and a C+ average or better, unless otherwise approved by the adviser. The remaining courses are free electives.

NOTES:

All laboratory courses in chemistry require a breakage deposit. The department does not usually grant transfer credits to students who, while registered at Polytechnic, take biology or chemistry courses at other schools.

BIOTECHNOLOGY PROGRAM

Academic Adviser: Evgeny Vulfson

GOALS AND OBJECTIVES

The main goal of the Master of Science in Biotechnology Program is to advance students' knowledge and experience beyond the BS level and equip them for the needs of a rapidly evolving environment of life sciences-based industries. The program is designed to provide students with a broad and comprehensive coverage of both the established and emerging bio-technologies. The constituent courses cover topics ranging from industrial application of enzymes and bio-polymer synthesis to modern approach to drug design and the role of biotechnology in health care. The availability of many elective courses enables students to further specialize in selected areas of biotechnology. The program also includes a guided study aimed at developing analytical skills. Students in the program are trained to perform at the mid-managerial level in life sciences-based industry and other organizations involved in biotechnology related work.

REQUIREMENTS FOR THE MASTERS OF SCIENCE

Students entering this program are expected to have an undergraduate degree in a science or engineering discipline, and must have taken undergraduate courses in 1) Biochemistry and 2) cell and molecular biology. The 30-credit curriculum consists of three parts:

1. Five required courses in biotechnology, protein and tissue engineering, enzyme catalysis and biosensors (15 credits);
2. Three elective courses in biotechnology and related fields (9 credits);
3. Project involving laboratory or literature work (6 credits) or two more electives.

Required Courses (15 credits)

The five required courses are listed below:

Course Title	Credits
BT 6013 Biotechnology and the Pharmaceutical Industry	3
BT 6253 Biosensors	3
BT 9053 Enzyme Catalysis in Organic Synthesis	3
BT 9433 Protein Engineering	3
BT 9443 Tissue Engineering	3

Elective Courses (9 credits)

Students must take three courses from the list shown :

Course Title	Credits
BE 6603 Drug Delivery	3
BE 6703 Materials in Medicine	3
BT 6023 Biotechnology and Health Care	3
BT 7013 Special Topics in Biotechnology	3
CM 7923 Natural Polymers and Materials	3

CM 8213 Bioanalytical Chemistry	3
BE 6013 Molecular Immunology	3
MG 7873 Managing Intellectual Property and Intellectual Capital	3
BT 6043 Biocatalysis in Industry	3
JW6003 Introduction to Technical Communication	3

Project (6 credits)

Students may take up to two Guided Studies courses, which involve laboratory or literature work as arranged with the student's adviser:

BT 8713 Guided Studies in Biotechnology I	3
BT 8723 Guided Studies in Biotechnology II	3

Total: 30 credits

GRADUATE COURSES

REQUIRED COURSES

BT 6013 Biotechnology and the Pharmaceutical Industry 3:0:0:3

The course offers an in-depth look at the role of biotechnology in the modern drug development process from the early stage of target identification and generation of lead compounds to the modern methods of drug delivery. All the key aspects, including pre-clinical development, clinical trials and regulatory requirements, will be covered in some detail with considerable input by the pharmaceutical industry professionals. Major classes of biotech drugs (e.g., antibodies and other biologics, antibiotics), will be discussed in some detail and real-life case studies will be presented to illustrate critical points in the overall development process. *Prerequisite: Adviser's approval.*

BT 6253 Biosensors 3:0:0:3

Discussion of various biosensors, which consist of bio-recognition systems, typically enzymes or binding proteins such as antibodies, immobilized onto the surface of physico-chemical transducers. Immuno-sensors, which use antibodies as their bio-recognition system, are also discussed. Other bio-recognition systems discussed are nucleic acids, bacteria, and whole tissues of higher organisms. Specific interactions between the target analyte and the complementary bio-recognition layer that undergoes a physico-chemical change is ultimately detected and measured by the transducer. Various transducers, which can take many forms depending upon the parameters being measured electrochemical, optical, mass and thermal

changes are also part of the course. *Prerequisite: Adviser's approval.*

BT 9053 Enzyme Catalysis in Organic Synthesis 3:0:0:3

Provides students with a working knowledge of how to use biotransformations as a tool in organic chemistry. Students will learn about general enzymatic reaction types that carry out the cleavage and formation of C-O bonds, P-O bonds, C-N bonds, C-C bonds, reduction reactions, oxidation reactions and isomerizations. In addition, students will be taught about advanced principles that are currently being applied to the engineering of catalytic proteins. *Prerequisite: Adviser's approval.*

BT 9433 Protein Engineering 3:0:0:3

This course will introduce students to the modern protein engineering techniques available to researchers to understand protein structure and function and to create entirely new proteins for a variety of purposes. This is a new field that lies on the interface of chemistry, biology and engineering. The first part of the course will discuss the protein composition and structure, various genetic, biochemical and chemical techniques required to engineer proteins, which then will be followed by specific topics. Topics will include designing proteins that are highly structured; active at high temperatures and in non-aqueous solvents; that selectively interact with other proteins, small molecules and nucleic acids for therapeutic purposes; and that catalyze new reactions. *Prerequisite: CM9413 or adviser's approval.*

BT 9443 Tissue Engineering 3:0:0:3

This courses instructs students in the following: i) basic biological processes that occur during blood contact with artificial surfaces, ii) how to critically read and review the literature in the field of tissue engineering, iii) how to anticipate bio-compatibility issues relevant to a variety of implant devices that the student may encounter in future endeavors, iv) current approaches directed toward the engineering of cell-based replacements for various tissue types. *Prerequisite: adviser's approval*

ELECTIVE COURSES

BT 6023 Biotechnology and Health Care 3:0:0:3

This course focuses on the contribution of biotechnology to the modern Health Care. It provides a broad overview of the most exciting new technologies, such as tissue engineering and stem cell research, and discusses a wide range of applications. The course also offers an overview of more traditional biotech products e.g., vaccination, blood preservation and substitutes, diagnostics and discusses in some detail the role of biotechnology in the management of the biggest health care challenges of our time, the aging population and obesity epidemics. Some key lecturers in the course will be delivered by leading industry professionals *Prerequisite: Adviser's approval.*

BE 6603 Drug Delivery 3:0:0:3

Provides an integrated approach to the basic and clinical science of drug delivery. This course discusses the following: highlights of the historical development of drug delivery; kinds of drugs to be delivered, including genes and proteins; various targeting mechanisms; pharmacokinetics and pharmacodynamics of drug delivery systems, polymeric drug delivery systems; various devices developed for controlled delivery. *Prerequisite: Adviser's approval.*

BE 6703 Materials in Medicine 3:0:0:3

Focuses on the following: the basic principles behind human tissue response to artificial surfaces and materials; the general types of polymeric and metallic materials used in soft and hard tissue replacements; tissue engineering and drug delivery devices; current approaches directed toward the engineering of cell-based replacement for various tissues; techniques utilized to control the physiologic response to artificial surfaces; critical review of the current biomaterials literature; current research in the field; and evaluation of the design criteria which a material must meet for a given biological application and what is required for "biocompatibility". *Prerequisite: Adviser's approval.*

BE 6723 Natural Polymers and Materials 3:0:0:3

This course provides an introduction to natural and biomimetic polymers taught with an interdisciplinary view of biology, chemistry and macromolecular science. Topics covered in this course include: natural build-

ing blocks and methods by which nature carries out polymer synthesis and modification reactions; DNA; structural proteins; plant proteins; polysaccharides; polyesters; biosurfactants; polymers built from natural monomers and a wide variety of renewable resources; Uses of these polymers as fibers, films, rheological modifiers, flocculants, foams, adhesives and membranes; Special applications of natural polymers in medicine and as biodegradable plastics. Co-listed as CM 7923, *Prerequisite: Adviser's approval.*

BT 7013 Special Topics in Biotechnology 3:0:0:3

Special topics in biotechnology. *Prerequisite: Adviser's approval.*

CM 8213 Bioanalytical Chemistry 3:0:0:3

Exciting new analytical methods used in biochemistry and biotechnology today, such as atomic force microscopy, capillary electrophoresis, surface plasmon resonance, microarrays, etc. The course is based directly on the current scientific literature. *Prerequisite: Adviser's approval.*

BE 6013 Molecular Immunology 3:0:0:3

Familiarizes students with the body of research that forms the foundation of our present understanding of the molecular basis and the cellular interactions that regulate the immune responses. The principal tool of learning is the reading and discussion of research papers in immunology by a small group of students supervised by a faculty member who is active in the specific research area. The topics to be covered include antibody structure, B-cell development, T-cell structure and development, T-cell-MHC interaction, MHC structure and antigen processing, complement chemistry, complement and Fc receptor structure and function, transplantation immunogenetics, mucosal immunology and allergic reactions. *Prerequisite: Adviser's approval.*

MG 7873 Managing Intellectual Property and Intellectual Capital 3:0:0:3

This course focuses in detail on the topic of managing intellectual property, which constitutes a major strategic and financial asset of a modern business. IP can be employed to protect existing products, services and business methods and to accelerate development of new products, services and business methods. IP can also be leveraged to enhance the competitiveness, value and profitability of a firm. This is true in the physical world and in

the online world of the Internet and e-business (where traditional principles of Intellectual Property Rights are often stretched and may need reinterpretation and even modification). Intellectual Property is complex and becoming more so as emerging digital technologies advances. *Prerequisite: adviser's approval.*

BT 6043 Biocatalysis in Industry 3:0:0:3

The course primarily focuses on the commercial use of biological catalysts across various industry segments, including pharmaceuticals, health care, fine chemicals and food. The course combines a broad overview of the cutting-edge technologies with industrial insights into the economics of bio-processing, and deals with newly emerging trends in biomaterials. Case studies will be presented to facilitate the analysis, formulate the trends and underline major challenges. *Prerequisite: Adviser's approval.*

JW 6003 Introduction to Technical Communication 3:0:0:3

An overview of the research, writing, editing, and design principles of technical communication. Particular attention will be paid to writing for new media. Students learn how to gather, organize and present information effectively, according to audience and purpose. Interviewing skills, technical presentation skills, and writing for the web will be covered. *Prerequisite: Adviser's approval.*

PROJECTS, THESES AND SEMINARS**BT 8713 / BT 8723: Guided Studies in Biotechnology I / II** 3:0:0:3

Special project (experimental, theoretical, computational, or literature search). *Prerequisite: adviser's approval.*

BIOTECHNOLOGY AND ENTREPRENEURSHIP PROGRAM

Program Director: Evgeny Vulfson

GOALS AND OBJECTIVES

The main goal of the Master of Science in Biotechnology and Entrepreneurship Program is to supplement students' knowledge of biotechnology beyond the BS level and provide them with a basic understanding of the business side of the biotech industry and the requirements for starting their own biotechnology businesses. The program is designed to provide students with a broad coverage of key areas of modern biotechnology combined with a wide choice of business- and finance-related courses.

This program is most suitable for mature students with prior work experience and those recent graduates who aspire to establish their own biotech enterprise.

REQUIREMENTS FOR THE MASTERS OF SCIENCE

Students entering this program are expected to have an undergraduate degree in a science or engineering discipline, and must have taken undergraduate courses in 1) Biochemistry and 2) cell and molecular biology. The 30-credit curriculum of this program consists of three parts:

1. Four required courses offering broad overview of cutting-edge areas of biotechnology: biocatalysis and biomaterials, biotechnology and health care, biosensors and biochips, biotechnology and the pharmaceuticals industry (15 credits);
2. One required and a wide choice of elective 1.5 and 3 credit courses on technology innovation, intellectual property management, finances, marketing, business plan preparation and fund raising (6 credits); and
3. Optional project involving either technology-competition analysis and business plan preparation or a placement in an early-stage start-up company (3, 6 or 9 credits) and/or electives up to 9 credits.

Required Courses (15 credits)

The five required courses are listed below:

Course Title	Credits
BTE 6013 Biotechnology and Pharmaceutical Industry	3
BTE 6023 Biotechnology and Health Care	3
BTE 6033 Biosensors and Biochips	3
BTE 6043 Biocatalysis in Industry	3
MG 7703 Entrepreneurship and Venture Creation	3

Elective Courses (min. 6 credits)

Students must take courses from the list below which will amount to at least 6 credits in total e.g., two 3-credit or four 1.5-credit courses:

Course Title	Credits
MG 6093 Managerial Accounting and Finance	3
MG 7871 Introduction to Managing Intellectual Property	1.5
or	
MG 7873 Managing Intellectual Property	3
MG 8203 Project Management	3
MG 8653 Managing Technological Change and Innovation	3
MG 8711 Introduction to Entrepreneurial Finance	1.5
or	
MG 8713 Entrepreneurial Finance	3
MG 8721 Introduction to Managing Growing Businesses	1.5
MG 8731 Introduction to Corporate Entrepreneurship	1.5
MG 8741 Introduction to Entrepreneurial Marketing and Sales	1.5
or	
MG 8743 Entrepreneurial Marketing and Sales	3
JW 6003 Introduction to Technical Writing	3
BT 7013 Special Topics in Biotechnology	3

Project (3, 6 or 9 credits)

Students may undertake the following project:
 BTE 9503/9513/9523 Project in Biotechnology and Entrepreneurship
 (3x3 credits = 9 credits)

Total: 30 credits

GRADUATE COURSES REQUIRED COURSES

BTE 6013 Biotechnology and the Pharmaceutical Industry 3:0:0:3

The course offers an in-depth look at the role of biotechnology in the modern drug development process from the early stage of target identification and generation of lead compounds to the modern methods of drug delivery. All the key aspects, including pre-clinical development, clinical trials and regulatory requirements, will be covered in some detail with considerable input by pharmaceutical industry professionals. Major classes of biotech drugs (e.g., antibodies and other biologics, antibiotics), will be discussed in some detail, and real-life case studies will be presented to illustrate critical points in the overall development process.

Prerequisite: adviser's approval.

BTE 6023 Biotechnology and Health Care 3:0:0:3

This course focuses on the contribution of biotechnology to the modern health care. It provides a broad overview of the most exciting new technologies, such as tissue engineering and stem cell research, and discusses a wide range of applications. The course also offers an overview of more traditional biotech products, e.g., vaccination, blood preservation and substitutes, diagnostics, and discusses in some detail the role of biotechnology in the management of the biggest health care challenges of our time: the aging population and obesity epidemics. Some key lectures in the course will be delivered by leading industry professionals.

Prerequisite: adviser's approval.

BTE 6033 Biosensors and Biochips 3:0:0:3

The course focuses on technologies underlying the development of modern biosensors and biochip, including nanotechnology, multi-array analytical formats, and adaptation of methods well established in the microelectronics industry. In addition, the course will cover the most promising practical applications of the biosensors and biochips technology in health care, medical diagnostics, defense and other areas. The state and economics of this dynamic market and emerging trends will also be discussed in some detail.

Prerequisite: Adviser's approval.

BTE 6043 Biocatalysis in Industry 3:0:0:3

The course primarily focuses on the commercial use of biological catalysts across various industry segments, including pharmaceuticals, health care, fine chemicals and food. The course combines a broad overview of the cutting-edge technologies with industrial insights into the economics of bio-processing, and deals with newly emerging trends in biomaterials. Case studies will be presented to facilitate the analysis, formulate the trends and underline major challenges.

Prerequisite: Adviser's approval.

MG 7703 Entrepreneurship and New Venture Creation 3:0:0:3

The course focuses on entrepreneurship and venture creation as key engines for wealth creation and successful business strategy in the modern innovation-intensive, high-tech economy. It deals with such key issues as: (1) assessing attractiveness of opportunities; (2) launching a new venture; (3) nurturing and growing an entrepreneurial venture; (4) obtaining the necessary financial, human and technology resources; (5) managing the transition from a small entrepreneurial firm to a large, sustainable professionally managed, but still entrepreneurial corporation; and (6) being an entrepreneur and promoting entrepreneurship in a large corporation.

Prerequisite: Adviser's approval.

ELECTIVE COURSES:**MG 6093 Managerial Accounting and Finance** 3:0:0:3

The course focuses on elements of accounting and finance of importance to managers, including analysis of principles and practices of the finance function, financing methods for internal and external ventures and innovations, capital budgeting; R&D portfolio analysis. The course also contrasts strategic perspectives emphasizing innovation and development with those emphasizing short-term return and investment.

Prerequisite: Adviser's approval.

MG 7871 Introduction to Managing Intellectual Property 1.5:0:0:1.5

This introductory course explores the topic of managing intellectual property, which constitutes a major strategic and financial asset of a modern business. IP can be employed to protect existing products, services and business methods and to accelerate development of new products, services and business methods. IP can also be leveraged to enhance the competitiveness, value and profitability of a firm. This is true in the physical world and in the online world of the Internet and eBusiness (where traditional principles of intellectual property rights are often stretched and may need reinterpretation and even modification). Intellectual property is complex and becoming more so as emerging digital technologies advances.

Prerequisite: Adviser's approval.

MG 7873 Managing Intellectual Property and Intellectual Capital 3:0:0:3

This course focuses in detail on the topic of managing intellectual property, which constitutes a major strategic and financial asset of a modern business. IP can be employed to protect existing products, services and business methods and to accelerate development of new products, services and business methods. IP can also be leveraged to enhance the competitiveness, value and profitability of a firm. This is true in the physical world and in the online world of the Internet and e-Business (where traditional principles of Intellectual property rights are often stretched and may need reinterpretation and even modification). Intellectual property is complex and becoming more so as emerging digital technologies advances.

Prerequisite: Adviser's approval.

MG 8203 Project Management 3:0:0:3

This course focuses on the management of technology-based projects ranging from individual research and development to large-scale and complex technological systems. The course covers topics such as feasibility and risk analyses, project selection and portfolio optimization, functional and administrative structures, coordination and scheduling of activities, personnel planning, negotiations and contracts, cost estimation, capital budgeting, cost controls, and effective matrix management.

Prerequisite: Adviser's approval.

MG 8653 Managing Technological Change and Innovation 3:0:0:3

The course focuses on the effective management of technological change and innovation, which is accomplished by employing a dual perspective. One perspective is based on individual, group and organizational theory, research and practice. This body of literature, viewpoints and experience provides essential guides for successfully managing the introduction of new technologies. Realizing the full potential of new technologies requires effectively managing change to assure the commitment of all stakeholders. The second perspective is based on innovation theory, research and practice. This body of literature, viewpoints and experience provides key insights for effectively managing the process of innovation and the impact of innovation on all parts of an enterprise. Specifically, there is explicit consideration of the need within a firm to manage and inspire people so that they can effectively communicate and innovate. *Prerequisite: Adviser's approval.*

MG 8711 Introduction to Entrepreneurial Finance 1.5:0:0:1.5

This course provides a brief introduction on the financial requirements of entrepreneurial ventures and on different sources of finance available to entrepreneurs. The course helps develop an understanding on how to assess various entrepreneurial financial strategies. The course also examines the unique roles occupied by such actors as retail banks, investment banks, VCs, angels, internal sources of capital and incubators in the entrepreneurial finance arena.

Prerequisite: Adviser's approval.

MG 8713 Entrepreneurial Finance 3:0:0:3

This course focuses in detail on the financial requirements of entrepreneurial ventures and on different sources of finance available to entrepreneurs. The course helps develop an understanding on how to assess various entrepreneurial financial strategies. The course also examines the unique roles occupied by such actors as retail banks, investment banks, VCs, angels, internal sources of capital and incubators in the entrepreneurial finance arena. *Prerequisite: Adviser's approval.*

MG 8721 Introduction to Managing Growing Enterprises 1.5:0:0:1.5

This introductory course provides an introduction to a critical challenge all successful entrepreneurial small or medium-size firms potentially confront: how to sustain and accelerate major growth. At some point in the life of all growing enterprises, a firm usually must change. This course introduces some of the ways a growing firm can transform itself from a small to a larger enterprise. The course begins to explore how such companies can maintain the benefits of an entrepreneurial commitment and spirit while still obtaining needed skills associated with professionally managed larger firms.

Prerequisite: Adviser's approval.

MG 8723 Managing Growing Enterprises 3:0:0:3

This course focuses in detail on the critical challenge all successful entrepreneurial small or medium-size firms potentially confront: how to sustain and accelerate major growth. At some point in the life of all growing enterprises, a firm usually must change. This course introduces some of the ways a growing firm can transform itself from a small to a larger enterprise. The course begins to explore how such companies can maintain the

benefits of an entrepreneurial commitment and spirit while still obtaining needed skills associated with professionally managed larger firms.

Prerequisite: Adviser's approval.

MG 8731 Introduction to Corporate Entrepreneurship 1.5:0:0:1.5

Although large firms require professional management, to innovate, large corporations also often must practice entrepreneurship. This course serves as a brief introduction on how large corporations nurture and sustain entrepreneurship.

Prerequisite: Adviser's approval.

MG 8741 Introduction to Entrepreneurial Marketing and Sales 1.5:0:0:1.5

This course provides an introduction to critical marketing and sales challenges facing entrepreneurial firms. An underlying theme of this course is that successful innovative enterprises must possess deep familiarity of relevant markets and must be effective in cultivating and reaching such markets. Topics discussed in this course include market identification, segmentation, sales, overall market planning, niche and viral marketing and customers as sources of innovative ideas.

Prerequisite: Adviser's approval.

MG 8743 Entrepreneurial Marketing and Sales 3:0:0:3

This course focuses in depth (MG 8743) on critical marketing and sales challenges facing entrepreneurial firms. An underlying theme of this course is that successful innovative enterprises must possess deep familiarity of relevant markets and must be effective in cultivating and reaching such markets. Topics discussed in this course include market identification, segmentation, sales, overall market planning, niche and viral marketing and customers as sources of innovative ideas.

Prerequisite: Adviser's approval.

JW6003 Introduction to Technical Communication 3:0:0:3

An overview of the research, writing, editing, and design principles of technical communication. Particular attention will be paid to writing for new media. Students learn how to gather, organize and present information effectively, according to audience and purpose. Interviewing skills, technical presentation skills, and writing for the web will be covered. *Prerequisite: Adviser's approval.*

BT 7013 Special Topics in Biotechnology 3:0:0:3

Special Topics in Biotechnology.

Prerequisite: Adviser's approval.

PROJECTS, THESIS, AND SEMINARS

BTE 9503/9513/9523 Project in Biotechnology and Entrepreneurship 3:0:0:3

This practical course offers students the opportunity to practically apply the knowledge/skills gained to the analysis of business opportunities, preparation of their own business plans or working in/with an early stage biotech company. The student may sign up for a total of 3, 6 or 9 credits of this course, which is normally taken in the third semester.



BUSINESS AND TECHNOLOGY MANAGEMENT PROGRAM

Program Directors:

Mel Horwitch (Interim Acad. Dir) and Bohdan Hoshovsky (Admin Dir.)

GOALS AND OBJECTIVES

The Bachelor of Science in Business and Technology Management (BTM) Program is designed with certain overarching themes in mind, including:

- Achieving via prowess innovation and technology management and entrepreneurship;
- Leading based on a broad understanding of technology in the modern enterprise;
- Developing a global perspective of modern value creation;
- Committing oneself to service to one's community;
- Adhering to the highest ethical standards; and
- Obtaining practical exposure, via speakers, on-site visits in New York City, etc., to the latest best practices in management.

BTM is designed to meet today's and tomorrow's business needs. Modern business leaders must be deeply familiar with technology and innovation. They must also leverage entrepreneurship, no matter what the setting. The BTM Program prepares students to become such leaders. BTM is forward looking, preparing the next generation of leaders, managers and professionals in fields where technological innovation are critical. BTM also provides the most relevant traditional management education and the most current learning related to technology, innovation and information management and entrepreneurship. In other words, BTM creatively fuses modern business administration with state-of-the-art technology management. Students completing this program will be prepared to succeed in a variety of positions, such as technology project leaders, new economy entrepreneurs, technology and IT analysts on Wall Street, customer relationship managers and in other roles in large and small companies that require a cross-functional understanding of both technology and the motivational, financial, innovative and international challenges that accompany it. BTM students will also be well prepared for advanced studies in the management of technological and informational intense environments; they will be able to succeed in both studies of practical aspects of management (e.g., in a MS-Man-

agement, MBA, etc.) and of theoretical and research analyses (e.g., a PhD program).

The BTM program also provides a rigorous training in the qualitative, quantitative and innovative aspects of technology and information management. All classes are designed to provide a broad managerial background with specific application of the ideas and practices relevant for the world of technological goods and services.

The art and science of management demands that its practitioners be able to communicate ideas effectively and efficiently. Therefore, this program's courses emphasize spoken and written presentations, in individual, team and classroom settings, as central components of the learning experience.

PEDAGOGY

Management courses are taught using a variety of pedagogical methods.

These include:

- Theory-led teaching
- Case-method education
- Project-based and team-based teaching

Experiential-based learning

Teaching based on exposition of theory is often appropriate for management classes. Case-method teaching emphasizes a variety of real-world business experiences and attempts to lead the students to draw general principles from the many examples. Project-based and team-based education is experiential; students learn by doing, much as they would in a natural sciences laboratory class. Learning by doing in the field is also encouraged. It is very common in management courses for all pedagogical approaches to be employed.

COURSE DISTRIBUTION

The BTM Program requires 128 credits for graduation. Key characteristics* of this curriculum include:

- 10 credits in courses in mathematics
- 34 credits in courses in humanities and social sciences
- 8 credits in science and engineering, taken during students' freshman year
- 4 credits in computer science
- 4 credits in a technical elective
- 8 credits in restricted electives chosen from math, science, social sciences and humanities
- 60 credits in management

*Please see the Typical Course of Study for the BSBTM at the end of this section.

Courses for the BS in BTM are taken in a 4x4 manner (four courses per semester, each 4 credits) for eight semesters; deviations from this template occur in the freshman year, when a calculus course and a management course of 2 credits each are taken; and in the fifth semester of the program, when two 2-credit courses in project management and business ethics are required.

Course Numbering

BTM courses are numbered using the following schema:

- The first digit of a course number corresponds to the year in which a BTM student would take the course (1 = Freshman, etc.)
- The second digit reflects the primary nature of the course material. Courses numbered with a second digit of:
 - "0" are focused primarily on processes in management
 - "1" are oriented toward organizational behavior
 - "2" are quantitative in nature
 - "3" describe a firm's relationships with external forces
 - "4" study innovation
 - "5" are capstone courses
- The third digit in a course number serves only to differentiate different courses
- The fourth digit reflects the number of credits

Thus, MG 3304 Introduction to Supply Chain Management is a 4-credit junior-year course focusing on external relationships.

Concentrations

Students in this degree program may focus their study in Technology Innovation and Strategy or in Technology and Innovation in Finance. Candidates who choose the first concentration will complete MG 3304 (Introduction to Supply Chain Management) in their 6th semester of study and MG 4004 (Management Strategy in Technology Sectors) in their 7th semester. Students electing the Technology and Innovation in Finance concentration of study will take MG 3214 (Advanced Corporate Finance) and MG 4204 (Management Science) at these points in their careers as students.

Graduation Requirements

To remain in good standing, candidates for the degree BS BTM must satisfy the following requirements, in addition to the University requirements for a minimum term and cumulative 2.0 GPA in all courses:

- An average of C (2.0) or better in all MG courses must be maintained
- A course in which the grade of I is received may not be used to satisfy any prerequisites until the incomplete is resolved.

Honors Capstone

Students who earn a 3.6 GPA or better in MG courses through their junior year of study qualify for the honors senior project capstone courses. These students are also free to not elect this project sequence.

Thesis and Honor's Thesis

Students who earn a 3.6 GPA or better in MG courses through their junior year of study qualify for an optional thesis and follow the guidelines as outlined in the Academic Policies and Degree Requirements section of this catalogue. They are advised to meet with the Department Chair in advance of completing their junior year.

Transfer Students

Courses at other schools may or may not be granted transfer credit based on evaluation of the content and level of material covered. Periodic re-evaluation of courses at other institutions may lead to a variation in the amount of credits granted from year-to-year. Thus, students completing the same program, but in different years, may receive different amounts of transfer credit.

Transfer students must present their records for evaluation at least two weeks before the regular registration period for their first semester.

Minor in Management

Students may obtain an undergraduate minor in management by completing 14 credits of management courses. An overall GPA of at least 2.0 must be maintained in these classes. At least 8 of the 14 credits must be taken by students while enrolled at Polytechnic.

Information

Curricula and prerequisite changes, new courses, special sections and other special announcements will be posted in the Department of Technology Management office suite and on the program's website at www.ite.poly.edu/bsmngt. Students are responsible for keeping informed and are encouraged to visit the BS BTM web site often.

UNDERGRADUATE COURSES**MG 1002 Foundations of Management**

4:0:0:2

Introductory course in the principles and practices of management. Management is viewed as a system of tasks and activities, including environmental scanning, planning, organizing, leading and controlling. Within each of these major tasks is a series of processes, which show how to do what has to be done. Management is both a science and an art; both aspects of management are covered in this course. Major emphasis is placed on management history, philosophy, and the theory and practice of management planning, decision making, organizing, motivating and leading.

MG 2004 Management of Information Technology and Systems

4:0:0:4

Provides foundation for understanding the role and potential contributions of information technologies and systems in business organizations—what they are, how they affect the organization and its employees, and how they can make businesses more competitive and efficient. The focus of the course is on the current state of IT in organizations, challenges and strategic use of IT, IT infrastructure and architecture, building, implementing and managing IT applications, and emerging issues such as intelligent systems, business process reengineering, knowledge management, and group support systems.

MG 2014 Operations Management

4:0:0:4

A firm has the opportunity to create competitive advantage through proficient management of its operations. To do so, the firm must first recognize and establish the strategic role of its operations within the organization. Then, at the more detailed operational level, the firm must execute effectively and efficiently. This course examines the strategic role that the operations function can play, and offers specific tools and techniques that the firm can use during implementation.

Prerequisite: 4 credits of calculus.

MG 2104 Organizational Behavior

4:0:0:4

Focuses on the study of human behavior in innovative organizations. Emphasis is on teams, leadership, communication theory, and organizational culture and structure. The course includes analyses of organizational behavior problems through the use of case studies, and by participation in experiential learning.

MG 2204 Financial Accounting

4:0:0:4

Provides a solid foundation in the construction and interpretation of financial statements. Topics include: accounting terminology, financial statement preparation and analysis, liquidity and credit-risk ratios, depreciation calculations, revenue recognition, accrued liabilities and asset valuation. Also covered are the effects of equity transactions, cash flows, and various accounting methods on financial statements.

MG 2304 Marketing

4:0:0:4

An undergraduate introduction to marketing. Discusses the fundamentals of marketing, e.g. the marketing mix, the role of the customer, marketing research and survey techniques. In addition, emerging marketing paradigms, like relationship marketing and online marketing, are also be introduced.

MG 3002 Project Management

4:0:0:2

This course provides students with practical and best practice project management theory, concepts and (hands-on) practical experience so that they may effectively contribute in and lead multicultural team projects framed for the new global economy. The practical component includes a team-based project that runs throughout the duration of the course.

MG 3024 Management of Data Communications and Networking

4:0:0:4

Introduces the fundamentals of modern telecommunications and networking such as components of data communication, data transmission, open system interconnection (OSI), TCP/IP and other models, data link and network layers, and local area networks (LANs). The course focuses on managerial issues related to the management of data communications and networking technologies. *Prerequisite: MG 2004.*

MG 3204 Introduction to Finance 4:0:0:4

An introduction to business finance for BTM majors. It emphasizes the financing and investment decisions of the financial manager, with special emphasis placed on examples from technological environments. Included are topics such as time value of money, asset valuation, risk analysis, financial statement analysis and capital budgeting. *Prerequisites: 6 credits of calculus and MG 2204.*

MG 3214 Advanced Corporate Finance 4:0:0:4

This course builds on the principles of basic corporate finance covered in MG 3204. It prepares students with an understanding of financial theory and how modern finance is used by firms for strategic and tactical decision-making. The critical issue of how these decisions impact the value of a firm and the returns of assets is addressed. Major topics include: bond valuation, the CAPM model, portfolio design and modeling, and option pricing using the Black-Scholes model. There is a strong emphasis on the use of spreadsheets as a financial modeling tool. *Prerequisites: MA 2052 and MG 3204*

MG 3304 Introduction to Supply Chain Management 4:0:0:4

An undergraduate-level introduction to supply chain management. The underlying objective is to introduce key supply chain management concepts and examine relevant business practice. This will enable the student to develop skills that are useful, in an increasingly global context, to analyze marketing, logistics, operations and channel management issues. *Prerequisites: MG 2004, MG 2304 and (MA 2054 or MA 2212 or MA 3012).*

MG 3404 Innovation Management 4:0:0:4

Examines the key managerial features of technology-enabled innovation and new product development. This course focuses on accessing innovative capabilities via R&D, acquisition, alliances, joint ventures and innovation-friendly cultures and organizations. The key perspective underlying this course is managerial. Although the innovation activities studied are overwhelmingly technology-enabled ones, success is largely determined by managerial factors. The interplay between the technology and management leading to innovation in a major concern of the discussion and work comprising this course.

MG 4004 Management Strategy in Technology Sectors 4:0:0:4

An overview of the process of implementing a successful management strategy in an information-, technology- and knowledge-intensive environment. Fundamental topics that are covered include: the development of strategic vision, objectives and plans, the implementation of strategy and the evaluation of performance, industry and competitive analysis, SWOT analysis, and competitive advantage and sustained advantage. Advanced concepts discussed in this course include: strategic positioning in global markets, Internet strategy, strategy in diversified firms, and the interactions between organizational structure and strategy and between ethics and strategy. *Prerequisites: MG 3204 and MG 3404.*

MG 4014 Introduction to E-Business 4:0:0:4

Since its introduction, the Internet has changed how businesses work. In addition to creating new opportunities, the Internet has also revolutionized existing businesses and entire industries. This course provides an undergraduate-level introduction to e-business. The main objectives of this course are to: (1) provide a hands-on introduction to the emerging area of e-Business, (2) discuss the major business concepts and issues in this domain and (3) develop high-quality content based on team discussion and individual/group research. *Prerequisites: MG 3204, MG 3002, MG 3304, and MG 3404.*

MG 4204 Management Science 4:0:0:4

Teaches the student to create mathematical models of managerial problems. Types of models discussed include: linear programming, integer linear programming, non-linear programming, queuing models, decision tree models, game theoretic models, simulation models, inventory models and more. Each model is discussed in the context of the assumptions necessary for modeling and the robustness of the model's managerial recommendations. *Prerequisites: 6 credits of calculus and (MA 2054 or MA 2212 or MA 3012).*

MG4214 Financial Strategy 4:0:0:4

This course deals with the financial strategy of modern firms. Topics covered include planning and implementation of financial strategies for start-up businesses and the utilization of venture capital; diverse issues related to designing financial strategies of rapidly growing companies after experiencing an IPO; challenges in constructing a financial strategy while undergoing a major corporate restructuring; key components of financial strategies for companies facing rapidly changing technological and competitive environments, and development of financial strategies for mature companies and declining business. *Prerequisites: MG 2204 and MG 3204.*

MG 4404 Entrepreneurship 4:0:0:4

This course focuses on key aspects of entrepreneurship as a critical engine for innovation. The course also treats entrepreneurship as a state of mind, not just limited to small firms. Discusses the current theories and practices related to starting and managing entrepreneurial enterprises, with an emphasis on firms in technology-, information- and knowledge-intensive environments. Particular attention is paid to the critical issues of: (1) identifying opportunities that provide competitive advantage; (2) the development of a solid business plan; (3) the marketing of new ventures; (4) entrepreneurial business operations, including human resource and process management; (5) ethical and social issues in entrepreneurial firms; and (6) financial management and fund raising for entrepreneurial firms. *Prerequisites: Junior or senior student status.*

**MG 4504 Global Perspectives on
Technology Management: A Capstone
Project Course** 4:0:0:4

Provides students with knowledge of current theories and practices related to managing international and multi-national firms. Students study the ways in which international management differs from the management of a firm residing solely within domestic boundaries. Topics covered include: planning, organizing, HR management, communication and negotiation, and co-ordination and control of international endeavors. Case studies are used extensively to focus the class on technological examples of problems in international management. Students undertake a term project that either: (1) develops a business plan for a technological international venture, (2) creates a case study of a technological firm's challenges in international management, or (3) analyzes an technological industry's position vis-à-vis international management. *Prerequisites: MG 3002, MG 3024, MG 3204, MG 3304, and MG 3404.*

**MG 4514 Honors Capstone Project
in Technology, Innovation and/or
Information Management and
Entrepreneurship I** 4:0:0:4

A qualified honors student or several such students work with a faculty member (and perhaps graduate students as well) on an advanced topic in technology, innovation and/or information management or entrepreneurship. This effort may be directed toward the development of theory, the development of case material, the development of a business plan and business strategy for a new venture, or another project of this caliber. *Prerequisites: senior status, 3.6 GPA or better through the junior year in major; all courses specified by the project adviser.*

**MG 4524 Honors Capstone Project
in Technology, Innovation and/or
Information Management or
Entrepreneurship II** 4:0:0:4

A qualified honors student or several such students work with a faculty member (and perhaps graduate students as well) on an advanced topic in technology, innovation and/or information management or entrepreneurship. This effort may be directed toward the development of theory, the development of case material, the development of a business plan and business strategy for a new venture, or another project of this caliber. *Prerequisites: senior status, 3.6 GPA or better through the junior year in major; all courses specified by the project adviser including MG 4514.*

Typical Course of Study for the Bachelor of Science in Business and Technology Management¹²

FRESHMAN YEAR

Fall Semester

Course No.	Course Title	Class	Hours/Week			Cr.
			Lab.	Rec.		
MA 1054	Calculus I with Pre-calculus ¹	4	0	0	0	4
EN 1014	Writing & Humanities I ²	4	0	0	0	4
CS 1114	Intro. Prog & Problem Solving Science/Engineering Elective ³	3	3	0	0	4
SL 1010	Freshman Seminar	1	1	0	0	0
						16

SOPHOMORE YEAR¹¹

Fall Semester

MG 2204	Financial Accounting	4	0	0	0	4
MG 2004	Mngt. of Info. Tech. & Systems	4	0	0	0	4
MG 2104	Organizational Behavior ⁹	4	0	0	0	4
HI 2104	Modern World History	4	0	0	0	4
						16

JUNIOR YEAR¹¹

Fall Semester

MG 3204	Introduction to Finance	4	0	0	0	4
MG 3024	Mngt. of Data Comm. & Netwk.	4	0	0	0	4
MG 3002	Project Management	2	0	0	0	2
PL 4052	Business Ethics Liberal Arts Elective ⁸	2	0	0	0	2
						16

SENIOR YEAR¹¹

Fall Semester

MG 4004	Mgmt Strat Tech Sect (Strat.Con.)					
MG 4214	Financial Strategy (Fin. Con.)					
MG 4404	Entrepreneurship ⁶ Restricted Elective ⁵ HU/SS Elective ⁴	4	0	0	0	4
						16

Spring Semester

Course No.	Course Title	Class	Hours/Week			Cr.
			Lab.	Rec.		
MA 1252	Calculus Bus & Life Sci IIA (1/2 semester)	4	0	0	0	2
MG 1002	Foundations of Management	2	0	0	0	2
EN 1204	Writing & Humanities II ² Technical Elective ⁷ Science/Engineering Elective ³	4	0	0	0	4
						16

Spring Semester

EC 2524	Math Microeconomics	4	0	0	0	4
MG 2304	Marketing	4	0	0	0	4
MG 2014	Operations Management	4	0	0	0	4
MA 2054	Applied Data Analysis	4	0	0	0	4
						16

Spring Semester

MG 3404	Innovation Management	4	0	0	0	4
MG 3304	Intro. Supply Chain Mngt. (Strat Con.)					
MG 3214	Adv. Corp. Finance (Fin. Con.) Restricted Elective ⁵ HU/SS Elective ⁴	4	0	0	0	4
						16

Spring Semester

MG 4504	Global Perspect. on Tech Mngt.	4	0	0	0	4
MG 4014	Intro. to E-Business	4	0	0	0	4
MG 4204	Management Science ⁶ HU/SS Elective ⁴	4	0	0	0	4
						16

Total credits required for graduation:

128

- Students who are placed by placement examination or by an adviser into MA 0902 must defer registration for calculus. Upon successful completion of MA 0902 (2 credits, 1st half) students take MA 0912 (2 credits, 2nd half). Upon successful completion of MA 0912 students may then register for MA 1054. MA 0902 and MA 0912 are developmental math courses and no credit is given towards graduation.
- Students who are placed either by the placement examination or by an adviser into EN 1080 should, upon successful completion of this course, enroll in EN 1034. Students originally placed in EN 1090 should, upon successful completion of this course, enroll in EN 1014. Subsequently, once these courses have been successfully completed, students in EN 1014 should register for EN 1204, while students in EN 1034 should enroll in EN 1234. Exceptions may be made to this sequence by the Director of Writing. EN 1080 and EN 1090 are developmental writing courses and no credit is given towards graduation.
- Approved science electives are CM 1004, BMS 1004 and PH 1004.
- Approved HU/SS electives are courses with the following prefixes: AH, AN, EC, EN, HI, MU, PL, PO, PS and SO. (LA, LW, TC and DM for example, are not approved). Students must follow the Liberal Studies Program directives for Level I Basic Courses, Level II Elective Courses and Level III Advanced Elective Courses, to fulfill the general education requirement.
- Restricted electives are courses in math, science, (HU/SS) humanities and social sciences. Restricted elective HU/SS courses follow the "Approved HU/SS electives" description in Note 4 above.

- Students with a 3.6 GPA or better in major at the end of junior year may substitute MG 4514 Honors Capstone Project I (4 credits) or the Bachelor's Thesis in Management (4 credits and with permission by the Department chair) for MG 4404. They may also substitute MG 4524 Honors Capstone Project II (4 credits) or the Bachelor's Thesis (4 credits and with permission by the Department chair) in Management for MG 4204.
- Technical electives can be chosen from computer science, engineering, mathematics, chemistry, physics, bio-molecular sciences, digital media, technical communications and undergraduate finance courses from financial engineering.
- The liberal arts elective can be fulfilled by: LA2014, PL2014, PL2064, PL2084, PL2094, PL2104, HI3424 and HI 3324. Students must follow the Liberal Studies Program directives for Level I Basic Courses, Level II Elective Courses and Level III Advanced Elective Courses, to fulfill the general education requirement.
- MG 2104 Organizational Behavior (is a BTM requirement and not an elective and) also counts as a bona fide HU/SS course.
- Students must select a BS BTM concentration by the end of the fall semester of the Junior year. The current BS BTM concentrations available are the Innovation and Strategy Concentration (Strat. Con.) and the Finance Concentration (Fin. Con.).
- BTM students have the option to register for CP 101 and CP 102, both provided by the Office of Career Services. Internships generally run for a two to three month period following the first year of study. No credit is offered for these CP courses, but they shall appear on university transcripts.
- Grandfathering rules may apply.



PROGRAMS OFFERED AT THE OTHMER-JACOBS DEPARTMENT OF CHEMICAL AND BIOLOGICAL ENGINEERING

Academic Directors:

Walter Zurawsky (undergraduate)
Jovan Mijovic (graduate)

Chemical and Biological Engineering is the fastest growing undergraduate engineering major in the United States. Recent years have witnessed major scientific discoveries in the fields of biology and medicinal science, from mapping of human genome and cloning of mammals to tissue and protein engineering. But the realization and implementation of those ideas on a large scale rest with the new generation of interdisciplinary engineers that will work at the interface of molecular and medicinal sciences with engineering. They are called chemical and biological engineers. By 2010, a 35 percent increase in employment for chemical and biological engineers is projected.

Chemical and biological engineers rely heavily on science, engineering methods, experience and inventiveness to develop the processes and equipment required for economical production of new and useful products. Chemical and biological engineers have contributed to the development of virtually every material common to modern life. In addition to bulk chemicals and petroleum products, they are involved with the production of plastics, pharmaceuticals, cosmetics, fertilizers and foodstuffs, synthetic rubber and rocket propellants, to name a few. Their influence has been felt in developing fuel cells, automatic controls, water desalination plants, missiles and artificial kidneys.

Chemical and biological engineers may choose from a wide range of activities, including research, process and product development, design and supervision of the construction and operation of industrial plants, technical sales and services, consulting, management and teaching. Opportunities in chemical and biological engineering are virtually unlimited.

The foundations of chemical and biological engineering are the sciences, with emphasis on chemistry, biology, mathematics, physics and the engineering sciences (including thermodynamics, fluid mechanics, kinetics and heat and mass transfer). Courses include the analysis, design and control of equipment, operations and processes. Through this course of study, students develop the knowledge and analytical skills necessary to bridge the gap between scientific advances and large-scale production of products.

UNDERGRADUATE PROGRAM

The undergraduate program in chemical and biological engineering provides a solid foundation in science and the engineering sciences. An integrated set of chemical and biological engineering courses is built upon this foundation. Thorough instruction is given in chemistry, biology, physics, mathematics and engineering science, which are basic to the understanding of physical, chemical and biological operations and processes. Courses in engineering science include engineering thermodynamics, reaction kinetics and engineering, process dynamics, fluid mechanics, heat and mass transfer.

The undergraduate program leads to a Bachelor of Science in Chemical and Biological Engineering and is accredited by the Accreditation Board for Engineering and Technology (ABET).

GOALS AND OBJECTIVES

The objectives of our undergraduate program in chemical and biological engineering are to produce graduates who:

1. Have a solid foundation in mathematics, physical science (including physics and advanced chemistry), and biology
2. Are well grounded in the fundamentals of chemical and biological engineering including knowledge of the principles of material and energy balances, thermodynamics, transport processes, continuous and stage-wise separations, kinetics and reactor engineering and process dynamics and control as applied to chemical and biological processes.
3. Have a working knowledge of modern experimental techniques and data analysis.
4. Have an understanding of and experience with modern computing techniques
5. Understand how to apply these scientific and engineering fundamentals to the analysis and design of chemical and biological processes.
6. Understand the social, economic and ethical problems inherent in the practice of chemical and biological engineering.
7. Are committed to a lifetime of learning.

With these attributes, graduates will be poised to become valuable members of the chemical and biological engineering profession and society as a whole. They will be prepared to work in industry or government or pursue advanced degrees. The department is committed to upgrading class offerings and

engineering tools to continuously assure that students stay abreast of the latest developments in the field.

CURRICULUM

Design is an essential part of the chemical and biological engineering education and is incorporated into many of the courses. Generally, as students progress through the curriculum and learn more fundamental engineering science, more design components are introduced into the courses and the complexity of the design problems increases. Elements of design are contained in many courses and culminate in senior process design course. In this course, students design chemical and biological processes and must include engineering, safety and economic considerations in their designs.

The chemical and biological engineering curriculum provides a background that enables the graduate to select a professional career from an extremely broad spectrum of opportunities. Graduates are prepared to take employment in a number of capacities in industry or to enter graduate school for advanced study.

REQUIREMENTS FOR THE BACHELOR OF SCIENCE

Most programs at Polytechnic require a 2.0 GPA or better for graduation. Students must also meet the academic standards of the department. For students to advance to their senior-year courses a 2.5 GPA must be maintained in courses CBE 1124, CBE 2124, CBE 3102, CBE 3153, CBE 3134, CBE 3234 and CBE 3224; the same course must not be failed twice. Students who do not meet these requirements will not be allowed to register for senior courses. All listed prerequisites must be satisfied before students are permitted to enroll in chemical engineering courses.

GRADUATE PROGRAMS IN CHEMICAL ENGINEERING

Graduate programs in chemical engineering are designed to introduce students to advanced designs, research and development. The department offers graduate programs leading to a Master of Science in Chemical Engineering and Doctor of Philosophy in Chemical Engineering. A BS degree in chemical engineering or a related field of science or engineering is generally required for admission to graduate study. An applicant who has earned a bachelor's degree from a foreign institution is required to submit Graduate Record Examination and TOEFL scores. Applicants with degrees in other fields or from other colleges may be admitted with undergraduate and/or graduate deficiencies as evaluated by the graduate adviser. Students must have had at least one course in differential equations. Our research areas comprise biopolymers at interfaces, drug delivery, dynamics of complex fluids, nanotechnology and nanomaterials, process systems engineering, protein engineering, sensors and biomolecular diagnostics, and systems biology, among others.

GOALS AND OBJECTIVES

The objective of the MS degree in chemical engineering is to provide an understanding of the fundamental principles of chemical engineering subjects. The mathematical and analytical skills of the student are enhanced, and advanced design concepts are also emphasized. Student's in the MS program develop a deeper understanding of engineering principles, laboratory and research skills, and conduct an in-depth study of a specialized chemical engineering topic through either a guided studies project or a research thesis.

The objective of the PhD degree in chemical engineering is to provide advanced knowledge of fundamentals and research in emerging fields in chemical engineering. Research skills are refined, and the candidate performs basic research that advances the understanding of a specific chemical engineering discipline. The department faculty plan programs of study individually with each candidate. Systematic study toward a doctorate is carried out under a guidance committee appointed by the Office of Research and Graduate Studies.

REQUIREMENTS FOR THE MASTER OF SCIENCE IN CHEMICAL ENGINEERING

Candidates for the MS in Chemical Engineering are to plan their programs in accordance with the following list of requirements:

GUIDED STUDIES OPTION

Required (core) courses, 12 credits, 3 credits each

CBE 6153	Applied Mathematics in Engineering
CBE 6333	Transport Phenomena
CBE 6733	Chemical Engineering Thermodynamics
CBE 6813	Chemical Reactor Analysis & Design

Electives	12 credits: At least two electives (6 credits) must be chosen from CBE 6003 - CBE 9413, while the other two (6 credits) may be chosen from other graduate programs with the approval of the graduate adviser in chemical engineering.
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CBE 9023	Guided Studies in Chemical Engineering (6 credits)
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Total: 30 credits

THESIS OPTION

Required (core) courses, 12 credits, 3 credits each

CBE 6153	Applied Mathematics in Engineering
CBE 6333	Transport Phenomena
CBE 6733	Chemical Engineering Thermodynamics
CBE 6813	Chemical Reactor Analysis & Design

Electives	9 credits: At least two electives (6 credits) must be chosen from CBE 6003 - CBE 9413, while the other one (3 credits) may be chosen from other graduate programs with the approval of the graduate adviser in chemical engineering.
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CBE 9973	Master's Thesis (9 credits)
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Total: 30 credits

To meet graduation requirements, students must have an overall B average in all courses (excluding MS Thesis or Guided Study Project) and must not obtain more than two grades of C in required subjects.

REQUIREMENTS FOR THE DOCTOR OF PHILOSOPHY IN CHEMICAL ENGINEERING

Students must pass a comprehensive qualifying examination in chemical engineering and present a doctoral dissertation. The qualifying exam is given once a year. Additional details on the qualifying examination should be obtained from the graduate adviser. Each candidate for the doctorate must complete a minimum of 75 credits of academic work past the bachelor's degree, including a minimum of 45 credits of dissertation research. Although the student may elect to take more than 45 credits of PhD thesis, only 45 of those credits can be counted in the required 75 credits. Furthermore, of those 45 credits, at least 36 must be taken beyond MS thesis and at Polytechnic University. A minimum of 30 graduate credits beyond the bachelor's degree (not including PhD or MS thesis

credits) are required in chemical engineering subjects, of which at least 12 must be taken at Polytechnic. Attendance is required at departmental seminars for at least four semesters. To meet graduation requirements, students must have an overall B average in all courses, excluding thesis, and must not obtain more than two grades of C in required subjects. Candidates for the degree Doctor of Philosophy in Chemical Engineering are to plan their programs in accordance with the following requirements:

Required Subjects: 12 credits, 3 credits each

CBE 6153	Applied Mathematics in Engineering
CBE 6333	Transport Phenomena
CBE 6733	Chemical Engineering Thermodynamics
CBE 6813	Chemical Reactor Analysis & Design
CBE 9910/9920*	Departmental Seminar (0 credits)

Electives	18 credits (6 courses): At least three electives (9 credits) must be chosen from CBE 6003-CBE 9413. The remaining courses may be chosen from other graduate programs with the approval of the graduate adviser in chemical engineering.
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CBE 9993	PhD Thesis (45 credits) Up to 9 credits of Master's Thesis can be included here.
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Total: 75 credits

* CBE 9910/9920 must be taken for two years.

UNDERGRADUATE COURSES

CBE 1124 Introduction to Chemical and Biological Engineering 4:0:0:4

This course introduces and develops design and analysis from a broad view through real-world examples. Simple material and energy balances are introduced along with the concept of mathematical modeling. Graphical analysis as a design tool is introduced along with basic concepts of error, uncertainty and data fitting. Dimensional analysis and the concept of scaling are developed. *Prerequisites: CM 1004 and EG 1004.*

CBE 2124 Analysis of Chemical and Biological Processes 4:0:0:4

This course prepares students to formulate and solve material and energy balances on chemical and biological process systems and lays the foundation for subsequent courses in thermodynamics, unit operations, kinetics, and process dynamics and control. More fundamentally, it introduces the engineering approach to problem solving: breaking a process down into its components, establishing the relations between known and unknown process variables, assembling the information needed to solve for the unknowns and, fi-

nally, obtaining the solution using appropriate computational methods.

Prerequisites: CM 1004 and MA 1024.

CBE 3102 Mathematical Methods for Chemical and Biological Engineers

3:0:0:2

This course examines a set of essential linear and nonlinear mathematical methods needed to the solution of engineering problems described by sets of algebraic equations, ordinary differential, as well as partial differential equations. Emphasis is placed in understanding the fundamental mathematical ideas through their effective application in complex engineering problems such as complex reaction networks, transient phenomena in reactors and mass transfer through membranes. *Prerequisites:* CBE 2124, MA 2122, MA 2132, or equivalent.

CBE 3134 Physical Rate Processes

4:0:0:4

Introduction to conservation of mass, momentum and energy in open systems. Newtonian fluids in laminar and turbulent flow. Differential equations for conservation of mass and momentum. Differential equations for heat transfer by conduction and convection. Use of those differential equations to analyze chemical and biological systems. *Prerequisites:* MA 2132 and CBE 2124.

CBE 3153 Chemical and Biological Engineering Thermodynamics

3:0:0:3

Thermodynamics of flow systems. Properties of fluids with advanced equations of state. Properties of non-ideal mixtures. Activity co-efficient models for nonelectrolyte and electrolyte solutions. Phase equilibrium calculations at low and elevated pressures by computer procedures. Chemical reaction equilibria. *Prerequisites:* CBE 2124 and CM 2514.

CBE 3224 Chemical and Biological Reactor Engineering

4:0:0:4

This course provides students with the fundamentals of thermodynamics and kinetics of chemical and biological reactions and the development of skills to analysis and design reactor systems. Typical topics include homogeneous and heterogeneous reactors of various types, catalyzed and non-catalyzed reactors and the design of single and cascaded chemical and bio-reactors. Students are given computer procedures for the design of reactors and the corresponding energy interactions. *Prerequisites:* CBE 3152, CBE 3134 and CBE 3103.

CBE 3234 Chemical and Biological Engineering Separations

4:0:0:4

Introduction to the many aspects of mass transfer. Topics range from diffusion, convection and mass transfer co-efficients to the analysis and design of separation processes such as distillation, absorption and extraction. Analytical and computer techniques are stressed. *Prerequisites:* CBE 3152 and CBE 3134.

CBE 401X Special Topics in Chemical and Biological Engineering

variable

Topics of special interest in chemical and biological engineering.

Prerequisites: CBE 3134 or adviser's approval.

CBE 4113 Engineering Laboratory I

1:6:0:3

Introduction to and performance of experiments in unit operations, transport processes and unit processes. Students analyze and design their experiments to meet stated objectives; results are presented in written and oral form. *Prerequisite:* CBE 3234.

CBE 4143 Process Dynamics and Control

3:0:0:3

Introduction to system dynamics and process control. Dynamic models of chemical processes are developed. The design and tuning of feed-back and feed-forward controllers are discussed and students are introduced to multiple input-multiple output systems and large system control issues. *Prerequisites:* CBE 3103 and CBE 3224.

CBE 4163 Chemical and Biological Process Design I

3:0:0:3

This course provides students with the skills necessary to synthesize and design chemical and biological processes with considerations of site and process selections, process economics, materials of construction, data requirements and acquisition flow sheeting and subsystems. Students are given computer procedures and case studies to gain experience in process simulation and analysis. *Prerequisites:* CBE 3234 and CBE 3152.

CBE 4173 Polymeric Materials

3:0:0:3

Processing, structure, properties and applications of polymers as engineering materials, including renewable-resource based biopolymers. Fundamentals of processing-morphology-property correlations in materials. Basic concepts of viscoelasticity, fracture behavior

and thermal and electrical properties of engineering polymeric materials. *Prerequisite:* CBE 3134.

CBE 4213 Engineering Laboratory II

1:6:0:3

Continued experiments in unit operations, transport processes and process control. Students analyze and design their experiments to meet stated objectives. Their results are presented in written and oral form. *Prerequisites:* CBE 4113 and CBE 4143.

CBE 4263 Chemical and Biological Process Design II

3:0:0:3

This course provides students with the skills to optimally design industrial processes synthesizing their knowledge from previous chemical and biological engineering courses. Students are given more advanced computer procedures and work on case studies to gain further experience in process simulation and analysis. Design projects are conducted in a team environment similar to that found in industry. *Prerequisites:* CBE 4163 and CBE 4143.

CBE 481X/482X Chemical Engineering Project

up to 4 credits

Independent work in areas of interest in chemical engineering selected by students and faculty supervisors. Not open to honors or senior thesis students. X = 1, 2, 3 or 4 and designates the number of credits.

Prerequisite: Adviser's approval.

CBE 491X/492X Bachelor's Thesis in Chemical Engineering

up to 4 credits

Original investigations of problems in chemical engineering with a faculty supervisor. A thorough search of the literature is required. Special apparatus constructed as required for experimental work. X = 1, 2, 3 or 4 and designates the number of credits.

Prerequisite: Adviser's approval.

CBE 4954 Chemical Engineering Internship

4 credits

Supervised, creative engineering experiences of at least two months' duration, typically taken during the summer, culminating in written and oral reports presented to industrial and faculty supervisors. Faculty visitations and conferences during internships are arranged. *Prerequisites:* Senior standing and adviser's approval.

GRADUATE COURSES

CBE 6153 Applied Mathematics in Engineering 3:0:0:3

Linear spaces: vectors, linear dependence, linear operators and linear algebraic equations. Eigenproblems and Sturm-Liouville Problem, vector calculus. Complex analysis. Series solutions and Bessel functions. Analytical methods for solving partial differential equations (PDEs): separation and combination of variables, examples for the solution of PDEs: the Homogeneous and Non-homogenous cases non-linear analysis and the phase plane. *Prerequisite: CBE 3103 or adviser's approval.*

CBE 6333 Transport Phenomena 3:0:0:3

Vector analysis review. Diffusive fluxes. Conservation equations for chemical species and thermal energy. Boundary conditions. Scaling and approximation techniques. Solution methods for conduction and diffusion problems. Transient unidirectional diffusion and conduction. Momentum diffusion and viscous stress. Conservation equation for momentum and the Navier-Stokes equations. Unidirectional and lubrication flows. Low Reynolds number flows. High Reynolds number flows. *Prerequisite: CBE 3134 or adviser's approval.*

CBE 6733 Chemical Engineering Thermodynamics 3:0:0:3

Advanced treatment of phase and chemical equilibria, ideal and non-ideal solutions, stability of thermodynamic systems, osmotic pressures, electrolyte solutions, solid-liquid equilibria, biochemical applications. *Prerequisite: CBE 3152 or adviser's approval.*

CBE 6813 Chemical Reactor Analysis and Design 3:0:0:3

Trends and issues in modern reactor design. Kinetics of complex homogenous and heterogeneous reactions: determination of non-linear kinetic parameters, effects of transport processes; catalyst deactivation. Analysis and design of reactors; laminar flow reactors, dispersion model, split boundary condition problems, effects of non-ideal flow on conversion; fixed-bed, fluidized-bed and multiphase reactors. *Prerequisite: CBE 3224 or adviser's approval.*

CBE 7213 Polymer Rheology and Processing 3:0:0:3

Science and engineering of polymer processing. Newtonian and non-Newtonian flow phenomena. Molecular and phenomenological models of polymer rheology. Experimental characterization of shear flows. Theory and application of engineering principles to extrusion, co-extrusion, blown film extrusion, injection molding and fiber spinning. *Prerequisite: CBE 3134 and 3234 or adviser's approval.*

CBE 7263 Engineering Physics of Synthetic and Biological Macromolecules 3:0:0:3

Physical states of synthetic and biological macromolecules; sizes, shapes and ordered structures. Dynamics of unentangled and entangled chains. Networks and gels. Mechanical, dielectric and optical properties. Viscoelasticity and fracture. *Prerequisite: CBE 4173 or adviser's approval.*

CBE 7283 Polymer Composites 3:0:0:3

Composites of linear or cross-linked polymer matrix and reinforcing fibers: carbon, graphite, Kevlar and glass. Manufacturing of composites. Autoclave bag molding, filament winding, pultrusion. Science and engineering of processing of composites. Chemorheology, heat and mass transfer, residual stresses, monitoring and optimization of processing. Mathematical models. In-situ real-time sensing. Nanocomposites and 'green' composites. *Prerequisite: CBE 4173 or adviser's approval.*

CBE 7523 Air Pollution Engineering Control 3:0:0:3

Control of air pollutants in response to government regulation, regeneration; Pollutant emissions control and the US Clean Air Act mandates; EPA control technology approaches, BACT, MACT and RACT. Analysis of pollutant properties, concentrations and atmospheric boundary conditions; absorptive and reactive recovery processes for moving and stationary sources; formation and removal of gaseous oxides (NO_x, SO_x, CO) of VOC's, Hg and HAP's) and of aerosols and other particulates. *Prerequisite: Adviser's approval.*

CBE 8113 Optimization in Biological Systems 3:0:0:3

Introduction. The mathematical programming approach. Tree and network representations. Review of the basic concepts in optimization. Kuhn-Tucker optimality conditions. Non-linear programming algorithms. Modeling techniques for formulating non-linear models. Review of linear programming. Modeling of continuous and discrete decisions. Mixed-integer linear programming techniques (MILP). Logical inference and MILP. Mixed-integer non-linear programming algorithms (MINLP). Applications in computational molecular biology. Genotyping of pooled micro-satellite markers. Genome rearrangement by DNA inversions. Multiple alignment problems. Optimization applications in protein systems. Optimization applications in metabolic networks. *Prerequisite: Adviser's approval.*

CBE 8313 Biointerfacial Engineering 3:0:0:3

Design, physical properties, and experimental analysis of interfaces from a bioengineering perspective. The course consists of approximately two-thirds lecture and one-third laboratory component. Topics covered incorporate experimental characterization including electrochemical, optical, and spectroscopic methods; the biochemistry of surfaces; physical properties including surface thermodynamics, electrostatics, and biomolecular properties at interfaces; and select biotechnological applications. *Prerequisite: CBE 3134, CBE 3224, CM 3314, CM2234 or adviser's approval.*

CBE 8373 Engineering Principles of Drug Delivery 3:0:0:3

Fundamental concepts in drug delivery from an engineering perspective. Biological organisms are viewed as highly interconnected networks where the surfaces/interfaces can be activated or altered 'chemically' and 'physically/mechanically'. The importance of intermolecular and interfacial interactions on drug delivery carriers is the focal point of this course. Topics include: drug delivery mechanisms (passive, targeted) for metastatic cancer, in particular, and for inflammatory-type-of-diseases, in general; therapeutic modalities and mechanisms of action; engineering principles of controlled release and quantitative understanding of drug transport (diffusion, convection); effects of electrostatics, macromolecular conformation, and molecular dynamics on interfacial interactions;

thermodynamic principles of self-assembly; chemical and physical characteristics of delivery molecules and assemblies (polymer based, lipid based); significance of biodistributions and pharmacokinetic models; toxicity issues and immuneresponses. *Prerequisite: CBE 3134 or adviser's approval.*

CBE 8813 Biochemical Engineering

3:0:0:3

Biochemical and bioprocess engineering. Enzyme kinetics. Cellular control systems. Genetic and protein engineering. Metabolism, stoichiometry, and metabolic engineering. Cell growth kinetics. Bioreactor design and operation. Heat/mass transfer in biological system. Biological product purification and characterization. *Prerequisite: CBE 3224 and CBE 3234 or adviser's approval.*

CBE 9403/ 9413 Selected Topics in Chemical and Biological Engineering I/II

3:0:0:3

Topics of special interest in chemical and biological engineering are announced in advance in each semester offering. *Prerequisite: Adviser's approval.*

PROJECTS, THESES AND SEMINARS

CBE 902X Guided Studies in Chemical Engineering (6 credits, 3 each)

Selections, analyses, solutions, and presentations of engineering reports of problems in products, processes or equipment design, or other fields of chemical engineering practices under supervision of a faculty member. Conferences scheduled. Master's degree candidates are required to submit three unbound copies of their reports to advisers one week before the last day of classes.

CBE 903X Guided Studies in Biomolecular Engineering (6 credits total, 3 each)

Selections, analyses, solutions, and presentations of engineering reports of problems in products, processes or equipment design, or other fields of biomolecular engineering practices under supervision of a faculty member. Conferences scheduled. Master's degree candidates are required to submit three unbound copies of their reports to advisers one week before the last day of classes.

CBE 9910/9920 Seminar in Chemical and Biological Engineering 0 credits

Recent developments in chemical and biological sciences and engineering are presented by engineers and scientists from industry and academia. Four semesters are required for PhD candidates.

CBE 997X Thesis for Degree of Master of Science in Chemical Engineering

(9 credits total, 3 each)

Theses for the master's degree in chemical engineering should give results of original investigation of problems in chemical engineering or application of physical, chemical or other scientific principles to chemical engineering. Theses may involve experimental research, theoretical analyses or process designs, or combinations thereof. Master's degree candidates are required to submit four unbound copies to advisers before the seventh Wednesday prior to commencement. *Prerequisite: Degree status.*

CBE 999X Thesis for Degree of Doctor of Philosophy in Chemical Engineering (45 credits total, each 3 credits)

Theses for the PhD degree must give results of independent investigations of problems in chemical engineering and may involve experimental or theoretical work. Theses must show ability to do creative work and must show that original contributions, worthy of publication in recognized journals, are made to chemical engineering. Candidates are required to take oral examinations on thesis subjects and related topics. Doctoral degree candidates must submit five unbound thesis copies to advisers before or on the seventh Wednesday prior to commencement. *Prerequisite: Doctoral qualifying examination.*

Typical Course of Study for the Bachelor of Science in Chemical and Biological Engineering

FRESHMAN YEAR

Fall Semester

Course No.	Course Title	Class	Hours/Week			Cr.
			Lab.	Rec.	Cr.	
MA 1024	Calculus I ¹	4	0	0	4	
CM 1004	General Chemistry	3	2	1	4	
EN 1014	Writing & Humanities I ²	4	0	0	4	
EG 1004	Intro. Engineering & Design	1	3	2	4	
SL 1010	Freshman Seminar	1	1	0	0	
						16

Spring Semester

Course No.	Course Title	Class	Hours/Week			Cr.
			Lab.	Rec.	Cr.	
MA 1124	Calculus II	4	0	0	4	
BMS 1004	Intro. to Cell & Molec. Biology	3	3	0	4	
CBE 1124	Intro. to Chem. & Biology Eng. Design	4	0	0	4	
EN 1204	Writing & Humanities II	4	0	0	4	
						16

SOPHOMORE YEAR

Fall Semester

MA 2012	Linear Algebra I (½ semester)	4	0	0	2	
MA 2132	Ordinary Diff. Equ. (½ semester)	4	0	0	2	
PH 1004	Introductory Physics I	4	1.5	1	4	
CM 2234	Industrial Organic Chemistry	4	0	0	4	
CBE 2124	Anal. of Chem. & Bio. Processes	4	0	0	4	
						16

Spring Semester

MA 2112	Multi. Calculus A (½ semester)	4	0	0	2	
MA 2122	Multi. Calculus B (½ semester)	4	0	0	2	
CS 1114	Intro. to Prog. & Prob. Solving	3	3	0	4	
CM 2514	Chem. & Bio. Equilibria	4	0	0	4	
PH 2004	Introductory Physics II	4	1.5	1	4	
						16

JUNIOR YEAR

Fall Semester

CM 3314	Biochemistry I	4	0	0	4	
CBE 3102	Math. Methods for Chem. & Bio. Engineers	2	0	0	2	
CBE 3153	Chem. & Bio. Eng. Thermo	3	0	0	3	
CBE 3134	Physical Rate Processes	4	0	0	4	
HI 2104	Modern World History	4	0	0	4	
						17

Spring Semester

CBE 3234	Chem. & Bio. Eng. Separations	4	0	0	4	
CBE 3224	Chem. & Bio. Reactor Eng. HU/SS Elective ³	4	0	0	4	
						4
						16

SENIOR YEAR

Fall Semester

CBE 4113	Engineering Laboratory I	1	6	0	3	
CBE 4143	Process Dynamics & Control	3	0	0	3	
CBE 4163	Chem. & Bio. Eng. Proc. Design I	3	0	0	3	
						4
						4
						17

Spring Semester

CBE 4123	Engineering Laboratory II	1	6	0	3	
CBE 4173	Polymeric Materials	4	0	0	3	
CBE 4263	Chem. & Bio. Eng Proc. Design II	4	0	0	3	
						3
						4
						16

Total credits required for graduation:

130

1. Students who are placed by examination or by an adviser into MA 0902, MA 0912 or MA 0922 must defer registration for MA 1024.
2. Students who are placed by examination or by an adviser into EN 1080 must subsequently register for EN 1034, rather than EN 1014.
3. Approved HU/SS electives are courses with the following prefixes: AH, AN, EC, EN, HI, MU, PL and PS. Two courses must be from Level II elective courses in different disciplines and one from Level III Advanced Elective courses.

TRANSFER STUDENTS must substitute an engineering elective for EG 1004 and may substitute an engineering elective for CBE 1124

CHEMISTRY PROGRAM

Program Directors

Bruce A. Garetz (undergraduate)
Mary K. Cowman (graduate)

Chemistry is concerned with knowledge of the structures, properties and reactions of matter and evolving theories to explain observations, predict chemical behavior and suggest experiments.

Classical divisions of chemistry are (1) organic chemistry, dealing primarily with compounds of carbon; (2) inorganic chemistry, concerned with all other compounds; (3) analytical chemistry, concerned with quantitative determinations of composition; and (4) physical chemistry, which seeks understanding of matter, including chemical bonds and molecular interactions.

These classical fields have increasingly overlapped, and several interdisciplinary fields are now of great importance: biochemistry, electrochemistry, photochemistry, polymer chemistry, solid-state chemistry and chemical physics.

The Department of Chemical and Biological Sciences (CBS) offers a full complement of undergraduate and graduate courses in various aspects of modern chemistry. Graduates are prepared for positions at educational institutions, research institutes, industrial organizations and government laboratories. Staff members conduct and supervise research at undergraduate, graduate and post-doctoral levels. This research is combined with teaching so that courses at all levels are taught by chemists highly competent in their respective fields. Undergraduates participating in required research activities are stimulated and well-prepared for graduate school or professional positions. The CBS department offers programs leading to a Bachelor of Science in Biomolecular Science, a Master of Science in Chemistry and a Doctor of Philosophy in Materials Chemistry.

GOALS AND OBJECTIVES

The goals of the Master of Science program are to advance students' knowledge and experience beyond the BS level and equip them with the needs of a changing industrial environment.

The goal of the PhD program is to offer candidates an opportunity to learn various aspects of materials chemistry especially associated with polymers and bio-active materials.

UNDERGRADUATE PROGRAM

The BS degree requirements are described in the Biomolecular Science Program section of this catalogue. The BS in biomolecular science, option in chemistry, with an appropriate selection of electives, is certified by the American Chemistry Society (ACS) to be a rigorous academic program, which is valued by both potential employers and graduate schools. ACS-certified graduates are immediately eligible for society membership.

GRADUATE PROGRAMS

Master of Science in Chemistry

Students in this program are trained to perform at the mid-managerial level of the chemical industry and other organizations involved in chemically related work. Many students in this program continue their efforts toward a doctoral degree, and are already employed in chemistry related institutions and will gain the knowledge to move ahead in these organizations. The MS program will allow graduate credit for special learning opportunities involving research as arranged with program advisers.

Doctor of Philosophy in Materials Chemistry

The PhD program in materials chemistry is highly interdisciplinary, exposing students to a wide-range of exciting, cutting-edge science. The program's objective is to educate students through classroom and research experiences in the emerging discipline of materials chemistry.

Students in the program engage in research topics that include: chemical and biological synthesis of polymeric materials, structural and physical properties of synthetic and biological macromolecules, understanding the interplay between molecular-level structure and function, and exploring the biological properties of macromolecules.

The program promotes interdisciplinary interactions among the students and faculty whose interests lie at the boundaries of chemistry, biology and engineering. In particular, our faculty specializes in the integration of biotechnology for the creation of new catalysts, sensors and macromolecules as well as in the detailed characterization and understanding of such polymers and novel super-molecular structures. The Materials Chemistry program encompasses the Polymer Research Institute, the Center for Biocatalysis and Bioprocessing of Macromolecules, and more.

REQUIREMENTS FOR THE MASTER OF SCIENCE

Candidates for the MS in chemistry plan their programs in accordance with the following list of requirements:

A. Required (core) courses, 4 courses, 3 credits each:

1. Physical chemistry
CM 7043 Statistical Thermodynamics and Kinetics
2. Organic chemistry
CM 9033 Physical Organic Chemistry
3. Analytical chemistry (choose one of the following two)
CM 8023 Principles of Spectroscopy
CM 8073 Organic Spectroscopy
4. Inorganic chemistry, polymer chemistry, or biochemistry (choose one of the following three)
CM 6013 Advanced Inorganic Chemistry
CM 9413 Biochemistry I
CM 7723 Synthesis of Macromolecules

B. Electives, 12 credits:

two courses from CM listing and two courses from CM, BE, BT, and CBE listings

C. Seminar, 1.5 credits:

CM 9731 Seminar in Chemistry I

D. Chemical Literature, 1.5 credits:

CM 5021 Information Sources for the Chemical Sciences

E. Chemical Laboratory Safety, 0 credits:

CM 5040 Chemical Laboratory Safety

F. Guided Studies Project, 3 credits:

CM 8713 Guided Studies in Chemistry I

Total: 30 credits

To meet graduation requirements, students must have an overall B average in all courses (excluding seminar, chemical information and guided studies). Where CM 9731 and CM 5021 are not offered, they may be replaced by an elective course or a second Guided Studies project (CM 8723 Guided Studies in Chemistry II). Students must be in continuous attendance at the departmental colloquia.

REQUIREMENTS FOR THE DOCTOR OF PHILOSOPHY

Candidates for the degree Doctor of Philosophy in Materials Chemistry are to plan their programs in accordance with the requirements listed below.

A. Required (core) courses, 4 courses, 3 credits each:

1. Physical chemistry
CM 7043 Statistical Thermodynamics and Kinetics
2. Organic chemistry
CM 9033 Physical Organic Chemistry
3. Analytical chemistry (one of the following two)
CM 8023 Principles of Spectroscopy
CM 8073 Organic Spectroscopy
4. Inorganic chemistry, polymer chemistry, or biochemistry (one of the following three courses)
CM 6013 Advanced Inorganic Chemistry
CM 9413 Biochemistry I
CM 7723 Synthesis of Macromolecules

B. Electives, 12 credits:

two courses from CM listing and two courses from CM, BE, BT, and CBE listings

C. Seminar, 3 semesters, 4.5 credits:

- CM 9731 Seminar in Chemistry I
CM 9741 Seminar in Chemistry II
CM 9751 Seminar in Chemistry III

D. Chemical Literature, 1.5 credits:

- CM 5021 Information Sources for the Chemical Sciences

E. Chemical Laboratory Safety, 0 credits:

- CM 5040 Chemical Laboratory Safety

F. Thesis Research, 36 credits (minimum):

- CM 999x Research in Chemistry

G. The rest, if any, are electives (from CM, BE, BT, and CBE listings). up to 9 credits

Total: 75 credits

Students must pass a comprehensive qualifying examination in chemistry and present a doctoral dissertation. The qualifying exam is given once a year. Additional details on the qualifying examination should be obtained from the graduate adviser. Each candidate for the doctorate must complete a minimum of 75 credits of academic work past the bachelors degree, including a minimum of 36 credits of dissertation research. Of those 75 credits required, at least 45 credits must be taken at Polytechnic. Of the total 36-45 dissertation research credits, up to 12 credits can be transferred from research credits taken at another institution prior to coming to Polytechnic. If the courses transferred from another institution do not include all four core courses, the missing core courses must be

taken at Polytechnic. The remaining courses to satisfy the doctoral degree will be selected in consultation with the student's adviser.

Candidates must have an overall B average in the core courses as well as in the core and elective courses (excluding seminar, chemical literature and thesis).

The student is required to declare a concentration by taking three courses from one of the following five areas: physical chemistry, organic chemistry, analytical chemistry, biochemistry, and polymer chemistry. One of the three courses can be a core course. The course description indicates which courses qualify for the five areas. The GPA of the three courses must be B or better. Students must be in continuous attendance at the departmental colloquia.

UNDERGRADUATE COURSES**CM 1004 General Chemistry for Engineers** 3:2:1:4

A one-semester introductory course in general chemistry. Chemical equations, stoichiometry, thermodynamics, gases, atomic and molecular structure, periodic table, chemical bonding, states of matter, chemical equilibrium, organic, inorganic and polymeric materials, electrochemistry.

CM 1014 General Chemistry I 3:2:1:4

Chemical equations, chemical conservation laws, stoichiometry, thermochemistry, properties of gases, atomic structure, periodic table, chemical bonding and molecular structure. Required course for students in the Biomolecular Science program.

CM 1024 General Chemistry II 3:2:1:4

States of matter, chemical thermodynamics and equilibria, kinetics, acidbase chemistry, electrochemistry, introduction to organic chemistry, natural and synthetic polymers. Required course for students in the Biomolecular Science program. *Prerequisite:* CM 1004 or CM 1014

CM 2214 Organic Chemistry I 3:3:0:4

Chemistry of organic molecules: structure, nomenclature, properties and reactions of carbon compounds with emphasis on aliphatic compounds. Introduction to reaction mechanisms and stereochemistry. Includes laboratory involving methods for preparation, isolation and purification of typical organic compounds. Experiments chosen to illustrate basic techniques. Lab fee required. *Prerequisite:* CM 1004 or CM 1024.

CM 2224 Organic Chemistry II 3:3:0:4

Continuation of CM 2214 with emphasis on finding the principles of organic chemistry in industrial practice and biochemical mechanisms. Includes laboratory stressing complex preparation, purification, characterization and identification of organic compounds by chemical and physical means. Introduction to instrumental methods of analysis and identification. *Prerequisite:* CM 2214.

CM 2234 Industrial Organic Chemistry 4:0:0:4

This course demonstrates the basic ideas of organic chemistry using industrial processes and important commercial materials. Covers the petroleum-based foundations of organic materials and shows how these petroleum-derived molecules ultimately lead, via important chemical reactions and intermediates, to the commercial products produced by the chemical industry. Course demonstrates how the principles of organic chemistry are intertwined with the many changes that characterize the chemical industry. The material presented in this course is couched in a historical context. *Prerequisite:* CM 1004 or equivalent.

CM 2514 Chemical and Biological Equilibria 4:0:0:4

Chemical thermodynamics with applications to solution, phase and chemical equilibria; chemical and biological kinetics. *Prerequisites:* CM 1004, and MA 1124 or MA 1154, and PH 1004

CM 2614 Physical Chemistry I 4:0:0:4

Chemical thermodynamics with applications to solutions, phase and chemical equilibria. Molecular motion and transport properties. *Prerequisites:* CM 1004 or CM 1024, and MA 1124 or MA 1154, and PH 1004.

CM 3114 Inorganic Chemistry 3:3:0:4

Atomic structures of elements as basis for periodic classification. Descriptive chemistry of elements and their compounds. Theories of chemical bonds and introduction to coordination chemistry. *Prerequisite:* CM 2514 or CM 2614.

CM 3314 Biochemistry I 4:0:0:4

Survey of modern biochemistry with emphasis on current areas of research. Structure-function relationships in proteins. Enzymes and their mechanisms of action. Bioenergetics principles and energy production. Biochemical theories and techniques. *Prerequisites: CM 2214 or CM 2234 and CM 2614 or CM 2514 or instructor's permission.*

CM 3324 Biochemistry II 4:0:0:4

Continuation of Biochemistry I. Principles of intermediary metabolism, energetics, membrane structure and transport; structure and function of DNA and RNA, principles of molecular biology, the immune system, hormonal regulation, cancer. *Prerequisite: CM 3314 or instructor's permission.*

CM 3514 Analytical Chemistry 3:3:0:4

Theories and applications of instrumentation techniques in modern analytical chemistry, including spectroscopy (UVVIS absorption, infrared absorption, fluorescence, Raman scattering, nuclear magnetic resonance), chromatography (gas, liquid), and other techniques (mass spectroscopy, electrophoresis). The accompanying laboratory part focuses on practical skills. *Prerequisite: CM 2514 or CM 2614.*

CM 3614 Physical Chemistry II 2:6:0:4

Chemical kinetics. Molecular structures and interactions, and their relationship to the bulk properties of matter. Laboratory component comprises and introduction to the experimental quantitative methods of analytical and physical chemistry, including volumetric, calorimetric and optical techniques. Computer analysis of data and report writing. *Prerequisite: CM 2514 or CM 2614.*

CM 4314 Biomaterials 4:0:0:4

Natural macromolecules, including polypeptides, polysaccharides, lignin, biodegradable polymers, and special characterizations of these biopolymers. *Prerequisite: CM 4414 or CM 4413.*

CM 4413 Polymer Science 3:0:0:3

This course gives students a broad perspective of polymer science and its application in everyday life. The course has three major components: a survey of polymers, polymer synthesis and aspects of polymer physics. *Prerequisites: CM 2214 and CM 2614 or CM 2514.*

CM 4414 Polymer Chemistry 3:3:0:4

An introduction to polymer science. The course includes principles of various polymerization methods, characterization and physical chemistry of polymers. Includes laboratory. *Prerequisites: CM 2214 and CM 2514 or CM 2614.*

CM 4914/ CM 4924 Undergraduate Research in Chemistry each 4 credits

Original investigations by student under guidance of staff members. Careful literature research required before inception of laboratory work; continued reference to chemical literature expected and active participation in conferences and seminars scheduled as work progresses. A written report is required. Full-time students are expected to register for 8 credits of thesis during senior year. Research (lab) fee required. *Prerequisites: CM 5011 and CM 5040.*

CM 5011 Information Sources for the Chemical Sciences 1:0:0:1

A hands-on introduction to methods and tools for searching. Includes both electronic (CD-ROM and online) as well as print databases. Students may emphasize topics related to their research. Required of all BS students in biomolecular science.

UNDERGRADUATE AND GRADUATE COURSES**CM 5040 Chemical Laboratory Safety** 1:0:0:0

Discussion of problems of health and safety arising in chemical laboratories. How to work safely with dangerous chemicals. This course must be completed by both graduate and undergraduate chemistry students before they undertake laboratory research. *Prerequisite: None. Co-requisite: None.*

GRADUATE COURSES**CM 5021 Information Sources for the Chemical Sciences** 1.5:0:0:1.5

A hands-on introduction to methods and tools for searching. Includes both electronic (CD-ROM) and online) as well as print databases. Students may emphasize topics related to their research. Graduate students are required to take this course. *Prerequisite: None. Co-requisite: None.*

INORGANIC CHEMISTRY**CM 6013 Advanced Inorganic Chemistry** 3:0:0:3

Theories of bonding in inorganic compounds. Introduction to group theory as applied to molecular orbital and ligand field theories. Spectra of inorganic compounds. Non-aqueous solvents. Introduction to transition metal chemistry. *Prerequisite: Adviser's approval. Co-requisite: None.*

CM 6153 Special Topics in Inorganic Chemistry 3:0:0:3

Special Topics in Inorganic Chemistry *Prerequisite: Adviser's approval. Corequisite: None.*

PHYSICAL CHEMISTRY**CM 7033 Quantum Chemistry** 3:0:0:3

Quantum structures of atoms and molecules. Fundamental ideas of quantum mechanics. Applications to atomic and molecular structures and bonding. Approximation methods. Interactions of light and matter. *Prerequisite: Undergraduate physical chemistry and physics or adviser's approval. Co-requisite: None.*

CM 7043 Statistical Thermodynamics and Kinetics 3:0:0:3

Statistical mechanics for chemical systems. Ensembles, partition functions, thermodynamic functions. Applications to various systems including non-ideal gas, gas of diatomic molecules, polymer, surface phenomena, chemical equilibria, biophysics, reaction kinetics. *Prerequisite: Undergraduate physical chemistry and physics or adviser's approval. Co-requisite: None.*

CM 7103 Biophysical Chemistry 3:0:0:3

Structure and properties of important biological macromolecules, including proteins, nucleic acids and polysaccharides; membranes and macromolecular complexes; applications of x-ray diffraction; NMR; vibrational and CD spectroscopy to the analysis of structure. *Prerequisite: CM7043 or adviser's approval. Co-requisite: None.*

CM 7503 Special Topics in Physical Chemistry 3:0:0:3

Special Topics in Physical Chemistry
Prerequisite: Adviser's approval. Co-requisite: None.

CM 8023 Principles of Spectroscopy
See ANALYTICAL CHEMISTRY section.**CM 7813 Characterization of Macromolecules**
See POLYMER CHEMISTRY section.**ORGANIC CHEMISTRY****CM 9033 Physical Organic Chemistry** 3:0:0:3

Molecular structure and bonding. Stereochemical and conformational principles. Theories of bonding and the physical parameters of stable and reactive molecular states. Applications in biochemistry and polymer chemistry. *Prerequisite: Undergraduate organic chemistry or adviser's approval. Co-requisite: None.*

CM 9043 Synthetic Organic Chemistry 3:0:0:3

Reactivity of molecules. The methods of mechanistic study of reaction pathways. Important reactions of organic and organometallic chemistry. Introduction to synthesis and applications in living systems and in polymer reactions. *Prerequisite: Undergraduate organic chemistry or adviser's approval. Co-requisite: None.*

CM 9053 Enzyme Catalysis in Organic Synthesis 3:0:0:3

The course will provide students with a working knowledge of how to use biotransformations as a tool in organic chemistry. Students will learn about general enzymatic reaction types that carry out the cleavage and formation of C-O bonds, P-O bonds, C-N bonds, C-C bonds, reduction reactions, oxidation reactions and isomerizations. In addition, students will be taught about advanced principles that are currently being applied to the engineering of catalytic proteins. *Prerequisite: Adviser's approval. Co-requisite: None.*

CM 9403 Special Topics in Organic Chemistry 3:0:0:3

Special Topics in Organic Chemistry
Prerequisite: Adviser's approval. Co-requisite: None.

CM 8073 Organic Spectroscopy
See ANALYTICAL CHEMISTRY section.**CM 7723 Synthesis of Macromolecules**
See POLYMER CHEMISTRY section.**BIOCHEMISTRY****CM 9413 Biochemistry I** 3:0:0:3

Structure and function of biological macromolecules: proteins, nucleic acids, polysaccharides. Enzymatic kinetics, mechanism and control. *Prerequisite: Undergraduate biochemistry or adviser's approval. Co-requisite: None.*

CM 9423 Biochemistry II 3:0:0:3

Membrane structure and function. Energy production, transformation and utilization. Regulation of biochemical systems. Replication, transcription and translation of DNA. Mutagenesis and carcinogenesis. Immune system. *Prerequisite: undergraduate biochemistry or adviser's approval. Co-requisite: None.*

CM 9433 Protein Engineering 3:0:0:3

This course will introduce students to the modern protein engineering techniques available to researchers to understand protein structure and function and to create entirely new proteins for a variety of purposes. This is a new field that lies on the interface of chemistry, biology and engineering. The first part of the course will discuss the protein composition and structure, various genetic, biochemical and chemical techniques required to engineer proteins, which then will be followed by specific topics. Topics will include designing proteins that are highly structured; active at high temperatures and in non-aqueous solvents; that selectively interact with other proteins, small molecules and nucleic acids for therapeutic purposes; and that catalyze new reactions. *Prerequisite: CM9413 or adviser's approval. Co-requisite: None.*

CM 9443 Tissue Engineering 3:0:0:3

This course instructs students in the following: i) basic biological processes that occur during blood contact with artificial surfaces, ii) to critically read and review the literature in the field of tissue engineering, iii) anticipate biocompatibility issues relevant to a variety of implant devices that the student may encounter in future endeavors, iv) current approaches directed toward the engineering of cell-based replacements for various tissue types. *Prerequisite: undergraduate biochemistry or adviser's approval. Corequisite: None*

CM 9463 Recombinant DNA Technology 3:0:0:3

The course will consist of lectures and demonstrations and will cover practical aspects of recombinant DNA technology, including: fundamental aspects of gene expression, restriction enzyme cleavage, plasmids, cloning, genetic transformation of bacteria, protein expression vectors, basic principles of protein purification, and manipulation of cloned genes (site-directed mutagenesis). *Prerequisite: CM 9413 or instructor's permission. Co-requisite: None.*

CM 9453 Special Topics in Biochemistry 3:0:0:3

Special Topics in Biochemistry
Prerequisite: adviser's approval. Co-requisite: None.

CM 7103 Biophysical Chemistry
See PHYSICAL CHEMISTRY section.**CM 8213 Bioanalytical Chemistry**
See ANALYTICAL CHEMISTRY section.**ANALYTICAL CHEMISTRY****CM 8023 Principles of Spectroscopy** 3:0:0:3

Rotational, vibrational, and electronic states of atoms and molecules. Interaction of radiation with atoms and molecules. Molecular symmetry. Rotational and vibrational spectroscopy. Electronic spectroscopy. *Prerequisite: Undergraduate physical chemistry or adviser's approval. Co-requisite: none*

CM 8073 Organic Spectroscopy 3:0:0:3

Structure elucidation by joint applications of spectroscopic techniques such as proton and carbon-13 magnetic resonance, infrared and mass spectroscopy, and other methods. *Prerequisite: Undergraduate organic chemistry or adviser's approval. Co-requisite: None.*

CM 8103 Liquid Chromatography 3:0:0:3

Fundamentals of liquid chromatography. Partitioning. Physical and chemical properties of packing materials. Size exclusion chromatography. Normal-phase and reversed-phase chromatography. Hydrophilic interaction liquid chromatography. Hydrophobic interaction chromatography. Ion exchange chromatography. Preparative chromatography. Gradient elution. Method development. *Prerequisite: Adviser's approval. Co-requisite: None.*

CM 8123 Mass Spectroscopy 3:0:0:3

Isotopes and molecular masses. Various ionization methods and mass analyzers. Application to biomolecules in sequential analysis of nucleic acids, peptides, proteins, and analysis of phospholipids, polysaccharides, fatty acids. *Prerequisite: Adviser's approval. Co-requisite: None.*

CM 8213 Bioanalytical Chemistry 3:0:0:3

Exciting new analytical methods used in biochemistry and biotechnology today, such as atomic force microscopy, capillary electrophoresis, surface plasmon resonance, microarrays, etc. The course is based directly on the current scientific literature. *Prerequisite: CM9413 or adviser's approval. Co-requisite: None.*

CM 8303 Nuclear Magnetic Resonance Spectroscopy 3:0:0:3

Principles of NMR. NMR spectrometers. Spin decoupling. Multi-pulse experiments. 2D NMR. Solid-state NMR. *Prerequisite: Adviser's approval. Co-requisite: None.*

CM 8323 Microscopy 3:0:0:3

Review of optics. Fundamentals of optical microscope. Phase contrast microscopy. Confocal microscopy. IR and Raman microscopy. Transmission and scanning electron microscopy. Atomic force microscopy. *Prerequisite: Undergraduate physics or adviser's approval. Co-requisite: None.*

CM 8503 Special Topics in Analytical Chemistry 3:0:0:3

Special Topics in Analytical Chemistry *Prerequisite: Adviser's approval. Co-requisite: None.*

POLYMER CHEMISTRY

CM 7723 Synthesis of Macromolecules 3:0:0:3

Organic aspects. Chemistry of monomer and polymer formation. Modern mechanistic analyses of reactions. Stereochemistry of polymer structures and forces of stereo regulation. Condensation, free radical (bulk, suspension, emulsion, solution), ionic, ring-opening and non-classical polymerization reactions. *Prerequisite: Undergraduate organic chemistry or adviser's approval. Co-requisite: None.*

CM 7813 Characterization of Macromolecules 3:0:0:3

Characterization methods for linear-chain polymer and macromolecules in solution such as static and dynamic light scattering, osmometry, size exclusion chromatography, viscometry. Characterization methods for macromolecules in solid state such as crystallography, mechanical and thermal analysis. *Prerequisite: Undergraduate physical chemistry or adviser's approval. Co-requisite: None.*

CM 7923 Natural Polymers and Materials 3:0:0:3

This course provides an introduction to natural and biomimetic polymers taught with an interdisciplinary view of biology, chemistry and macromolecular science. Topics covered in this course include: natural building blocks and methods by which nature carries out polymer synthesis and modification reactions; DNA; structural proteins; plant proteins; polysaccharides; polyesters; biosurfactants; polymers built from natural monomers and a wide variety of renewable resources; Uses of these polymers as fibers, films, rheological modifiers, flocculants, foams, adhesives and membranes; Special applications of natural polymers in medicine and as biodegradable plastics. *Prerequisite: undergraduate chemistry and biology or adviser's approval. Co-requisite: None.*

CM 7853 Special Topics in Polymer Chemistry 3:0:0:3

Special topics in polymer chemistry *Prerequisite: Adviser's approval. Co-requisite: None.*

PROJECTS, THESES AND SEMINARS

CM 8713, CM 8723 Guided Studies in Chemistry I, II 3:0:0:3

Special project (experimental, theoretical, computational, or literature search). *Prerequisite: Adviser's approval. Co-requisite: None.*

CM 9731, CM 9741, CM 9751 Seminar in Chemistry I, II, III 1.5:0:0:1.5

Chemical topics of current interest, presented by participating students, staff, and outside speakers. One semester is required for MS chemistry students; three semesters required for PhD candidates. *Prerequisite: None. Co-requisite: none*

CM 999X Research in Chemistry 36 credits minimum

Original experimental or theoretical research (undertaken under guidance of a chemistry faculty member), which may serve as basis for a PhD. Minimum research registration requirement is 36 credits. Registration required each semester consecutively until students have completed adequate research projects and acceptable theses and have passed required oral examinations. Research fees required. *Prerequisite: Doctoral qualifying examination. Co-requisite: None.*



CIVIL ENGINEERING PROGRAM

Program Advisers

Roger P. Roess
José M. Ulerio
Magued G. Iskander

UNDERGRADUATE PROGRAM

The Department of Civil Engineering develops engineering graduates capable of contributing to and advancing the practice of civil engineering and its sub-disciplines. Through its research programs, the department strives to be at the forefront in selected areas in the development of new knowledge and applications in civil engineering. Through its educational programs, graduates will be well rounded in state-of-the-art techniques and will develop the skills needed to apply them in a complex profession. Among these skills are the abilities to communicate effectively in written and verbal form and understand the context of civil engineering projects in a complex society.

GOALS AND OBJECTIVES

The general goals of the Bachelor of Science program in Civil Engineering are that undergraduates should have sufficient exposure to all major sub-disciplines in order to (1) allow them to intelligently choose a career path, (2) elect a program of depth in at least two sub-disciplines and (3) continue in a Master of Science program in any civil engineering sub-discipline.

Specific program objectives have been established to reinforce these general goals. Graduates of the undergraduate civil engineering program should:

- Have a solid foundation of knowledge in the major sub-disciplines of civil engineering: structural and geotechnical engineering, environmental and water resources engineering, transportation engineering, and construction management.
- Have the opportunity to develop depth of knowledge in at least two of these sub-disciplines within the scope of their undergraduate education.
- Be capable of professional practice at the entry level in any civil engineering sub-discipline or to pursue graduate work in any of the sub-disciplines.
- Develop design knowledge and skills in at least three sub-disciplines of civil engineering.
- Develop good oral and written communications skills.

- Develop a basic understanding of the societal context in which civil engineering occurs and a thorough appreciation for their responsibilities as professionals to society.

REQUIRED COURSES

The undergraduate curriculum provides a solid foundation in all major sub-disciplines through required courses.

Four courses provide the engineering science and professional underpinnings for all sub-disciplines: CE2114 Statics and Dynamics, CE2124 Mechanics of Materials, CE2214 Fluid Mechanics and Hydraulics, and CE1003 Fundamentals of Civil Engineering. Structural engineering is covered in CE3133 Structural Analysis and CE3144 Steel Design. The required environmental and water resources sequence includes CE3223 Environmental Engineering I, and CE4243 Water Resource Engineering I. CE3324, Traffic Engineering I introduces the student to highway and traffic engineering. CE4413 Construction Management provides a thorough overview of this important sub-discipline.

Design is covered in many of these courses, giving students exposure to design in the various sub-disciplines. Courses CE2214, CE3144, CE3223, CE4243, CE3153, and CE3324 all have significant design content. Most elective courses also have strong design components and all students are required to complete a 4-credit senior design project (CE4814) during their senior year. An introduction to design is provided by EG1004 in the freshman year. Thus, students have progressive design exposure in each year of the program.

Undergraduate elective courses are provided in structural, geotechnical, environmental, water resources, construction management, and transportation engineering. These allow students to gain significant depth in these areas. Selected students with sufficient grade-point averages may take beginning graduate courses in these areas. Special topics courses are provided in each major sub-discipline and are offered as needed.

Communications skills are emphasized throughout the curriculum. The humanities and social sciences portions of the curriculum provide a strong focus on developing writing and verbal skills. The freshman engineering program also includes substantial emphasis on oral presentations and written report assignments. CE 1003 Fundamentals of Civil Engineering, includes numerous written as-

signments, class debates, and oral presentations. All courses with associated laboratories require written laboratory or project reports; many design courses require formal submission of design reports, some with oral presentations. The senior design project experience includes many verbal and written progress reports, and is formally presented and defended as part of final submissions.

Humanities and social science courses also contribute to students' understanding the societal context of their profession. CE 1003, Fundamentals of Civil Engineering, reinforces this with specific civil engineering references and provides a focused treatment of professional ethics. These aspects are also highlighted in other courses in the civil engineering curriculum.

ACCREDITATION

The BS in Civil Engineering is accredited by the Accreditation Board for Engineering and Technology (ABET).

CURRICULUM

The curriculum for the BS in Civil Engineering is described in the tables that follow. Table 1 summarizes the curriculum and its requirements in subject area categories. Table 2 summarizes elective courses available in civil engineering by sub-discipline. A typical four-year course of study for civil engineering majors is shown on the full-page chart in this section.

TABLE 1: CURRICULUM FOR THE BS (CIVIL ENGINEERING)

Course No.	Course Title	Credits	Sem ¹
Required Courses in Mathematics²			
MA 1054	Calculus I with PreCalculus	4	F1
MA 1154	Calculus II with PreCalculus	4	F2
MA 2012	Linear Algebra I	2	So1(a)
MA 2132	Ordinary Differential Equations	2	So1(b)
MA 2212	Data Analysis I	2	So1(a)
MA 2222	Data Analysis II	2	So1(b)
Total mathematics credits required:		16	
Required Courses in Physical Sciences			
CM 1004	General Chemistry for Engineers	4	F1
PH 1004	Introductory Physics I	4	F2
PH 2004	Introductory Physics II	4	So1
Total physical science credits required:		12	
Mathematics or Science Electives: Required Courses in Freshman Engineering and Computer Science			
EG 1004	Introduction to Engineering & Design	4	F1
CS 2102	Computer Systems for Civil Engineers	2	J1
Total freshman engineering and CS credits required:		6	

Required Courses in Civil Engineering

CE 1003	Fundamentals of Civil Engineering	3	F2
CE 2114	Statics & Dynamics	4	So1
CE 2214	Fluid Mechanics & Hydraulics	4	So2
CE 2124	Mechanics of Materials	4	So2
CE 3133	Structural Analysis	3	J1
CE 3223	Environmental Engineering I	3	J2
CE 3144	Steel Design	4	J2
CE 3153	Geotechnical Engineering	3	J2
CE 4243	Water Resource Engineering I	3	J1
CE 3324	Traffic Engineering I	4	J1
CE 4163	Structural Materials	3	S2
CE 4413	Construction Management	3	S2
CE 4814	Civil Engineering Design Project	4	S1
CE	Civil Engineering Elective ³	3	S1
CE	Civil Engineering Elective	3	S2
CE	Civil Engineering Elective	3	S2
CE	Civil Engineering Elective	3	S1
Total civil engineering credits required:		57	

Required Courses in Humanities and Social Sciences⁴

EN 1014	Writing & the Humanities I	4	F1
EN 1204	Writing & the Humanities II	4	F2
HI 2104	Contemporary World History	4	So1
	Level II Elective ⁵	4	So2
	Level II Elective	4	J1
	Level III Elective ⁶	4	J2

Total humanities and social science credits required: 24

Other Electives

Free Elective I ⁷	3	J2
Free Elective II	3	S1
Technical Elective ⁸	3	S1

Total Other Electives: 9
Total credits required for BS in Civil Engineering: 128

Footnotes for Table 1

- Semester Codes: F=freshman, So= Sophomore, J=Junior, S=Senior, 1=Fall, 2=Spring, (a)(b) refer to half-semester courses with (a) being first half, (b) second half.
- The Department of Civil Engineering prefers all of its students to take the MA 1054/1154 calculus sequence. This sequence includes two additional hours of pre-calculus review which the department believes is helpful, even for students with an excellent math background. Students may choose to take a placement exam to be placed in MA 1014/1124 (Calculus I, II), or may be advanced-placed based upon AP test results.
- Civil engineering electives are technical electives, which must be taken from among civil engineering (CE) courses. A list of civil engineering elective courses is found in Table 2.
- Students must take a placement examination in English. They may be placed in a remedial writing program for native English speakers, or ESL (English as a Second Language) or in a special EN 1034 Writing and the Humanities ESL.
- Level II electives are elective courses in the humanities or social sciences that have a prerequisite of EN 1014 (or EN 1034), EN 1204, and/or HI 2104. The two Level II elective courses must be taken in two different disciplines. These courses generally have course numbers 2xxx, with an appropriate subject prefix.
- Level III electives have a prerequisite of a Level II elective. These courses generally have course numbers 3xxx with an appropriate subject prefix.
- Free electives include any course from any department for which the student has the appropriate prerequisites.
- Technical electives can be taken as any math, science, computer science or engineering course for which students have appropriate prerequisites.

TABLE 2: ELECTIVE COURSES IN CIVIL ENGINEERING*

Course No.	Course Title	Semester
CE 3313	Introduction to Transportation Systems	Fall
CE 3353	History of the NYC Transit System and Its Impact on NYC	Fall
CE 3364	History of Urban Infrastructure	Spring
CE 4033	Introduction to Urban Infrastructure Systems Management	Spring
CE 4043	Sustainable Cities	Spring
CE 4053	BIOSOMA-Environmental Design of the City of the Future	Fall
CE 4173	Foundation Engineering	Fall
CE 4183	Reinforced Concrete Design	Fall
CE 4193	Timber & Masonry Structures	Occasional Offerings
CE 4253	Water Resource Engineering II	Occasional Offerings
CE 4263	Environmental Geotechnology	Occasional Offerings
CE 4273	Environmental Engineering II	Fall
CE 4333	Traffic Engineering II	Spring
CE 4343	Design of Traffic Facilities	Spring
CE 4423	Information Systems in Construction Management	Occasional Offerings
CE 4613	Selected Topics in Structural & Geotech. Eng.	Either
CE 4623	Selected Topics in Env. & Water Res. Eng.	Either
CE 4633	Selected Topics in Transportation Eng.	Either
CE 4643	Selected Topics Construction Management	Either
CE 4710	Readings in Civil Engineering	As arranged

All courses are 3 credits except CE 3364, which is 4 credits. Readings courses have variable credit.

Additional electives for CE undergraduates are available from courses of the construction management curriculum. Consult the construction management section of the catalogue or the latest construction management manual.

TRANSFER STUDENTS AND CREDITS

Potential transfer students should refer to the University guidelines in this catalogue. The Department of Civil Engineering has established additional requirements and interpreted the University guidelines as indicated in this section.

The 128-credit curriculum is fulfilled through a combination of transfer credits, credits by examination and courses taken while at Polytechnic. Transfer credits in mathematics, chemistry, physics, humanities and social sciences are evaluated by the Office of Academic Affairs with the guidance of faculty from appropriate departments. Transfer credits in civil engineering and other technical areas are evaluated by the faculty of the Department of Civil Engineering.

The length of time for a transfer student to complete the BS in Civil Engineering depends upon three factors:

- The total number of transfer credits awarded

- The particular courses required to complete degree requirements
- Enrollment status (part-time or full-time)

TRANSFER NOTES:

Transfer students should be aware that they can be awarded transfer credits for courses only in which a C grade or better has been earned and then only for courses that are applicable towards the BS in Civil Engineering as described in this catalogue.

There is a residency requirement that must also be fulfilled. To earn a BS, all students must complete a minimum of 30 credits of course work at Polytechnic at the junior or senior level (courses numbered CE 3XXX or CE 4XXX). These credits must include the design project, CE 4814.

PART-TIME STUDENTS

Students may register as part-time students (less than 12 credits per semester). Such students must be advised, however, that the department no longer offers many undergraduate courses in the evening and that part-time students will have to take most of their courses during the day. Part-time students should maintain close contact with their academic advisers to work out the details of course sequence in the most efficient and effective manner.

UNDERGRADUATE MANUAL

Curriculum changes may occur before the publication of a new catalogue. The Department of Civil Engineering maintains an Undergraduate Manual, which details the most current curriculum at all times.

PREVIOUS CURRICULA

It is a generally accepted rule that students are subject to the requirements of the catalog that was in effect when they initially enrolled at the Polytechnic. In many cases, however, it will be easier to complete the current curriculum. Academic advisers work with students to make sure that they fulfill the proper requirements for graduation.

MASTER OF SCIENCE PROGRAM IN CIVIL ENGINEERING

The Master of Science in Civil Engineering allows students to special-ize in one of the following six areas of concentration:

- Construction Management and Engineering
- Structural Engineering
- Geotechnical Engineering
- Environmental and Water Resource Engineering

- Urban Systems Engineering and Management
- Highway and Traffic Engineering

Students may also elect to follow a general program by taking courses across several areas of concentration. The Department of Civil Engineering also offers graduate programs in transportation planning, management and engineering (see the Transportation section in this catalog), environmental science and engineering (see Environmental Science and Engineering section in this catalog), construction management (see the Construction Management section of this catalog) and urban systems engineering and management (see Urban Systems Engineering and Management section in this catalog).

GOALS AND OBJECTIVES

The degree MS in Civil Engineering prepares graduates to practice their profession at an advanced level. Specific objectives of the program are to provide the skills and knowledge necessary to:

- Specialize in one of the primary sub-disciplines of civil engineering or to achieve depth across a number of the sub-disciplines
- Design and analyze civil engineering infrastructure
- Understand civil engineering materials, technologies and processes as applied to modern civil engineering infrastructure
- Obtain civil engineering project management skills
- Provide a basis for continued, lifelong learning in the civil engineering profession

ADMISSION

Students seeking admission to the MS program should hold a bachelor's degree in civil engineering from a program accredited by the Accreditation Board for Engineering and Technology (ABET) and have a 2.75 GPA or better. Applicants lacking a BS from an ABET-accredited program in civil engineering (including those possessing undergraduate degrees in other engineering disciplines, engineering science, engineering technology, architecture or from a foreign university) will have their qualifications reviewed by a graduate adviser. Admission may be granted and may include the requirement for additional undergraduate courses to make up deficiencies. These additional courses are not counted toward the MS degree, nor are undergraduate courses included in the computation of graduate grade-point averages.

Applicants from universities outside the United States should take the Graduate

Record Examination (GRE advanced tests) and achieve a minimum grade of 550 on the quantitative section and 550 on the verbal section. They must also take the Test of English as a Foreign Language (TOEFL) and achieve a minimum grade of 550. In some cases, the department head may waive the GRE and/or TOEFL after a graduate adviser examines the student's transcripts and interviews the candidate.

Foreign candidates who meet all other admission requirements but who fail to satisfy the TOEFL requirement may be required to take one or more remedial courses in English before admission.

GRADE REQUIREMENTS

To earn an MS degree from Polytechnic, students must maintain a B average (3.0 GPA) or better in (1) all graduate courses taken at Polytechnic, (2) all graduate courses taken in the Department of Civil Engineering and (3) all graduate guided studies (readings, project, thesis). Poor scholastic performance (under 3.0 GPA) may lead to a student being placed on graduate probation. If students' grades do not improve, they may be disqualified from further graduate study in the department. Students may repeat a course with their adviser's approval. When a course is repeated, the latest grade counts toward the GPA. In the rare case where a course is repeated more than once, only the first grade is dropped from the GPA computation.

ADVISING

Graduate students are assigned a faculty adviser. It is important that students maintain frequent contact with their adviser throughout the course of their studies. Students must meet with their academic adviser prior to each registration and at any other time they need advice or consultation. Students must have a detailed program of study formally approved by their adviser prior to registration. Advisers also handle requests for waivers of certain degree requirements, where warranted. Such waivers must be approved in writing and must be entered into the student's departmental .Where specific courses are waived, the approval of the course instructor is also required. When waivers are granted, students may be required to take other specific courses in their place or to select additional electives. Students registering for any guided studies (readings, projects, theses) are assigned advisers for each such activity. The guided studies adviser may or may not be the same as the student's academic adviser, depending upon the subject matter selected. To register for any guided study activity, a student must submit written proposals for the topic(s) to be covered to an ap-

propriate project adviser before registration. To register, students must obtain the written approval of the project adviser and the academic adviser. While academic advisers consult with and advise students, it is the student's responsibility to ensure that all degree requirements are fulfilled and to submit all proper forms and applications when required.

TRANSFER CREDITS

The residency requirement for MS degrees is 24 credits. Students may transfer up to 6 credits of acceptable courses toward an MS degree, subject to their academic adviser's approval. To be transferred, the course(s) must be relevant to the student's program and from an acceptable institution. A grade of B or better is required for granting of transfer credit. Courses graded on a pass/fail basis are not considered for transfer unless accompanied by a detailed written evaluation by the course instructor. All transfer requests must be accompanied by an official transcript from the transferring institution. Applications for transfer credits are accepted only after the student has earned 12 units at Polytechnic.

Validation credits by examination may not be used toward any civil engineering graduate degree program.

GRADUATE MANUAL

The Department of Civil Engineering publishes an annual Graduate Student Manual. As changes in curricula sometimes occur more frequently than the catalog is printed, students should consult the manual each year to be informed of the most recent changes.

REQUIREMENTS FOR THE MASTER OF SCIENCE DEGREE IN CIVIL ENGINEERING

All students must complete the requirements Shown in Table 1:

Table 1: Avenues for Obtaining M.S. (Civil Engineering)	
Students Selecting a Single Area of Concentration	
Core Courses:	12 credits (min.)
Courses Within Concentration:	12 credits (min.)
Technical Electives:	6 credits
Students Selecting the General Program	
Core Courses:	12 credits (min.)
Courses in 3 Concentration Areas:	18 credits (min.)

Credits Required for M.S. Degree: 30 credits

A. Core Courses: 12 credits

Students must complete at least four of the following six core courses.

Table 2

CE 6023	Materials Engineering	3
CE 6073	Instrumentation, Monitoring, and Condition Assessment of Civil Infrastructure	3
CE 7673	Environmental Impact Assessment	3
CE 7843	Introduction to Urban Systems Eng	3
CE 8253	Project Management for Construction	3
CE 8283	Risk Analysis	3

B. Concentration Area Courses: 12 – 18 credits

Students must complete at least four courses in their area of concentration, or, if selecting the general program, a minimum of at least two courses in three areas of concentration. Note that areas of concentration may involve some courses that are required within the concentration. The requirements of the various concentration areas are listed in Tables 3-8. For students following the general program, requirements within concentrations do not apply; such students must, however, satisfy all course prerequisites. All courses in Tables 3 through 8 are 3 units.

C. Technical Electives: 0 to 6 credits

Depending upon the choice of a project or thesis and the choice of a single or multiple areas of concentration, the student may have up to an additional 6 credits of course work to complete by selecting from the following options:

- **Electives:** Electives are normally selected from the courses given by the Department of Civil Engineering. However electives may be selected from courses offered by other departments with the written consent of the graduate adviser.
- **Project:** CE 9963 Project for the M.S. in Civil Engineering, (3 credits)
- **Thesis** CE 9976 Thesis for the M.S. in Civil Engineering (6 credits)

Table 3: GEOTECHNICAL ENGINEERING CONCENTRATION

Students *must* select CE 6073 among their core courses.

Required for concentration:

CE 8423	Ground Improvement
CE 8663	Advanced Foundation Design
CE 8673	Excavation Support Systems

Select at least three from:

CE 8403	Geotechnics and Geomaterials
CE 8433	Urban Geotechnology
CE 8493	Environmental Geotechnics
CE 7233	Groundwater Hydrology and Pollution
CE 8603	Selected Topics in Geotechnical Engineering
CE 9963	Project for the M.S. in Civil Engineering
CE 9976	Thesis for the M.S. in Civil Engineering

Table 4: STRUCTURAL ENGINEERING CONCENTRATION

Students *must* select CE 6023 and CE 6073 among their core courses.

Required for concentration:

CE 6013	Theory of Structural Analysis
CE 6163	Finite Element Analysis

Select at least two from:

CE 6033	Selected Topics in Structural Engineering I
CE 6043	Selected Topics in Structural Engineering II
CE 6063	Bridge Engineering
CE 6133	Stability of Structures
CE 6143	Steel Structures
CE 6183	Concrete Structures
CE 6193	Earthquake and Wind Eng.

Table 5: CONSTRUCTION MANAGEMENT AND ENGINEERING CONCENTRATION

Students *must* select CE 8253 and CE 8283 among their core courses.

Select at least 4 from:

CE 8263	Construction Cost Estimating
CE 8273	Contracts and Specifications:
CE 8293	Construction Operation Analysis
CE 8303	Information Systems in Project Management
CE 8313	Engineering for Construction I
CE 8323	Engineering for Construction II

Any course in the EXEC 21 Construction Management certificate program. (See Construction Management section of this catalog.)

Table 6: ENVIRONMENTAL/WATER RESOURCE ENGINEERING CONCENTRATION

Students *must* select CE 7673 among their core courses.

Required for concentration:

CE 7233	Groundwater Hydrology and Pollution
CE 7373	Environmental Chemistry and Microbiology I

CE 7423	Water and Wastewater Treatment I
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Select at least two from:

CE 7353	Special Topics in Water Resource and Hydraulic Engineering
CE 7393	Environmental Chemistry and Microbiology II
CE 7433	Water and Wastewater Treatment II
CE 7453	Water and Wastewater Treatment Laboratory
CE 7473	Analysis of Stream and Estuary Pollution
CE 7533	Hazardous/Toxic Waste Management
CE 7703	Solid Waste Management
CE 8493	Environmental Geotechnics

Table 7: HIGHWAY AND TRAFFIC ENGINEERING CONCENTRATION

Required for concentration:

TR 6313	Traffic Control and Signalization I
TR 6323	Traffic Control and Signalization II

Select at least two from:

TR 6013	Fundamental Concepts in Transportation
TR 6023	Analytic Methods in Transportation
TR 6223	Intelligent Transportation Systems and Their Applications
TR 7033	Transportation Safety
TR 7123	Transportation Planning and Congestion Management
TR 7323	Design of Parking and Terminal Facilities
TR 7333	Design & Mgmt of Arterial & Street

TR 7343	Networks Urban Freeways and Intercity Highways
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Table 8: URBAN SYSTEMS ENGINEERING AND MANAGEMENT CONCENTRATION

Students *must* select CE 7643 among their core courses.

Required for concentration:

CE 7813	Infrastructure Planning, Engineering, and Economics
CE 7853	Concepts and Implementation of Infrastructure Management Systems

Select at least 2 from:

CE 6073	Instrumentation, Monitoring, and Condition Assessment of Civil Infrastructure
CE 7753	Environmental Systems Management Performance Assessment
CE 8713	Construction and the Law
CE 8733	Infrastructure Financing: the Art of The Deal
TR 6223	ITS & Their Applications

DOCTORAL PROGRAM IN CIVIL ENGINEERING

The Department of Civil Engineering currently offers two doctoral degree programs: PhD (Civil Engineering) and PhD (Transportation Planning and Engineering). Requirements for the Civil Engineering degree are detailed here. For information on the Transportation Planning and Engineering program, see the "Transportation" section of this catalog.

Goals and Objectives

The PhD in Civil Engineering is a research-oriented degree intended for those whose goal is a career in basic civil engineering research and/or teaching at the university level or in private research organizations. Specific objectives of the doctoral program are to develop the skills and knowledge necessary to:

- Specialize within one of the sub-disciplines of civil engineering
- Perform independent fundamental research in one of the sub-disciplines of civil engineering
- Produce a piece of fundamental research that meaningfully advances the state-of-the-art of one of the sub-disciplines of civil engineering, and is publishable in a first-tier refereed civil engineering-related journal

Areas of Concentration

Students pursuing the PhD in Civil Engineering must choose to specialize in one of the following sub-disciplines of civil engineering:

- Structural materials and engineering.
- Geotechnical and geo-environmental engineering.
- Environmental and water resources engineering.

- Construction management and engineering.
- Highway and traffic engineering.
- Urban infrastructure systems engineering and management.

Other focus areas are possible, and can be developed with the assistance of faculty advisors. All subject areas must be, of course, relevant to the degree sought, and there must be a faculty member who is willing and able to guide the student's research.

Program Administration

There are four graduate program coordinators in the Department of Civil Engineering:

- Graduate Program Coordinator for Civil Engineering (MS& PhD)
- Graduate Program Coordinator for Environmental Engineering/Environmental Science (MS)
- Graduate Program Coordinator for Urban Systems Engineering and Management (MS)
- Graduate Program Coordinator for Transportation (MS & PhD)

The graduate coordinators form the departmental Graduate Committee. All PhD applications are reviewed by the Committee, and admissions decisions are made by the Committee and implemented by the appropriate graduate coordinator. For each registration, the student's program must be approved by the Academic Adviser, and signed by the appropriate graduate coordinator.

Admission Criteria

1. Admission to the Ph.D. (Civil Engineering) requires an M.S. (Civil Engineering) or equivalent with a GPA of 3.5 or better (on a 0-4 scale).
2. Admission to Ph.D. programs does not require GRE's (Graduate Record Examination), but applicants are encouraged to take these examinations. If these examinations are taken, the student must submit the results for consideration.
3. Foreign applicants must take the TOEFL examination and submit the results for consideration.

In criteria 1 and 2 above, the equivalent" can be achieved in several ways. The candidate may have an M.S. degree with a different title that covers substantially the same material. In more general terms, the applicant must demonstrate that he/she has the equivalent of all undergraduate and master's level course work to be able to pursue doctoral level work in the major area chosen, as well as in a minor area within the umbrella of civil engineering. Further, equivalence" is

evaluated based on the totality of the student's undergraduate and graduate record, not on a course-by-course basis. Thus, an applicant who wishes to pursue doctoral work in the area of Environmental Engineering, for example, must have all of the undergraduate and master's level course background expected in Environmental Engineering, but does not have to demonstrate such a background in structures. Because admission to a Ph.D. program requires an appropriate M.S. (or equivalent), those applicants who have not yet achieved a master's degree would normally be admitted as M.S. students. They are expected to earn an M.S. degree while completing their major and minor course requirements. In rare cases, an applicant with only a B.S. degree may be directly admitted into the Ph.D. program with the written approval of the department head.

Doctoral Committees

Every Ph.D. student is assigned an Academic Adviser, who is assigned by the department head upon admission. Any member of the civil engineering faculty can be an academic adviser to a graduate student. In cases where a student is being supported on a research contract, the principal investigator of the contract would normally be appointed as the academic adviser for the student. Where a student has a particular research interest and is working with a particular faculty member, the student may request that the faculty member be appointed as his/her academic adviser. In rare cases where a Ph.D. student enters the program without a prior selection of a major area of study, the initial academic adviser will be the Graduate Coordinator of the appropriate program area. In the course of fulfilling their academic requirements, Ph.D. candidates, will deal with two advisory committees:

Academic Advisory Committee:

The student's Academic Adviser works out an appropriate program of courses to fulfill major and minor requirements for the Ph.D. The Academic Advisory Committee generally will consist of the Academic Adviser and one faculty member for each minor area of study. The Academic Advisory Committee guides the Ph.D. student's work through the successful completion of a qualifying examination. A letter signed by the academic adviser and approved by the department head is placed in the student's file indicating the composition of the Academic Advisory Committee.

Dissertation Committee:

The Dissertation Committee is formed immediately after the student passes the quali-

fying examination. It consists of a major adviser, a dissertation adviser, and a minor adviser for each minor the student has pursued. Additional faculty members may also be on the Dissertation Committee. The dissertation committee may be the same as the Academic Advisory Committee, or may be different.

The Dissertation Committee guides the student's course and research work after the student has passed the qualifying examination. The dissertation committee shall have no less than 5 members, one of whom must be a faculty at another department within Polytechnic. One external member who is either a faculty member in another university or a noted Ph.D. level practitioner is encouraged. The Dissertation Committee must be formally assigned with the approval of the department head and is filed with the Office of Graduate Studies.

The major adviser must be a full-time faculty member of the Department of Civil Engineering. The major and dissertation advisers may be the same individual where appropriate.

Doctoral Degree Requirements

To earn a doctoral degree in Civil Engineering, the following requirements must be met:

1. 54 credits of graduate course work (not including the Ph.D. dissertation) in relevant major and minor areas of study beyond the bachelor's degree, with an average grade of B or better (cumulative average of 3.0 or better on a 0-4 scale). Up to 6 credits of the 54 credits may be satisfied by individual guided studies, readings, projects, theses, etc.
2. Completion and successful defense of a 21-credit dissertation related to the major area of study. Dissertations must consist of original research that meaningfully advances the state-of-art in the subject area of the research, and should result in the publication of at least one paper in a strictly peer-reviewed technical journal appropriate to the subject. A grade of B or better must be achieved for the dissertation. There are two types of dissertation credits:
 - CE 9998: Independent original investigation demonstrating creativity and scholarship worthy of publication in a recognized engineering journal. Registration for a minimum of 6 credits is required prior to registering for CE 9999.
 - CE 9999: Registration for 3-6 credits per semester is permitted prior to the successful completion of the doctoral qualifying examinations. *Prerequisites: degree status and approval of the dissertation adviser.*

- CE 9999: Independent original investigation demonstrating creativity and scholarship worthy of publication in a recognized engineering journal. Candidates must successfully defend dissertations orally. Registration for a minimum of 12 credits is required prior to the defense. Registration must be continuous (excluding summer semesters), unless a formal leave of absence is requested and approved. Registration for 3-12 credits per semester is permitted. In the final semester of work, registration for credit is permitted with the approval of the department head. *Prerequisites: CE9998, degree status, successful completion of doctoral qualifying examinations and approval of the dissertation adviser.*
- 3. Completion of two minor areas of study, as follows:
 - **Out of Department Minor:** Completion of 9 credits of graduate or undergraduate course work in one or two technical areas of study.
 - **In-Department Minor :** Completion of 6 credits of graduate course work in a minor area outside the major sub-discipline in civil engineering.
- 4. Residency requirements for the Ph.D. (Civil Engineering) include the 21-credit dissertation plus a minimum of 15 credits of applicable graduate course work taken at the Polytechnic.
- 5. In satisfying the 54 credit course requirement (Item 1), the student must satisfy all requirements for the major and minor areas selected, or their equivalent.
- 6. In satisfying these basic Ph.D. requirements, students must also satisfy one of the two following conditions:
 - a) 48 credits of appropriate graduate course work, not including individual guided studies (readings, projects, theses, etc.) beyond the bachelor's degree, with an average grade of B or better (cumulative average of 3.0 or better on a 0-4 scale).
 - b) 24 credits of appropriate graduate course work, not including individual guided studies (readings, projects, theses, etc.) beyond the master's degree, with an average grade of B or better (cumulative average of 3.0 or better on a 0-4 scale). Satisfying condition 2 requires that the department accept the student's M.S. degree in toto without regard to its specific content. This requires a recommendation from the department's Graduate Committee, and the approval of the department head.

Transfer Credits

A maximum of 39 credits of appropriate graduate work may be transferred. Transfer credits for Ph.D. students may be awarded

on a course-by-course basis, or by the transfer of an M.S. degree from another institution in to in satisfaction of 30 graduate credits. The latter requires a recommendation from the department's Graduate Committee, and the approval of the department head. Transfer credits are generally awarded at the time of admission and must be approved by the Academic Adviser, the appropriate Graduate Coordinator, and the department head.

Qualifying Examinations

Departmental qualifying examinations for the Ph.D. (Civil Engineering) are given once per year, in October. If sufficient demand exists, a second qualifying examination may be scheduled in March. Every Ph.D. student must pass a qualifying examination in the major area of study and in any in-department minor areas of study before becoming a candidate for the Ph.D. Further:

1. No student may register for CE9999 credits until the Qualifying Examination is passed.
2. A dissertation committee cannot be formed until the student passes the Qualifying Examination.
3. A student may take the Qualifying Examination twice. A third attempt is permitted only with the written recommendation of the Academic Advisory Committee and the approval of department head. In no case may a student take the examination more than three times. Students normally take the Qualifying Examination (for the first time) after successfully completing most of their course requirements in the major and in-department minor areas of study.

The Qualifying Examination consists of a six-hour written portion (generally given in two 3-hour blocks on the same day) and an oral portion of approximately one hour. Both written and oral portions of the examination focus on the student's major and in-department minor. The oral portion may also explore higher-level skill areas required to successfully conduct independent research. Students are deemed to have passed the examination based upon an overall evaluation of results of both the written and oral portions. While some students may not be invited to the oral examination if they have done poorly in the written portion, invitation to the orals does not imply that the student has "passed" the written portion of the exam.

The Qualifying Examination is either "passed" or "failed." A letter indicating the result of each examination is placed in the student's graduate file. In rare cases, a stu-

dent may be deemed to have conditionally passed the Qualifying Examination. This occurs in cases where the student does extremely well in all areas except for a single subject area in which weakness has been noted. Such a student must follow a prescribed preparation plan for strengthening their knowledge and skills in the area of weakness, and must pass a special examination on the area of weakness within one calendar year. A student who has conditionally passed the Qualifying Examination may register for dissertation credits, and may form a Dissertation Committee.

While each student may face a different Qualifying Examination, based upon the major and in-department minor areas of study, the exam is considered to be a departmental exam. All departmental faculty members in each sub-discipline will participate in submitting written problems in the sub-discipline, in the grading process, and in the oral examination. All departmental faculty members are welcome to observe any oral examination and to ask appropriate questions. Each student's Academic Advisory Committee will have the opportunity to review the entire exam before it is administered, and may suggest changes if it deems that the examination as presented is not an equitable test of the student's abilities. Recommendations on the results of the examination are submitted by each student's Academic Advisory Committee, augmented by any departmental faculty in the sub-disciplines tested. The departmental faculty, acting as a whole, votes to accept or reject such recommendations at a meeting scheduled for this purpose.

Dissertation Proposal

Following passage of the Qualifying Examination and the appointment of a Dissertation Committee, the Ph.D. candidate must submit a written dissertation proposal outlining the subject of the proposed research. This proposal should be between 15-20 pages long, and should address the following specific items:

1. Description of the topic.
2. Literature review sufficient to insure that the work contemplated is original.
3. Methodology(ies) to be employed in the research.
4. Data and/or laboratory needs, and their availability to the student.
5. Anticipated outcomes.
6. Names of proposed members of dissertation committee

The Dissertation Proposal must be submitted within one semester of full-time study, or before 9 credits of dissertation credit are completed.

The Dissertation Proposal is orally presented and defended before the Dissertation Committee and any other interested departmental faculty. The date of the oral defense and copies of the draft Dissertation Proposal must be made available to departmental faculty at least two weeks (14 calendar days) prior to the defense.

When the Dissertation Proposal is formally accepted, the Dissertation Adviser enters a letter into the student's graduate file indicating this, together with a copy of the proposal. While the Dissertation Committee has reasonable flexibility in modifying the proposal as appropriate during the course of the research, any significant change in focus area or methodology requires that an amended Dissertation Proposal be written and formally accepted following the same procedure noted herein.

Dissertation Defense

The culmination of the student's Ph.D. work is the oral presentation and defense of the final draft dissertation. A defense is generally scheduled after the Dissertation Committee has reviewed the draft dissertation and determined that it is complete and of sufficient quality to be presented and defended.

The defense is organized and scheduled by the Dissertation Committee. All University faculty members are invited to observe and ask appropriate questions at all Polytechnic dissertation defenses. Therefore, the date of the defense must be announced University-wide at least one month prior to the event, and copies of the draft dissertation must be made available to any faculty member who requests one in a timely fashion and in no case less than two weeks prior to the defense.

UNDERGRADUATE COURSES

GENERAL COURSES

CE 1003 Fundamentals of Civil Engineering 2:3:0:3

This course introduces the student to the profession and practice of civil engineering. The course has five primary components: (1) a review of the principal subdisciplines of civil engineering and their relationship to urban and regional infrastructure, (2) a review of professional ethics and the responsibilities of engineers to their profession and to the general public; this includes a detailed study and discussion of the American Society of Civil Engineers (ASCE) and National Society of Professional Engineers (NSPE) codes of practice, and the use of case studies for illustration and discussion; (3) a study of civil engineering measurements and the use of surveying tools

and instruments; this will include an overview of GIS and GPS systems in civil engineering, (4) the use of AutoCAD as a tool for computer-based drawings, and (5) the use of spreadsheets to develop analytic algorithms to solve simple engineering problems.

CE 4033 Introduction to Urban Infrastructure Systems Management 3:0:0:3

This course provides students with an overview of key issues involved in the planning, management, operations, and maintenance of urban infrastructure systems, including transportation, water supply, power, communications, and information systems. It includes elements of engineering and technology, management, economics, finance, regulatory and public policy that impact the sustainable development of the urban environment. The course features several distinguished guest lecturers from infrastructure industries and public agencies who share significant case studies with students. The course includes a component on GIS, with a focus on how to collect, integrate, and share spatial data in urban infrastructure management. Group projects are required.

CE 4043 Sustainable Cities 3:0:0:3

The purpose of this course is to provide an overview of the issues that need to be addressed in making a city sustainable, beginning with a definition of what is intended by the concept of sustainability, and a discussion of what is the essence of a city. Students will be asked to become familiar with the major challenges in making a city sustainable, and to provide, as part of their homework assignments, a paper addressing a topic covered by the course through research and, where appropriate, proposing solutions.

CE 4053 BIOSOMA – Environmental Design of the City of the Future 3:0:0:3

The goal of this course is to improve the engineering design of a city and its components. The course focuses on the city as an entity which concentrates living organisms, societal organizations and activities, and machines, interacting with the environment both outside and inside the city. A number of essential questions about the future of cities will be examined, such as: (1) What does urbanization mean for the future of human-kind in terms of resources, capabilities, ideologies, and culture? (2) How can the design of cities affect their future? (3) What

should be the role of the engineer? (4) How can the engineer of the future be prepared for that role? (5) What critical engineering interventions are needed to influence the future of today's cities? Each student will select a project dealing with some aspects of the course, and present its results to the class.

STRUCTURAL AND GEOTECHNICAL ENGINEERING

CE 2114 Statics and Dynamics 4:0:0:4

A thorough treatment of basic statics and dynamics. Subjects include: vector treatment of static and dynamic equilibrium of particles and rigid bodies; equivalent force and couple systems; distributed force systems; static analysis of trusses, frames and machines; friction and impending motion. Newton's Laws are also treated. *Co-requisite: PH 1004 or equivalent.*

CE 2124 Mechanics of Materials 3½:11/2:0:4

Basic principles of stress and deformation in axial, torsion and bending members are introduced. Elastic stability of compression members and an introduction to mechanics of fracture and fatigue is included. Stress analysis laboratories are conducted in which students work individually and in groups on stress analysis measurement projects. *Prerequisites: PH 1004, CE 2114 or equivalents.*

CE 3133 Structural Analysis 3:0:1:3

In-depth coverage of structural analysis techniques. Topics covered include: analysis of statically determinate structures; deflection calculations using energy methods; analysis of statically indeterminate structures using superposition; influence lines; slope deflection, moment distribution, and matrix analysis of structures. Computer applications are included. *Prerequisites: MA 2012 and CE 2124, CE 2114 with a grade of B+ or better.*

CE 3144 Steel Design 3:3:0:4

A thorough treatment of steel design principles and techniques. Topics included: design of tension and compression members, beams, beam-columns, slabs and footings; design of bolted, riveted and welded connections for steel structures. The course includes a design laboratory in which students, working alone and in groups, develop design projects. *Prerequisite: CE 3133 or equivalent.*

CE 3153 Geotechnical Engineering 2:3:0:3

Introduction to soil mechanics and foundation engineering, including origin of soils; phase relationships; classification of soils; permeability; effective stress; seepage; consolidation; shear strength; slope stability; and bearing capacity. *Prerequisites: CE 2124 and CE 2214 or equivalents.*

CE 4163 Structural Materials 2:3:0:3

This course covers the mechanical behavior and durability of structural materials. Properties of steel, concrete, wood, asphalt, and fiber composites are discussed. Material processing, optical metrology, and stress analysis laboratories are conducted in which students work independently and in groups on material preparation and evaluation topics. *Prerequisite: CE 2124 or equivalent.*

CE 4173 Foundation Engineering 2:3:0:3

Introduction and development of foundation engineering, including site exploration; soil sampling; interpretation of boring logs; bearing capacity of footings; settlement of structures; lateral earth pressure; design of retaining walls, braced excavations and sheet pile walls; design of deep foundations. *Prerequisite: CE 3153 or equivalent.*

CE 4183 Reinforced Concrete Design 2:3:0:3

Detailed treatment of reinforced concrete design: Material properties, ACI load factors, and design strength; shear and diagonal tension in beams; reinforced concrete columns; two-way slabs; footings; shear walls; torsion. *Prerequisite: CE 3133 or equivalent.*

CE 4193 Timber and Masonry Structures 3:0:0:3

Properties and classification of structural lumber; design of timber connectors; design and construction of residential and industrial timber buildings; beams, frames, columns and trusses of sawn lumber and glued laminated construction; manufacture and properties of concrete masonry units; properties of mortar and grout; design and construction of load-bearing reinforced and un-reinforced masonry structural elements. *Prerequisite: CE 3144 or equivalent.*

ENVIRONMENTAL AND WATER RESOURCE ENGINEERING

CE 2214 Fluid Mechanics and Hydraulics 3½:1½:0:4

The basic principles of fluid mechanics with beginning applications to hydraulic design. Topics covered include fluid properties, hydrostatics, continuity, energy, and momentum equations. Additional topics cover laminar and turbulent flow, boundary layer drag, dimensional analysis, Euler's equation, two-dimensional ideal fluid flow, pipe flow, pumps, turbines, fluid measurements, pipe networks, open channel flow, and reservoir balance. *Prerequisite: CE 2114 or equivalent.*

CE 3223 Environmental Engineering I 3:3:0:3

Introduction to water and wastewater treatment. Stream assimilation and public health. Introduction to air pollution and solid waste management. Laboratory analysis of water and wastewater samples and treatment process tests. *Prerequisite: CE 2214 or equivalent.*

CE 4243 Water Resource Engineering I 3:0:0:3

This course provides a detailed overview of water resources engineering, including both analysis and design elements. Topics covered include: open channel flow; pipe networks; reservoir balances; hydrologic techniques; surface water and ground water supplies; water demand and development of water resources for multiple purposes. *Prerequisite: CE 2214 or equivalent.*

CE 4253 Water Resource Engineering II 3:0:0:3

This course covers feasibility-level planning and design for water resources projects, including water conveyance works; concrete dams and assorted waterways; pumping stations; hydroelectric, irrigation, navigation and flood mitigation projects. Subjects considered include layouts, dimensions, and capacities of facilities; hydraulic and structural forces; and stability analysis. *Prerequisite: CE 4243 or equivalent.*

CE 4263 Environmental Geotechnology 2:3:0:3

This course is intended to benefit students who are about to enter the consulting industry. It is difficult to separate environmental and geotechnical concerns in the urban environment. This course teaches students what environmental concerns to expect when planning construc-

tion projects, investigating sites and overseeing construction. The course covers methods for addressing these concerns. Topics covered include clay mineralogy, soil/ water/contaminant interactions, interfacial tension and capillarity and remediation techniques. *Prerequisite: CE 3153 or equivalent.*

CE 4273 Environmental Engineering II 2:3:0:3

Detailed coverage of water and wastewater treatment unit operations; includes a laboratory on processes and process design. Experiments are performed to evaluate laboratory-scale conventional water and waste treatment processes. Lectures cover detailed theory, design, and advanced concepts. *Prerequisites: CE 2214 and CE 3223 or equivalents.*

HIGHWAY AND TRANSPORTATION ENGINEERING

CE 3313 Introduction to Transportation Systems 3:0:0:3

This course focuses on the fundamental conceptual elements of transportation systems, and describes the approaches used in the analysis and design of transportation systems. The course covers the basic material about transportation systems, the context within which they operate, and a characterization of their behavior. *Prerequisites/Corequisites: Junior Status*

CE 3324 Traffic Engineering I 4:0:0:4

A basic overview of the traffic engineering profession. Traffic stream parameters and characteristics are presented, along with study techniques for their measurement, analysis, and interpretation. Characteristics of road users, vehicles, roadways, and traffic control devices are treated in detail, as is their impact on traffic stream behavior. Functional characteristics of roadways are introduced. Traffic operations and control techniques are treated. Detailed coverage of isolated signal design and timing, both pre-timed and actuated, is included. Signal coordination on arterials and in networks is introduced. *Prerequisite: Junior status or permission of instructor.*

CE 3353 A History of NYC Transit and the Development of NYC 3:0:0:3

This course traces the technological history of public transportation in New York City, and investigates its role in the development of the city, its economy, and its social fabric. From the early days of horse-drawn public

carriages to the modern subway system, the role of the public transit in the historical development patterns of New York City is treated. The course covers trolley systems, the age of the elevated railways, and the subway system. Political, social, and economic issues involved in the development of these critical infrastructures are discussed. Students will develop independent project reports on aspects of the NYC public transit system, or on public transit systems in other major world cities. *Prerequisites: HI 2104, Junior Status, or permission of instructor.*

CE 4333 Traffic Engineering II 3:0:0:3

A second semester of traffic engineering for undergraduate students: The focus is on highway capacity and level of service analysis on uninterrupted and interrupted flow facilities. Additional analysis of signalized and unsignalized intersections is also included using current computer software packages. Facility types include freeways, freeway weaving areas and ramp junctions, rural and suburban multilane highways, two-lane rural highways, suburban and urban arterials, and intersections. *Prerequisite: CE 3324 or permission of instructor.*

CE 4343 Design of Traffic Facilities 3:0:0:3

This course provides an introduction to design of traffic facilities with emphasis on highway design. Students will be introduced to the basic design concepts of horizontal and vertical alignment, superelevation, and cross-section design. The course will also cover fundamentals of intersection and interchange design, pavement design, design of parking facilities, as well as bikeway and walkway design. Lectures will be supplemented by a design laboratory. *Prerequisite: CE 3324, or equivalent, or permission of instructor.*

CONSTRUCTION MANAGEMENT AND ENGINEERING

CE 4413 Construction Management 3:0:0:3

The participants, processes, and techniques required to maintain the life-cycle of a construction project are covered: planning of construction operations, including estimating and economic evaluation of alternatives; analysis of construction bid processes, contracting and related issues of ethics in project engineering; productivity, safety, and quality on a constructed project; time scheduling of the project, including CPM and PERT; trends in computer analysis of project infor-

mation. Students will prepare and formally present team projects. *Prerequisite: senior status or instructor's permission.*

CE 4423 Information Systems in Construction Management 3:0:0:3

Development of a strong understanding of contemporary tools for managing the vast array of information in the project life-cycle. Information is reviewed both from the perspective of knowledge acquisition and knowledge representation. The course focuses on the concepts of Fully Integrated and Automated Project Processes (FIAPP), and the relationships of 3D computer models, simulation, cost estimating, scheduling, procurement, and information technology. Emphasis is given to the implementation of 3D computer models and relational databases and information systems for processing and automating project information. The class makes heavy use of computer applications related to civil engineering and construction management. *Prerequisite: Senior status or permission of instructor.*

Additional construction management courses are listed in the "Construction Management" manual. Most of these are available to civil engineering students as electives.

SELECTED TOPICS, READINGS AND PROJECTS

CE 4613 Selected Topics in Structural and Geotechnical Engineering 3:0:0:3

Topics of current interest in structural and geotechnical engineering. The specific subject of each offering is generally unique. The course may feature a detailed look at a single topic or a series of focused topical presentations. *Prerequisite: advisor approval.*

CE 4623 Selected Topics in Environmental and Water Resources Engineering 3:0:0:3

Topics of current interest in environmental and water resources engineering. The specific subject of each offering is generally unique. The course may feature a detailed look at a single topic or a series of focused topical presentations. *Prerequisite: advisor approval.*

CE 4633 Selected Topics in Transportation Engineering 3:0:0:3

Topics of current interest in transportation engineering. The specific subject of each offering is generally unique. The course may

feature a detailed look at a single topic or a series of focused topical presentations. *Prerequisite: advisor approval.*

CE 4643 Selected Topics in Construction Management 3:0:0:3

Topics of current interest in construction management. The specific subject of each offering is generally unique. The course may feature a detailed look at a single topic or a series of focused topical presentations. *Prerequisite: advisor approval.*

CE 4710 Readings in Civil Engineering variable credit (1-4)

Individually guided study in a subject area related to the civil engineering curriculum. Topic must arise from a regular course and must extend and go beyond what is covered in the traditional curriculum. The student must have the prior approval of the instructor with which he/she is to work and a topic approved by that instructor before registering for a readings course. A readings course shall require a written report on the subject of the student's readings before a grade is given. A student may take this course more than once.

CE 4814 Civil Engineering Design Project 2:1:3:4

This is the senior Capstone design experience in civil engineering. A project (or projects) involving integration of the civil engineering subdisciplines will be described and presented. Working groups will be established. All groups may work on a single project or several may be prescribed, depending upon the semester. Lectures will be devoted to particulars of the project and will present specific design applications that may not have been included in other courses. A full design report must be submitted and orally presented by each group. *Prerequisites: CE 3144 and CE 3153 or equivalents. Co-requisites: CE 3223 and CE 4243 or equivalents.*

GRADUATE COURSES

CORE COURSES

CE 6023 Materials for Civil Engineers 3:0:0:3

Materials composition and production of cementitious materials; polymeric composites and metals; mechanical properties subject to short-term and long-term loads, impact, and fire; fatigue and fracture; transport properties, chemical degradation, and long-term durability. *Prerequisite: Graduate Status.*

CE 6073 Instrumentation, Monitoring, and Condition Assessment of Civil Infrastructure 3:0:0:3

A systematic approach to planning and executing instrumentation, monitoring, and condition assessment programs; strain measurements; civil engineering sensors (static, dynamic, optical); environmental measurements; mechatronic sensors; signal conditioning, information measurements, and error analysis; business aspects; advanced measurement systems.

CE 7673 Environmental Impact Assessment 3:0:0:3

An examination of legal and technical requirements in the preparation of environmental impact statements. Considerations include legal and technical requirements, the procedure and the interdisciplinary nature of the analysis. Topics include overall impact evaluation, categories of impacts, problem definition, quantification of impact, methods used in analysis, field evaluations, mitigations, hearing procedures, and management. Practical examples and case studies are used.

CE 7843 Introduction to Urban Systems Engineering 3:0:0:3

A descriptive overview of the key infrastructure systems and technologies that must be managed, operated, and maintained. Systems treated include buildings and structures, water supply, solid and liquid waste handling and disposal, transportation, power, communications and information systems, health and hospitals, police and preprotection. Course treats the financial, political, administrative, legal and institutional settings of these systems and technologies. A portion of the course features distinguished guest lecturers who are experts in some of the systems and technologies included.

CE 8253 Project Management for Construction 3:0:0:3

Topics specific to the development and coordination of large projects, including organizational structures, management functions, pricing and estimating project costs, bidding and contracting, risk allocation, scheduling, time and cost control, labor relations, quality management and project life-cycle activities. Note: Also listed under MG 8253.

CE 8283 Risk Analysis 3:0:0:3

A thorough investigation of the ever-rising importance of risk analysis in project management. Analysis of qualitative and quantitative risk. Techniques in probability analysis, sensitivity analysis, simulation of risk and utility theory. Computational methods for calculating risk. An exposure to the complexity of real-world corporate and public problems through case investigations.

CONSTRUCTION MANAGEMENT AND ENGINEERING

For courses in this area, please consult the M.S. in Construction Management section of this catalog.

ENVIRONMENTAL AND WATER RESOURCE ENGINEERING

CE 7223 Hydrology 3:0:0:3

Hydraulic cycle. Meteorological considerations. Analysis of precipitation, runoff, unit hydrographs, flood routing, and reservoir storage. Principles of groundwater hydrology. Introduction to frequency analysis of floods and droughts. *Prerequisites: adviser's approval and undergraduate calculus and fluid mechanics.*

CE 7233 Groundwater Hydrology and Pollution 3:0:0:3

Characteristics of confined and unconfined flow of water through porous media; groundwater and well hydraulics; quality of groundwater; environmental influences; groundwater pollution; management aspects of groundwater and groundwater modeling. *Prerequisites: CE 2214 (Fluid Mechanics) or equivalent or instructor's permission.*

CE 7353/ CE 7363 Selected Topics in Water Resources and Hydraulic Engineering I / II 3:0:0:3

Topics in water resources and hydraulic engineering of current interest. Some examples include Topics vary with each offering and are disseminated prior to the semester of offering. *Prerequisite: instructor's permission.*

CE 7373 Environmental Chemistry and Microbiology I 1.5:1.5:0:3

Introduction to the chemistry and microbiology of polluted and natural waters, including applications of principles developed.

CE 7393 Environmental Chemistry and Microbiology II 3:0:0:3

Advanced topics in chemistry and microbiology of polluted and natural wastewater treatment. *Prerequisite: CE 7373 or equivalent*

CE 7423 Water and Wastewater Treatment I 3:0:0:3

Physical, chemical and biological principles involved in process design and treatment of water and wastewater. Topics include aeration, filtration, softening, chemical treatment, coagulation, occulation, desalination, taste and odor control. *Co-requisite: CE 7373.*

CE 7433 Water and Wastewater Treatment II 3:0:0:3

Continuation of CE 7423. Topics include sedimentation, adsorption, aerobic and anaerobic biological treatment, sludge treatment and disposal. *Prerequisite: CE 7423. Co-requisite: CE 7393.*

CE 7453 Water and Wastewater Treatment Laboratory 1:2:0:3

Laboratory processes in water and wastewater engineering, dealing with physical, chemical, and biological methods and principles. Processes include disinfection, softening, sedimentation, oxygen transfer, coagulation, adsorption, filtration, and aerobic and anaerobic biological treatment systems. Warburg analysis of waste. *Co-requisite: CE 7433.*

CE 7473 Analysis of Stream and Estuary Pollution 3:0:0:3

Dispersion and decay of contaminants introduced into lakes, streams, estuaries, and oceans. Effects of pollutants on chemical quality and ecology of receiving waters

CE 7523 Air Pollution 3:0:0:3

Causes and effects of air pollution. Methods of sampling. Interpretation of data. Meteorological aspects. Methods of air pollution control.

CE 7533 Hazardous/Toxic Waste Management 3:0:0:3

Methods in the management of hazardous/toxic waste sites. Topics covered include health and safety, legal aspects, contamination of the environment, treatment processes, toxicology and risk assessment.

CE 7543 Site Remediation 3:0:0:3

Treatment and disposal technologies for hazardous waste site remediation. Insitu and ex-situ processes. Physicochemical processes, stabilization and solidification; biological processes including aerobic and anaerobic systems for degradation and detoxification; thermal processes and incineration; storage, land disposal and containment. Remediation planning and technology selection for hazardous waste containment and clean up for typical case studies. Decision-making framework and technology selection will be a key course component. *Prerequisite: CE 3153 or equivalent.*

CE 7583 Air Pollution Engineering Control 3:0:0:3

Pollutant emissions control; analysis of pollutant properties, concentrations, and boundary conditions; absorptive and reactive recovery processes for moving and stationary sources; formation and removal of gaseous oxides (NO, SO, CO, etc.), and of aerosols and other particulates. *Prerequisite: adviser's approval. Also listed under CH 7523.*

CE 7703 Solid Waste Management 3:0:0:3

Engineering aspects of solid waste collection, transport, and disposal, including incineration, sanitary landfill, composting, recovery, and reutilization. Economic evaluation of factors affecting selection of disposal methods.

CE 7713/ CE 7723 Selected Topics in Environmental and Water Resources Eng I/II 3:0:0:3

Current topics including nitrification in natural and treated waters, hazardous and toxic wastes, organic removal from water supplies, water reuse, specialized aspects of biological wastewater treatment, environmental health, solids disposal, modeling natural waters and treatment systems, hydro-economic models, finite difference and finite element models, synthetic hydrology, desalinated and recycled water systems, and others. *Prerequisite: instructor's permission.*

GEOTECHNICAL AND GEOENVIRONMENTAL ENGINEERING**CE 8403 Geotechnics and Geomaterials** 3:0:0:3

Index properties of soil, mechanical behavior, shear strength, stress-strain characteristics, drained and undrained soil behavior,

permeability, seepage, groundwater flow and control, consolidation of soils. *Prerequisite: undergraduate soil mechanics, CE 3153 or equivalent*

CE 8423 Ground Improvement 3:0:0:3

Foundation engineering practice, foundation rehabilitation, emerging ground improvement technologies. Selection and design analysis of appropriate ground improvement techniques for different foundation problems. Construction, monitoring, and performance evaluation. *Prerequisites: undergraduate soil mechanics and foundations, CE 4173 or equivalent*

CE 8433 Urban Geotechnology 3:0:0:3

Case histories on geotechnical design, construction, and rehabilitation in the urban environment. Special construction problems and innovative solutions; unforeseen ground conditions, performance monitoring, remedial planning and implementation, geotechnical design and construction issues from a practicing engineer's perspective. *Prerequisite: undergraduate soil mechanics and foundations, CE 4173 or equivalent*

CE 8493 Environmental Geotechnology 3:0:0:3

Clay mineralogy; soil-water interaction processes; chemical transport through soils; hydraulic conductivity, diffusion and attenuation mechanisms; water disposal systems, design of land-fills, seepage barriers; and cut-off walls; geo-environmental site characterization techniques; soil remediation techniques. *Prerequisite: undergraduate soil mechanics, CE 3153 or equivalent*

CE 8603 Selected Topics in Geotechnical Engineering 3:0:0:3

Current topics of special interest, such as ground improvement, geotechnical earthquake engineering, site characterization, and remediation. Topics vary with each offering and are disseminated prior to registration. *Prerequisites: CE 4173 or equivalent.*

CE 8663 Advanced Foundation Design 3:0:0:3

Advanced analysis of foundations, shallow foundations, bearing capacity, settlement, deep foundations, axial and lateral loading of piles, wave equation analysis, drilled piers and design and construction issues. Case histo-

ries. *Prerequisites: undergraduate soil mechanics and foundations, CE 4173 or equivalent.*

CE 8673 Excavation Support Systems 3:0:0:3

Advanced analysis of foundations, shallow foundations, bearing capacity, settlement, deep foundations, axial and lateral loading of piles, wave equation analysis, drilled piers and design and construction issues. *Prerequisites: undergraduate soil mechanics and foundations.*

CE 8683 Instrumentation, Monitoring, And Condition Assessment Of Civil Infrastructure 3:0:0:3**STRUCTURAL AND GEOTECHNICAL ENGINEERING****CE 6013 Theory of Structural Analysis and Design** 3:0:0:3

Theories of structural analysis and their relationship to design. Classical structural mechanics, matrix procedures, and numerical methods of solution. Analysis of statically indeterminate beams, frames, and trusses using force and displacement methods. Emphasis on elastic supports, movement of supports, and temperature effects. *Prerequisite: undergraduate structural analysis.*

CE 6033/ CE 6043 Selected Topics in Structural Analysis I/II 3:0:0:3

Special topics of current interest offered at irregular intervals by advance announcement. Graduate advisers may approve repeat registration for different topics. *Prerequisite: adviser's approval.*

CE 6063 Bridge Engineering 3:0:0:3

Types of bridges; geometric design of bridges; construction materials and construction techniques; simplified bridge analysis; special problems in the design of steel and reinforced concrete bridges; bridge inspection policies; bridge rehabilitation procedures; bridge management systems; effects of wind and earthquakes on long-span bridges. *Prerequisites: undergraduate structural analysis and steel design.*

CE 6133 Stability of Structures 3:0:0:3

Stability concepts. Investigation of buckling structural configurations composed of beams, plates, rings, and shells. Effects of ini-

tial geometric imperfections, load eccentricities, and in-elastic behavior. Application of energy measures and numerical techniques. *Prerequisite: adviser's approval.*

CE 6143 Steel Structures 3:0:0:3

Compression members; elastic and in-elastic buckling of columns and plates. Lateral supported beams; torsion of open and closed sections; warping; lateral torsional buckling of beams; bi-axial bending. Plate girders; stability of webs and flanges. Combined bending and axial load; instability analysis. Design of rigid and semi-rigid mechanisms of continuous beams and rigid frames. Elastic/plastic design criteria. *Prerequisite: undergraduate steel design.*

CE 6163 Finite Element Methods 3:0:0:3

Students will review the basic theory of the finite element method and learn how to apply it using ANSYS, one of the most widely used programs in engineering. The emphasis of the course will be on developing finite element models and executing the analysis. Students will also learn to recognize modeling errors and inconsistencies that could lead to either inaccurate or invalid results. *Prerequisite: adviser's approval.*

CE 6183 Concrete Structures 3:0:0:3

Design principles and construction methods for reinforced and pre-stressed concrete structural elements; response of members subject to axial loading, shear and flexure; design of columns, deep beams, and shear walls; design and detailing for connection regions; design of pre-tensioned and post-tensioned beams and slabs; effect of short-term and long-term deformations. *Prerequisite: Graduate Status*

CE 6193 Wind and Earthquake Engineering 3:0:0:3

Characteristics of wind and earthquake loads; atmospheric motions and boundary layer; response of structures to wind forces; code treatments of wind loads on structures; calculation of lateral forces from seismic events; lateral force resisting systems; diaphragm and center of rigidity; response spectrum and time-history; ductility; concrete and steel frame structures; braced frames; shear walls; dual systems; story drift; detailing requirements. *Prerequisite: Graduate Status*

CE 6253 Structural Dynamics 3:0:0:3

Dynamic response of single degree of freedom systems. Theory of vibration of finite degree of freedom systems. Influence coefficient method. Analytical and numerical solution of dynamic response problems. Nonlinear analysis of single degree of freedom systems. Emphasis on computer analysis of large complex systems.

CE 7823 Forensic Engineering 3:0:0:3

Emphasizes lessons learned by analyzing structural failures and resulting outstanding practicing professional engineers. Application of engineering principles for proper performance of civil engineering structures.

HIGHWAY AND TRAFFIC ENGINEERING

For courses in this area, please consult the Transportation section of this catalog.

CE 4033 Introduction to Urban Infrastructure Systems Management 3:0:0:3

This course provides students with an overview of key issues involved in planning, management, operations, and maintenance of urban infrastructure systems, including transportation, water supply, power, communications, and information systems. It includes elements of engineering and technology, management, economics, finance, regulator and public policy that impact the sustainable development of the urban environment. The course features several distinguished guest lecturers from infrastructure industries and public agencies who share significant case studies with students. The course includes a component on GIS, with a focus on how to collect, integrate, and share spatial data in urban infrastructure management. Group projects are required. *Prerequisites: None*

CE 7753 Environmental Systems Management 3:0:0:3

An overview of information technologies as applied to the remote sensing of environmental infrastructure systems. Development of infrastructure system databases to assist in complex decision-making on environmental infrastructures.

CE 7813 Infrastructure Planning, Engineering and Economics 3:0:0:3

Methods for the identification, formulation, preliminary appraisal and detailed analysis of

individual projects and systems of civil engineering projects. Different approaches appropriate for government agencies, public utilities, industrial firms, and private entrepreneurs. Planning considers projects that satisfy single and multiple purposes and objectives, meet local and regional needs and takes advantage of opportunities for development. Financial and economic analyses, including sensitivity and risk analysis. Mathematical models for evaluation of alternatives and optimization. Impacts of projects: environmental, social, regional economic growth, legal and institutional and public involvement.

CE 7833 Infrastructure Rehabilitation: A Practical Approach 3:0:0:3

Upgrading the nation's aging infrastructure will be a top national priority well into the 21st century. A preeminent civil engineer who has overseen major rehabilitation projects focuses on the direct practical application of engineering principles required to address today's infrastructure rehabilitation needs. Emphasizes conceptual thinking, brainstorming techniques, team evaluation of alternative solutions, verbal and written communication, and intensive classroom participation.

CE 7843 Introduction to Urban Systems Engineering 3:0:0:3

A descriptive overview of the key infrastructure systems and technologies that must be managed, operated, and maintained. Systems treated include buildings and structures, water supply, solid and liquid waste handling and disposal, transportation, power communications and information systems, health and hospitals, police, and re-protection. Course treats the financial, political, administrative, legal, and institutional settings of these systems and technologies. A portion of the course features distinguished guest lecturers who are experts in some of the systems and technologies included.

CE 7853 Concepts and Implementation of Infrastructure Management Systems 3:0:0:3

Review of state-of-the-art performance monitoring and system condition assessment methodologies as part of infrastructure management systems. Emphasis is placed on information technologies as applied to remote sensing and data base development for urban systems management. Infrastructure tools, such as GIS and dedicated databases for condition assessment are presented in a

laboratory environment. Invited experts participate in such areas as transportation, water distribution, and utilities.

CE 7863 Infrastructure Monitoring and Performance Assessment 3:0:0:3

Introduction to the physical nature of infrastructure materials and systems. Concept of performance is introduced from the point of view of strength and durability. Lectures and laboratory demonstrations identify the mechanism of degradation and cover techniques for condition assessment and quality assurance.

CE 7983 / CE 7993 Name Special Topics in Infrastructure Systems and Construction I/II 3:0:0:3

Contemporary topics of interest, such as methodologies and procedures for analysis of existing infrastructure systems, geographic information, data and management systems, photogrammetric and remote sensing techniques, and utilization and design of infrastructure facilities and systems. Other topics include, but are not limited to, intelligent buildings and other modern constructed works, temporary structures for construction and problems in construction engineering, new approaches in construction management, and integration and automation of construction processes.

CE 9903 Case Study in Urban Systems Engineering and Management 3:0:0:3

A comprehensive independent case study involving a specific urban infrastructure engineering and management project under the guidance of a faculty adviser and generally in coordination with a participating infrastructure agency. Case studies are submitted as formal reports and must be formally presented and defended. Students will be expected to prepare a project report on a selected IMS in cooperation with an infrastructure agency.

GENERAL COURSES

CE 5983 Selected Topics in Civil Engineering I 3:0:0:3

Special topics in current areas of civil engineering that cover more than one sub-disciplinary category. Open to undergraduate students with exceptional records on approval of the undergraduate adviser.

CE 5993 Selected Topics in Civil Engineering II 3:0:0:3

Special topics in current areas of civil engineering that cover more than one sub-disciplinary category. Open to undergraduate students with exceptional records on approval of the undergraduate adviser.

GUIDED STUDIES AND RESEARCH

CE 901X Readings in Civil Engineering

Up to 3 credits Variable credit (1-3 credits). Individual study of selected literature in civil engineering under the guidance of a faculty adviser. Acceptable written report or successful completion of an examination is required. Only one registration permitted, except with the permission of the department head. Prerequisite: instructor's permission.

CE 9013 Readings in Civil Engineering 3:0:0:3

Individual study of selected literature in civil engineering under the guidance of a faculty adviser. Acceptable written report or successful completion of an examination is required. Only one registration permitted, except with the permission of the department head. Prerequisite: instructor's permission.

CE 9913 MS Thesis in Urban Systems Engineering and Management 6 credits

A 6-credit thesis focusing on a topic of current importance infrastructure engineering and management. Thesis generally involves the development of a system approach to some aspect of infrastructure and may include elements of case studies. Thesis is under the guidance of a faculty adviser and thesis committee and may involve cooperative elements with an infrastructure agency. All theses are formally submitted as bound reports (see University requirements for bound theses and dissertations).

CE 9963 Project for the MS in Civil Engineering 3 credits

Analytical, design or experimental studies in civil engineering under the guidance of a faculty adviser and following departmental guidelines. A written report is required. Prerequisites: degree status and project adviser's approval.

CE 9973 Thesis for the MS in Civil Engineering 6 credits

Original investigation or design in the student's principal field of study prepared under close supervision of a faculty adviser. Candidates must successfully defend theses orally. Registration for a minimum of 6 credits is required. Prerequisites: degree status and thesis adviser's approval.

CE 9993 Dissertation Level Research 6 credits

Independent original investigation demonstrating creativity and scholarship worthy of publication in a recognized engineering journal. Registration for a minimum of 6 credits is required prior to registering for CE 9998. Registration for 3-6 credits per semester is permitted prior to the successful completion of the doctoral qualifying examinations. Prerequisites: degree status and approval of the dissertation adviser.

CE 9993 Dissertation for the PhD in Civil Engineering 3 credits

Independent original investigation demonstrating creativity and scholarship worthy of publication in a recognized engineering journal. Candidates must successfully defend dissertations orally. Registration for a minimum of 15 credits is required prior to the defense. Registration must be continuous (excluding summer semesters), unless a formal leave of absence is requested and approved. Registration for 3-12 credits per semester is permitted. In the final semester of work, registration for 0.5 credit is permitted with the approval of the department head. Prerequisites: CE 9998, degree status, successful completion of doctoral qualifying examinations and approval of the dissertation adviser.

Typical Course of Study for the Bachelor of Science in Civil Engineering

FRESHMAN YEAR

Fall Semester

Course No.	Course Title	Class	Hours/Week			Cr.
			Lab.	Rec.	Cr.	
MA 1054	Calculus I with Precalculus ¹	4	0	0	4	
CM 1004	General Chemistry	3	2	1	4	
EN 1014	Writing & Humanities I ²	4	0	0	4	
EG 1004	Intro. Engineering & Design ³	1	3	2	4	
SL 1010	Freshman Seminar	1	1	0	0	
						16

Spring Semester

Course No.	Course Title	Class	Hours/Week			Cr.
			Lab.	Rec.	Cr.	
MA 1154	Calculus II with Precalculus	4	0	0	4	
PH 1004	Introductory Physics I	4	1½	1	4	
EN 1204	Writing & Humanities II	4	0	0	4	
CE 1003	Fundamentals of Civil Engin.	2	3	0	3	
						15

SOPHOMORE YEAR

Fall Semester

MA 2012	Linear Algebra I (½ semester)	4	0	0	2	
MA 2132	Ordinary Diff. Equ. (½ semester)	4	0	0	2	
HI 2104	Modern World History	4	0	0	4	
PH 2004	Introductory Physics II	4	1½	1	4	
CE 2114	Statics & Dynamics	4	0	1	4	
						16

Spring Semester

MA 2212	Data Analysis I (½ semester)	4	0	0	2	
MA 2222	Data Analysis II (½ semester)	4	0	0	2	
CE 2214	Fluid Mechanics & Hydraulics	3½	1½	0	4	
CE 2124	Mechanics of Materials	3½	1½	0	4	
HU/SS	Elective ³	4	0	0	4	
						16

JUNIOR YEAR

Fall Semester

	Math/Science Elective ⁴				4	
CS 2102	Comp. Sci. for Civil Engineers ⁵				2	
CE 3324	Traffic Engineering I	4	0	0	4	
CE 3133	Structural Analysis	3	0	1	3	
	HU/SS Elective ³	4	0	0	4	
						17

Spring Semester

CE 3144	Steel Design	3	3	0	4	
CE 3153	Geotechnical Engineering	2	3	0	3	
CE 3223	Environmental Engineering I	3	3	0	3	
	Technical Elective ⁶	3	0	0	3	
	Free Elective ⁷				3	
						16

SENIOR YEAR

Fall Semester

CE 4243	Water Resources Engineering I	3	0	0	3	
CE	CE Elective I				3	
	CE Elective II				3	
	Free Elective II				3	
	HU/SS Elective ³				4	
						16

Spring Semester

CE 4163	Materials Engineering	2	3	0	3	
CE 4413	Construction Management	3	0	0	3	
CE 4814	CE Design Project	2	1	3	4	
	CE Elective III				3	
	CE Elective IV				3	
						16

Total credits required for graduation:

128

- The Department of Civil Engineering prefers all of its students to take the MA 1054/1154 Calculus with Precalculus sequence. This sequence includes two additional hours of pre-calculus review which the department believes is helpful, even for students with an excellent math background. Students may choose to take a placement exam to be placed in MA 1014/1124 (Calculus I, II), or may be advance-placed based upon AP test results.
- Students who are placed by examination or by an adviser into EN 1080 must subsequently register for EN 1034, rather than EN 1014. Some students with an ESL background may be placed in EN 1034, which is equivalent to EN 1014 with additional hours.
- Approved HU/SS electives are courses with the following prefixes: AH (Art History), AN (Anthropology), EC (Economics), EN (English Literature), HI (History), MU (Music), PL (Philosophy), PO (Political Science) and PS (Psychology). Two courses must be from Level II Elective courses (course numbers 2xx4) in different disciplines (prefixes) and one from Level III Advanced Elective courses (course numbers 3xx4, with a level II prerequisite).

- The math/science elective may be selected from among any course in mathematics, chemistry, physics, or biomedical science for which the student has the appropriate prerequisites.
- This course is given under a computer science course number, but is specifically designed for civil engineering students.
- Technical electives/civil engineering electives: There are 15 credits of technical and civil engineering electives in the program. A civil engineering elective must be taken from among elective civil engineering courses (CE prefix) for which the student has the appropriate prerequisites. A technical elective can be taken from mathematics, science, computer science, or any engineering subject for which the student has the appropriate prerequisites.
- There are 6 credits of free elective in the civil engineering program. Students may select any course from any program for which they have the appropriate prerequisites.

COMPUTER ENGINEERING PROGRAM

Program Directors

Ramesh Karri (undergraduate)

Garrett Rose (graduate)

The Department of Electrical and Computer Engineering offers a computer engineering program for the degrees Bachelor of Science and Master of Science. The BS in computer engineering is administered in cooperation with the Department of Computer and Information Science.

COMPUTER ENGINEERING PROFESSION

As the use of digital computers became pervasive in all branches of human endeavors, the discipline of computer engineering developed to encompass the work of designing computers and devising ways to use them has improved the efficiency and quality of almost all activities in business, industry, government, education and entertainment. Computer engineering draws heavily on electrical engineering topics, including electronic circuit design and analysis of physical communication and control systems; and on computer science topics, including logic design, system architecture, computer software and logarithms.

Computer engineering is a rapidly growing profession and computer engineers are in the midst of exciting times with unlimited opportunities in all walks of life. For instance, computer engineers interact with and design large supercomputers as well as the ubiquitous personal and portable computers. Furthermore, computer engineers play a key role in networking computers with other computers and intelligent devices. Computer engineers are also involved in projects as varied as designing specialized computer hardware to reconstruct the human genome to monitoring and controlling industrial plants and the environment, computer graphics, robotics and the design of biomedical devices and computer networks. Finally, computer engineers design and develop hardware and embedded software-hardware systems.

The computer engineering program provides an outstanding and up-to-date education in computer systems with an emphasis on both hardware and software. To achieve this goal, the department incorporates into the educational experience the latest trends in the marketplace and in technology, combining traditional disciplines of electronics, communications, control and computer programming with newer courses such as En-

ryption, Circuit Design, Parallel Machines, Image Processing, Java programming, Wireless Networks, Local Area Networks and ASIC (Applications Specific Integrated Circuit) and VLSI (Very Large Scale Integrated).

A strong design faculty has been developed through sponsored research programs, many of which are coordinated in Polytechnic's Center for Advanced Technology in Telecommunications (CATT).

Additional information about computer engineering careers can be found online at www.careercornerstone.org/compeng/compeng.htm.

UNDERGRADUATE PROGRAM

The Bachelor of Science program in computer engineering gives students a broad-based background in computer engineering, preparing them for immediate employment in industry and government or for graduate study.

GOALS AND OBJECTIVES

The undergraduate program achieves the following objectives for students:

- Instills in them a broad-based understanding of the fundamental technical subject areas associated with computer engineering.
- Requires them to achieve technical depth in at least one area of specialization and allows them to take electives in other areas.
- Develops their problem-solving skills with modeling, analysis, design and computer simulation as tools.
- Provides them with a broad educational component that complements the technical content of the computer engineering discipline, including multidisciplinary experience, humanistic and societal issues, with particular emphasis on the development of effective oral and written communication skills.

The BS program includes analysis and design courses in the major areas of computer engineering that build on fundamental courses in mathematics and science. Many of the computer engineering courses include hands-on laboratory components. A variety of electives are available to undergraduates to provide depth and specialization, many in commercially viable areas such as high speed networks, data bases, embedded control systems, image processing and archiving and privacy/security.

Since most current engineering design is

computer facilitated, the department includes computer-aided design (CAD) programs in many undergraduate courses to emphasize possibilities for large-scale design, corrections for unmodelled complexities, trade-offs among performance criteria and real-time simulations. The senior design project challenges each student to integrate analytical and design concepts from earlier courses to design a device or system to meet specified performance requirements.

The program recognizes that communication and interpersonal skills are essential to a successful career in any profession. Students in the program are required to take courses in history, writing and literature, as well as elective courses in the areas of humanities and social sciences. Those skills are also developed in team projects in design courses. The computer engineering program keeps abreast of market changes through the CATT Industrial Affiliates Program, hiring of professors and part-time adjunct teachers who have industrial experience, frequent contacts with alumni, review of professional journals and encouraging faculty to work in industry part-time or while on sabbatical. Where possible, classroom work challenges students to apply their knowledge to current design situations. Industry's need for the systems approach in engineering is also reflected in the curriculum through senior projects in areas such as control and robotics, advanced hardware design, imaging and embedded controllers. The economic aspects of engineering are addressed by allowing undergraduates to choose electives such as macro/micro economics, psychology and ethics. Cost evaluation is required in the design projects for EG 1004 Introduction to Engineering Design. Senior projects emphasize time management and planning.

Exceptional undergraduate students are given the opportunity for advanced study in two programs:

- (1) the BS/MS Honors Program, which requires students to complete the MS option of the MS degree, and
- (2) the summer junior research internship program, which allows undergraduates to work on research projects with graduate students and their advisers.

Up-to-date information about program requirements, course offerings, senior project topics and research projects is available online from the Department of Electrical and Computer Engineering at www.poly.edu/ece/undergraduate/ce/index.php [A1]

UNDERGRADUATE DEGREE REQUIREMENTS

The BS program in computer engineering gives students broad based preparation for a career in computer engineering in any of its specialization and readies them for immediate employment in industry, business and government, or for further graduate education. The program is accredited by the Accreditation Board for Engineering and Technology (ABET).

The table at the end of this section outlining the Typical Course of Study for a BS shows a typical semester-by-semester program for students who enter as freshmen in fall 2005 or later. The notes identified by superscript numbers are an essential part of the table. Students are responsible for making themselves aware of changes that might be made in this program after the publication date of this catalogue. Those changes are posted outside the department's advising offices and on the department's web page. (Students who started their studies before fall 2005 should consult the department's web page for program and course requirements applicable to them.)

CONCENTRATIONS FOR THE BS IN COMPUTER ENGINEERING

Each BS student in computer engineering is required to take two elective courses that are associated with a specified concentration area. Students may enrich the quality of a concentration by taking additional electives in related areas and/or doing a senior project on a topic in the concentration area. Students should also note that some concentration courses have other elective courses as prerequisites.

Students who plan to enroll in the MS electrical engineering program should include EE 3054 as an elective in the BS program. A 2.7 GPA or better is required to take 6XX-level graduate courses.

The following list shows possible concentration areas and course groupings. Students should consult departmental posting and it's web page for up-to-date information on concentrations.

CONCENTRATIONS I AND II:

Computer Architecture

CS 3254 Intro to Parallel & Distributed Systems
CS 6133 Computer Architecture I

Electronics

EE 3124 Fundamentals of Electronics II
EL 6443 VLSI System & Architecture Design

Software Engineering

CS 4531 Software Engineering
CS 3234 Data Base Systems
CS 391 Java and Web Designs
CS 9053 Intro. to Java Programming Security

CS 392 Computer Security
CS 393 Network Security Communications
EE 3054 Signals & Systems
EE 3404 Fundamentals of Communications Theory
EL 5013 Wireless Personal Communication Systems
EL 6013 Principles of Digital Communications: Modulation & Coding
EL 5023 Wireless Information Systems Lab I

Networking

EL 5013 Wireless Personal Communication Systems
EL 5373 Internet Architecture & Protocols
EL 6383 High-speed Networks Signal

Processing

EE 3054 Signals and Systems
EL 5123 Image Processing
EL 5143 Multimedia Laboratory Systems/Control
EE 3064 Feedback Control
EL 6253 Linear Systems

SENIOR DESIGN PROJECT

The two-semester Senior Design Project allows students to focus on an application area of computer engineering. In the first semester students choose to concentrate in either the hardware or software aspect of computer engineering. They develop skills using specialized laboratory equipment and computer design packages, are introduced to techniques for planning projects and making effective presentations, and they learn to balance design requirements such as performance, safety, reliability and cost effectiveness.

In the final semester, students design, build or simulate and test a device or system to meet prescribed engineering specifications. Informal and formal written and public oral presentations help prepare students for professional careers. Design project students frequently work in groups or pairs to develop interaction skills essential to good engineering.

GRADUATION REQUIREMENTS

The University requires a 2.0 GPA in all courses taken and specifies other general requirements in the section "University Degree Requirements," which describes the core curriculum for all engineering majors, including placement procedures in writing, mathematics and programming; course credits by transfer and advanced placement; and credit by examination. To graduate, students must (1) have a C- grade or better in CS 1114, 1124, 2134 and 2204 and in EE 2013 and 2024 and (2) have a technical GPA of 2.0 based on all courses prefixed EE, CS or EL. Seniors may elect graduate courses labeled EL 5XX3, but not CS 5XX3. To enroll in other graduate courses, seniors must have a 2.7 GPA or better in related courses and adviser approval. Students are expected to meet the degree requirements in effect at the

time when they first enrolled in a Polytechnic program. Those requirements apply as long as a student remains in good standing and less than eight years have elapsed since entering the program. The period for unchanged requirements is proportionately less for a transfer student.

GOOD STANDING, PROBATION AND DISQUALIFICATION

Students who fail to meet University GPA requirements or other conditions of adequate progress toward completing a degree are put on probation. (See the "General University Requirements" section in this catalog for more details.) Students on final probation may not register for courses in one semester until grades are available from their previous semester's courses, and they are limited to a reduced number of credits per semester. Students who improve their academic performance are removed from probation and returned to good standing. Continued poor academic performance can lead to final probation and, eventually, disqualification from the University. To remain in good standing in the undergraduate computer engineering program, students must:

- (1) maintain, term-by-term and cumulatively, a technical GPA (based on EEEL and CS courses) and a University GPA of at least 2.0;
- (2) earn a C- or better in CS 1114, 1124, 2134 and 2204 and in EE 2013 and 2024
- (3) fulfill all course pre co-requisites; and
- (4) remove any incomplete I grades within 30 days of the last day of final exams. Occasionally an adviser may permit a third enrollment in a course for which a C-grade is required. In such cases, the student must earn a C or better in that course.

Students facing difficulties, whether educational or personal, should consult their instructor or a departmental adviser at the earliest possible time. Students who do not meet program conditions are placed on departmental probation.

Probation conditions may require students to:

- (1) repeat courses, including courses where they received transfer credits and courses where they received a C grade or less at Polytechnic;
- (2) specify their credit load and permissible withdrawals; or
- (3) take other remedial programs.

Students who do not meet departmental probation requirements, fail twice to earn the required grade in any one course or do not conform to the University Student Code of Practice are subject to being disqualified from working toward a bachelor's in computer engineering or taking any further computer engineering courses. Actions taken depend on individual cases. Students who are disqualified may appeal in writing. Students may also apply for readmission after two terms (fall, spring or summer) have passed if they show evidence of an improved chance of success.

DUAL UNDERGRADUATE MAJORS

With departmental permission, students may earn a single bachelor's degree in electrical and computer engineering. This degree requires a total 142 credits rather than the usual 128 required for individual bachelor's degrees.

SENIOR THESIS

See description in "Electrical Engineering Program" section of this catalogue.

MINOR IN COMPUTER ENGINEERING

Students may obtain a minor in Computer engineering by taking the following courses.

Course Credits		
EE 2013	Electric Circuits I	3
EE 2024	Electric Circuits II	4
CS 2204	Digital Logic	4
EE 3144	Embedded Systems	4
Total credits		15

For students not earning the BS Degree in Computer Science, EE3144 may be replaced by CS2214-Computer Architecture. A GPA of 2.0 or better in the entire minor is required. Minimum of 8 credits must be taken at Poly. Students, for whom CS1114 is not required for major, should note that CS1114 is a prerequisite for CS2204. The minor in computer engineering is not open to students earning the BS degree in electrical engineering.

TRANSFER STUDENTS

Transfer credits for courses taken at other schools are based on evaluation of content and level. Students completing the same program at another school, but in different years, may receive different amounts of transfer credits. They should consult with a computer engineering undergraduate adviser for current information.

Transfer students must arrive and present their records for evaluation at least one week before the regular registration period of their first semester at Polytechnic. Transfer credits

are awarded only for courses completed with C grades or better. Qualified students from two-year pre-engineering programs, such as those at liberal arts and community colleges, may fulfill the requirements for the BS in computer engineering in two additional years. Since pre-engineering programs vary, a prescribed program is not possible; consequently, students should consult with an undergraduate adviser at the beginning of their pre-engineering program. Graduates of technology programs may be able to fulfill the requirements for the BS in computer engineering in two to three and a half years, depending on the scope and level of their previous education. They should consult with an undergraduate adviser for details.

THE BS/MS ACCELERATED HONORS OPTION

The BS/MS Accelerated Honors Option leads to the simultaneous awarding of a bachelor's and master's degree's. Depending on the student's preparation and objective, the two degrees may be completed in as few as four years of study. Each program is individually designed in cooperation with the departmental BS/MS Accelerated Honors Option adviser to allow varied transfer and AP credits, co-op program participation, professional summer jobs and other goals consistent with the Honors program. Possible BS/MS combinations include a BS in computer engineering with an MS in computer engineering, computer science, electrical engineering or telecommunications networks. Incoming freshmen with superior admissions qualifications are invited to participate in the Accelerated Honors Program. Later admission may be considered after students complete no more than one year at Polytechnic. Students must complete 16 to 20 credits each semester, maintain a 3.5 GPA overall and technical average, particularly in key courses, and display a record free of course repetitions and withdrawals. The required courses for the two degrees include all courses required for the individual BS and MS degrees, except for the senior Design Project II, and all curriculum footnotes apply. Required credits are the sum of the credits for the two degrees minus the 3 credits of senior Design Project II. Student in this program must complete a Master's Thesis (6 credits) (generally optional for other MS students).

Acceleration may be achieved through summer course work, extra course loads, careful course sequencing or credit by examination. Students may also achieve acceleration through advanced placement credit in such courses as calculus, computer science or physics.

GUIDANCE FOR UNDERGRADUATE STUDENTS

Instructors provide help for students in their courses during hours posted on their doors or by appointment. Students taking project or thesis courses work closely with faculty project advisers. Computer engineering advisers in the undergraduate ECE office are available to advise on courses and program adjustments resulting from academic needs or personal problems. The Office of Special Services sponsors a peer tutoring program. The Polytechnic Tutoring Center provides drop-in tutoring in mathematics and physics. Personalized career counseling is available. SL 1010 Freshman Seminar introduces students to Polytechnic and its curricula. Fellow students are an excellent source of advice on adjusting to the University environment and the demands of an engineering program. In addition to meeting students in class, students are urged to meet students who can provide experienced advice by joining clubs such as the student branch of the Institute for Electrical and Electronics Engineers (IEEE) professional society, Association for Computing Machinery (ACM) or religious or ethnic clubs.

Students are advised to meet with other students to study and to do homework. In this way, they benefit both from explanations provided by others and by the deeper understanding they get when they explain a concept or technique to someone else.

INFORMATION

Undergraduate advising information is available on the Department of Electrical and Computer Engineering's website, www.ece.poly.edu. Students should consult that page for further details on honors, probation, approved electives, projects, elective concentrations, course offerings, senior project topics and other matters of interest. Curriculum and prerequisite changes, new courses, special sections and other last minute announcements are also posted on the bulletin boards outside the Office of Electrical and Computer Engineering Undergraduate Advising.

All students are responsible for keeping informed about the latest procedures and regulations. Descriptions of undergraduate electrical engineering and computer science courses used in the computer engineering program are located in those programs' sections of this catalogue.

GRADUATE PROGRAM

The MS in Computer Engineering educates professionals in computer engineering by offering graduate courses that meet the current and projected needs of industry and government in the metropolitan New York area. The program promotes computer engineering through basic and applied research carried out by faculty and students in collaboration with industry and government agencies.

Polytechnic's MS program in Computer Engineering targets two important needs:

- (1) as a terminal degree for students intending to round-out their education and seek employment and
- (2) as the tools and background necessary to carry out self-directed research for students planning a PhD. Outstanding students should apply for financial aid in the form of research fellowships, teaching fellowships or partial tuition remission. Students wishing to continue graduate study toward a PhD in computer engineering may do so in the electrical engineering program.

The electrical engineering and computer science faculty's research and teaching interests in computer engineering include computer networks, VLSI design and CAD, verification and testing of VLSI systems, embedded systems design and computer architecture. The MS in Computer Engineering focuses on the principles and concepts underlying the design and integration of hardware and software components and systems.

The needs of modern society for sophisticated and efficient electronically controlled systems and devices are increasing exponentially. Advanced studies in computer engineering provide a needed bridge between the University and industry. The Department of Electrical and Computer Engineering is committed to developing and administering a topnotch academic and research program in computer engineering with strong focus on telecommunications, computer networks and microelectronics.

GOALS AND OBJECTIVES

The MS program in computer engineering prepares graduates to practice computer engineering profession at an advanced level. The program's specific goals and objectives provide students with the following:

- The opportunity to specialize in one of the primary sub-disciplines of computer engineering (VLSI, High-Speed networking, etc.), or to achieve breadth across a number of the sub-disciplines
- Analysis and design knowledge necessary to design general purpose as well as specialized, application specific computer hardware.
- The knowledge and skills to design embedded software-hardware systems.
- Exposure to state-of-the-art computer engineering techniques and technologies such as new computer architectures and design styles.
- A basis for continued lifelong learning in the computer engineering profession.

ADMISSION REQUIREMENTS

Admission to the MS program requires a bachelor's degree in computer engineering, electrical engineering or computer science from an accredited institution. Students not meeting these requirements are considered for admission on an individual basis and may be admitted subject to the completion of appropriate courses to remove any deficiencies in preparation. Topics in which deficiencies must be removed include logic circuits design, state analysis and synthesis techniques, computer architecture, data structures and algorithms and C or C++ programming.

DEGREE REQUIREMENTS

To satisfy the requirements for a MS degree, students must complete a total of 30 credits as described below. Of these, at least 18 credits should be EL credits and at least 6 credits should be CS credits.

GROUP 1: Core courses (Choose 3 out of following)

- EL 5363 Principles of Communication Networks
 - EL 5473 Introduction to VLSI design
 - EL 5493 Advanced Hardware Design (VHDL)
 - CS 6133 Computer Architecture I
- Total: 9 credits**

GROUP 2

Two sequences each containing two courses; one course in each sequence may be a core course in group 1. Both sequences must be in EL or CS courses and at least one must be an EL sequence. Approved course sequences are provided in the ECE Graduate Student Manual.

Total: 6-12 credits

GROUP 3

Approved electives may be chosen with adviser approval from graduate offerings in EL, CS and, occasionally, pertinent courses from other departments. With adviser approval, students may select other groups or individual courses provided they relate to the various facets of computer engineering.

Total: 6-12 credits

GROUP 4

Students must take a project (EL9953) that relates to the computer engineering discipline and is approved by an adviser.

Total: 3 credits

Minimum total: 30 credits

Thesis option:

A 6-credit thesis (EL997x) may be selected and used to replace:

- (1) one elective from Group 3 and
- (2) The 3-credit project from Group 4.

A GPA of 3.0 is required in all graduate courses taken at Polytechnic, except those used for the undergraduate degree. No more than 9 of 30 credits may be taken outside Polytechnic. Also, such credits are not used in computing the GPA. An average of 3.0 is also required in the courses taken to satisfy groups 1 and 2 above. These courses must all be taken at Polytechnic. If some of these courses are excused because they were taken as part of an undergraduate program or were awarded transfer credits, substitute courses approved by the adviser are used in calculating this average. In any case, a total of 30 credits are required for the degree. Students should consult the Department of Electrical and Computer Engineering Graduate Student Manual (www.poly.edu/ece/graduate/menu.php) for more detailed rules and procedures, including student status, transfer credits, recommended electives and one-year sequences, current areas of research and disqualification for low grades.

Typical Course of Study for the Bachelor of Science in Computer Engineering

FRESHMAN YEAR

Fall Semester

Course No.	Course Title	Hours/Week			
		Class	Lab.	Rec.	Cr.
EG 1004	Intro. Engineering & Design	1	3	2	4
CS 1114	Intro. Prog. & Problem Solving ¹	3	3	0	4
MA 1024	Calculus I	4	0	0	4
EN 1014	Writing & Humanities I ³	4	0	0	4
SL 1010	Freshman Seminar	1	1	0	0
					16

Spring Semester

Course No.	Course Title	Hours/Week			
		Class	Lab.	Rec.	Cr.
PH 1004	Introductory Physics I	4	1½	1	4
CS 1124	Object-Oriented Programming ¹	3	3	0	4
MA 1124	Calculus II	4	0	0	4
EN 1204	Writing & Humanities II	4	0	0	4
					16

SOPHOMORE YEAR

Fall Semester

PH 2004	Introductory Physics II	4	1½	1	4
EE 2013	Fundamentals of Electric Circuits I ¹	3	0	1	3
CS 2134	Data Structures & Algorithms ¹	4	0	0	4
MA 2012	Linear Algebra I (½ semester)	4	0	0	2
MA 2132	Ordinary Diff. Equ. (½ semester)	4	0	0	2
					15

Spring Semester

CM 1004	General Chemistry	3	2	1	4
EE 2024	Fundamentals of Electric Circuits II ¹	3	1	1	4
MA 2112	Multi. Calculus A (½ semester)	4	0	0	2
MA 2312	Discrete Math I (½ semester)	4	0	0	2
CS 2204	Dig Logic & State Mach Design ¹	3	3	0	4
					16

JUNIOR YEAR

Fall Semester

EE 3114	Fundamentals of Electronics I	3½	1½	1	4
CS 2214	Computer Architech. & Organ. ¹	3	3	0	4
MA 2212	Data Analysis I (½ semester)	4	0	0	2
MA 2222	Data Analysis II (½ semester)	4	0	0	2
HI 2104	Modern World History	4	0	0	4
					16

Spring Semester

EE 136	Communication Networks ³	3	0	0	3
CS 3224	Operating Systems	4	0	0	4
	HU/SS Elective ⁴	4	0	0	4
	EE/CS Elective I				4
EE 3193	Intro. VLSI Circuits ³	3	0	0	3
					18

SENIOR YEAR

Fall Semester:

EE or CS					
4513 4313	CompE or CS Design Project I ¹	1	3	1	3
EE 4144	Intro. Embedded Sys. Design	3½	1½	0	4
	Concentration I ⁵				3-4
	HU/SS Elective ⁴	4	0	0	4
	Free Elective ⁷				4
					18-19

Spring Semester

EE 4323	CompE Design Project II	0	6	1	3
	EE/CS/EL Elective				3-4
	Concentration II ⁵				3-4
	HU/SS Elective ⁴	4	0	0	4
					13-15

Total credits required for graduation:

128

- Grade of C- or better is required.
- Students who are placed by examination or by an adviser into MA 0902, MA 0912 or MA 0922 must defer registration for MA 1024.
- Students who are placed by examination or by an adviser into EN 1080 must subsequently register for EN 1034, rather than EN 1014.
- Approved HU/SS electives are courses with the following prefixes: AH, AN, EC, EN, HI, MU, PL and PS. Two courses must be from Level II Elective courses in different disciplines and one from Level III Advanced Elective courses.
- See list of concentration areas and course groupings in this program section.
- A list of approved sequence electives is available from the department.
- Any course for which student has a prerequisite.



COMPUTER SCIENCE PROGRAM

Program Director: Stuart A. Steele

Computer science is the study of the theory and practice of how to design, build and use computers. The field of study includes the design and analysis of algorithms, principles of programming languages and compilers, operating systems, software engineering, artificial intelligence, computer organization and architecture, computational geometry, database systems, parallel and distributed computing, and image analysis and understanding. The Computer Science Program is administered by the Department of Computer and Information Science.

UNDERGRADUATE PROGRAM

This program in computer science is accredited by the Computing Accreditation Commission (CAC) of the Accreditation Board for Engineering and Technology (ABET). The program in computer science offers a curriculum that prepares students for a professional career as computer scientists or graduate studies in computer science leading to research or teaching careers. The undergraduate program in computer science at Polytechnic is based on the principle that a well-rounded graduate should have a rigorous education in the fundamentals of computer science, including significant exposure to the design and operation of computers. Extensive hands-on experience with projects and teamwork, breadth and flexibility in elective courses, solid training in mathematics and science, and a general education based upon multidisciplinary courses are an integral part of the curriculum.

GOALS AND OBJECTIVES

The goals and objectives of the Bachelor of Science program in Computer Science are to provide students with the following:

- Strong fundamental science and mathematical base of knowledge
- Skills and fundamentals of computer science
- Proper balance of theory and practice for problem solving
- Well balanced education with knowledge in humanities, mathematics, science, business and computer science
- Opportunity to explore various aspects of computer science and other fields through flexible electives

OVERVIEW OF THE UNDERGRADUATE CURRICULUM

The main focus of the undergraduate program is on theory, practice, interdisciplinary activities and problem-solving techniques. The curriculum addresses (1) the core/common knowledge that should be required of all computer science graduates and (2) a set of other important topics in computer science that students can choose to study depending on individual interests and career goals. For the required computer science core, courses are chosen in the following six areas: theoretical foundations of computer science, algorithms, data structures, software design, the concepts of programming languages and computer elements and architecture. For the computer science elective courses, the program offers a wide range of advanced topics, including java programming, UNIX programming, parallel and distributed processing, database systems design and interactive computer graphics.

The Computer Science Program allows students to receive a balanced education in the three processes of computing discipline: theory, abstraction and design/skill. Theory provides the underlying mathematical or scientific principles that apply to the discipline of computing. In the abstraction process, students develop models for potential algorithms, data structures, architectures and so forth. In the design process, students engage in the development of a computer system or software using necessary computer skills (e.g., proficiency in a particular programming language or database package).

Undergraduates in computer science at Polytechnic have the advantage of being in a department with a strong graduate division. This means that the undergraduate students study in a rich intellectual environment where many of their instructors are engaged in state-of-the-art research. This significantly contributes to the quality of education and provides highly motivated undergraduates with the opportunity to engage in advanced projects with first-rate researchers.

COMPUTER SCIENCE COMPONENT (48 credits)

One of the distinctive features of the computer science component is the balance of emphasis on subjects related to the design of computers and theoretical computer science. For example, students study computer organization and architecture, as well as data structures, software development, database systems, operating systems, C++ and object

oriented technologies, advanced algorithms and the principles of programming languages. The department believes that this balance of emphasis is important in preparing graduates for a professional or research career.

To work with a variety of students who have different levels of computer experience, the Department of Computer and Information Science offers two different levels of CS 1114 Introduction to Programming and Problem Solving: inexperienced and experienced. The experienced level is designed for students who already know some of the basics, such as keyboards, simple prompts, input/output, variables and simple loops, and who therefore would be bored if these topics were covered slowly. The course for inexperienced users will be paced for first time users and will go more slowly through the basic material.

The elective strategy for the proposed BS Computer Science Program consists of eight electives: two approved courses, four CS electives, one technical elective and one free elective.

At least two of the four required CS electives must be chosen from the following list:

- Artificial Intelligence I
- Computer Networking
- Computer Security
- Digital Logic and State Machine Design
- Introduction to Databases
- Introduction to Parallel and Distributed Systems

Computer science is an ever changing field; the department regularly offers selected topics courses in current areas of computer technology; selected topics are announced every semester.

Mathematics Component (20 credits)

Mathematics is essential to the computer science curriculum. It forms the basis for understanding computer architecture and organization, principles of programming languages, algorithms, compilers and operating systems. The mathematics sequence is designed to enhance the integration of mathematics with the computer science component. If students did not have a chance to learn high school math well (as determined by the Polytechnic placement examination in mathematics), they will be placed in preparatory mathematics courses in order to prepare them for the calculus sequence. The physics

sequence begins in the first term of the sophomore year to take advantage of students' preparation in mathematics.

**Basic Science Component
(12 credits)**

Basic courses in physics and chemistry provide a well-rounded education in science. Computer scientists find that their training in basic science plays an important role in their career by allowing them to understand the theoretical principles of new devices.

**Basic Engineering Component
(4 credits)**

Today, computers are used in all disciplines of engineering. Applications range from computer simulation of wind tunnels to computer aided design (CAD) of automobile parts and load flow analysis of electric power circuits. It is important that computer scientists can communicate with engineers from different disciplines to understand their needs. EG 1004 Introduction to Engineering and Design introduces computer science students to practical design experience in various disciplines of engineering.

**Humanities and Social Sciences
Component (30 credits)**

Courses in the humanities and social sciences are an important part of the curriculum. Career advancement is based not only on technical skills and knowledge; it is equally based on the ability to communicate effectively and the ability to apply the wisdom that results from a serious study and appreciation of the humanities and social sciences. Thus, in addition to basic humanities and social sciences courses, the department requires students to take PL 4062 Computer Ethics.

**Approved Electives
(8 credits)**

A list of approved Electives for computer science majors is available in the Department of Computer and Information Science.

**Technical Elective and Free Elective
Components
(3 credits each)**

It is important for students to have the opportunity to explore other subject areas or to delve into areas in more depth. This is the purpose of having 3 credits of technical electives and 3 credits of free electives.

MINOR IN COMPUTER SCIENCE

The minor in Computer Science consists of 15 credits. Students must obtain a grade of C- or better in CS 1114 and maintain an average of 2.0 GPA or better in the entire minor. Transfer students must take at least two of the

four courses at Polytechnic University.

HONORS PROGRAM

Full time students may apply for the BS/MS Accelerated Honors Program, which leads to the simultaneous award of a bachelor's and a master's degree. Depending on the student's preparation and objectives, completion of the two degrees may come as early as the end of three and three-quarter calendar years of study, or as late as five and one half years. But each program is individually designed in cooperation with a departmental BS/MS Accelerated Honors Program adviser to allow for varied transfer and AP credits, coop program participation, professional summer jobs and other goals consistent with an honors program. Possible BS/MS combinations: a BS in Computer Science with an MS in Computer Science; a BS in Computer Engineering with an MS in Computer Science; and a BS in Electrical Engineering with an MS in Computer Science.

In order to be admitted to the BS/MS Honors Program, students must have exemplary academic achievements in high school, such as high GPAs, strong SAT scores and Advanced Placement credit in calculus and computer science. Students will be invited to join the program by the department prior to the start of the first semester of their freshman year. If students are not accepted at that time, their application may be reconsidered after their first semester at Polytechnic by reapplying with the departmental Honors Program Director. Program participants must complete 16 to 20 credits each semester, maintain a technical and overall 3.5 GPA and display a record essentially free of course repetitions and withdrawals.

The required courses for the two degrees include all courses required for the individual BS and MS degrees, and all curriculum footnotes apply. Required credits are the sum of the credits for the two degrees, except that 3 free elective credits are excused. Six credits of Master's Thesis are required, and a special nine week full time summer honors research project at the end of the second or third year is urged, if offered.

Acceleration may be achieved through summer course work; research participation; extra course loads; careful course sequencing; and AP credit in such courses as MA 1024 and 1124 (AP Calculus BC, grade of at least 4 or 5); and CS 1114 (AP Computer Science A or AB, grade of 4 or 5).

TRANSFER STUDENTS

Transfer students are accepted into the Undergraduate Computer Science Program on the same basis described in the admissions section of this catalog. In addition, the de-

partment requires that at least 28 credits in computer science, as well as CS 4513 and CS 4523, be completed at Polytechnic. Graduates of technology programs may be able to fulfill the requirements for the BS in Computer Science in two to three and one half years, depending on the scope and level of their previous education. Consult an undergraduate adviser for details.

Courses taken at other schools may be granted transfer credit based on evaluation of the content and level of material covered. Periodic reevaluation of courses at other institutions may lead to a variation in the amount of credits granted from year to year. Thus, students completing the same program, but in different years, may receive different amounts of transfer credit. Consult a computer science undergraduate adviser for current information. All computer science courses will be evaluated by the Department of Computer and Information Science. Transfer students who are exempted from EG 1004 Introduction to Engineering and Design must take a substitute course that includes presentation preparation. Students should meet with their undergraduate adviser for more information.

**DEPARTMENTAL STANDARDS,
PROBATIONS AND GRADES OF I
(INCOMPLETE)**

Computer scientists are professionals who are expected to achieve work of acceptable quality and quantity within a specified time. Similarly, Polytechnic students need to assure timely academic progress. It is this ability, the ability to work and to achieve, which is most desired by prospective employers.

To remain in good standing, computer science majors must satisfy the requirements listed below. These requirements are in addition to the University requirements for a minimum term and cumulative 2.0 GPA in all courses.

The following requirements apply to all undergraduate computer science students:

1. Students must maintain an average of C (2.0 GPA) or better in CS
2. Students must earn a grade of C- or better in the following courses: MA 1024 Calculus I; MA 1124 Calculus II; CS 1114 Introduction to Programming and Problem Solving; CS 1124 Object Oriented Programming; and CS 2134 Data Structures and Algorithms
3. Students may repeat a course in which they earned a substandard grade, but no CS course may be taken more than three times (grades of W and AUDIT are not counted for the purpose of this rule)

4. A course in which the student received an I grade may not be used to satisfy any pre-requisites until the incomplete is resolved. See The “Universities Policies on Grading and Grades” in this catalog for additional information on incomplete grades.

Students failing to meet any of the above requirements are placed on departmental probation as a warning that they are not progressing acceptably toward their degree. Repeated failure to meet probation requirements may lead to disqualification from the undergraduate computer science program and courses. If students have any questions, they should feel free to discuss them with an adviser, and preferably in a timely fashion so that good solutions can be found to any problems that may arise.

INFORMATION

Curricula and prerequisite changes, new courses, special sections and other last minute announcements are posted on the bulletin boards outside the offices of the Department of Computer and Information Science. Each student is responsible for keeping informed of such changes.

List of CS Electives:

Undergraduate Courses

- CS 205 Assembly Language
- CS 239 Advanced UNIX System Programming
- CS 308 Introduction to Databases
- CS 391 Java & Web Design
- CS 392 Computer Security
- CS 393 Network Security
- CS 394 Special Topics in Computer Science*
- CS 6843 Computer Networking
- CS 2204 Digital Logic & State Machine Design
- CS 3254 Introduction to Parallel & Distributed Systems
- CS 3714 Secure Information Systems Engineering I
- CS 3734 Scientific & Engineering Computing I
- CS 4724 Secure Information Systems Engineering II
- CS 4744 Scientific & Engineering Computing II
- EE 136 Communication Networks
- MA4423 Introduction to Numerical Analysis

Graduate Courses Open to Undergraduates

- CS 6093 Advanced Database Systems
- CS 6913 Web Search Engines
- CS 6273 Performance Evaluation of Computer Systems
- CS 6533 Interactive Computer Graphics
- CS 6613 Artificial Intelligence I
- CS 6643 Computer Visions & Scene Analysis
- CS 6673 Neural Networking Computing
- CS 6843 Computer Networking
- CS 9013 Unix Systems
- CS 9023 Applied Electronic Commerce
- CS 9033 Programming Workshop

(Algorithms & Software Libraries)

- CS 9043 Cryptography with Financial Applications
- CS 9053 Introduction to Java
- CS 9073 Human & Computer Interaction
- CS 9093 Computer Simulation
- CS 9103 Object Oriented Design with Java
- CS 6923 Machine Learning
- CS 9133 Emerging Technology for IP Development
- CS 9163 Application Security
- CS 9963 Advanced Project in Computer Science
- EL 5143 Multimedia Laboratory
- EL 5473 Introduction to VLSI

* Offered every semester under different topics: information security management; penetration testing and system analysis; digital forensics; and cryptography.

GRADUATE PROGRAMS

GOALS AND OBJECTIVES

Masters of Science

The goals and objectives of the Master of Science in Computer Science program are to provide students with the following:

- Maximum curriculum flexibility, allowing students to adapt their program to their ambitions and goals as well as to their educational and professional backgrounds
- A solid grounding in the fundamentals of computer science
- Professional level courses in computer science
- Opportunity to specialize in selected technology areas of utmost interest
- Opportunities for a research oriented program, in preparation for the Ph.D. program in computer science.

MASTER'S DEGREE REQUIREMENTS

To satisfy the requirements for the master's degree, the student must complete a total of 30 credits, as described below, with an overall average of B. In addition, a B average is required across the six core courses, as indicated below. The master's curriculum has two components: 18 credits of core elective courses and 12 credits of general elective courses.

Core electives and Requirements

The core electives are organized into three core areas: Computer Systems, Programming/ Software, and Theory. Students are required to take at least six core elective courses, with two courses coming from each of the core areas.

Systems Core Area:

- CS 6133 Computer Architecture I
- CS 6143 Computer Architecture II
- CS 6233 Operating Systems I
- CS 6243 Operating Systems II
- CS 6253 Distributed Operating Systems
- CS 6843 Computer Networking
- CS 6813 Information, Security and Privacy
- CS 6823 Network Security

Theory Core Area

- CS 6003 Foundations of Computer Science
- CS 6033 Design & Analysis of Algorithms I
- CS 6043 Design & Analysis of Algorithms II
- CS 6753 Theory of Computation
- CS 6903 Modern Cryptography
- CS 6703 Computational Geometry

Programming/Software Core Area:

- CS 6063 Software Engineering I
- CS 6073 Software Engineering II
- CS 6083 Principles of Database Systems
- CS 6373 Programming Languages
- CS 6413 Compiler Design and Construction I
- CS 6533 Interactive Computer Graphics
- CS 6613 Artificial Intelligence I
- CS 9163 Application Security

Additionally, for each of the courses Computer Architecture I (CS 6133), Operating Systems I (CS 6233), Design and Analysis of Algorithms I (CS 6033), Programming Languages (CS 6373), the following rule applies:

The student is required to take the course unless the student has already taken an equivalent course (at either the graduate or undergraduate level) with a grade of B or higher; if the student has taken an equivalent course and received a B grade or higher, he/she will not be permitted to take cover course at Poly as part of this master's program without special permission.

GENERAL ELECTIVES REQUIREMENTS

In addition to the core electives, students are required to take four general elective courses. There is considerable flexibility, with the only restriction being that no more than two of the courses being taken from outside the Department of Computer and Information Science. In particular:

- Master's thesis (6 credits) and/or independent study courses may be part of a student's 4 elective courses
- Any of the courses in the three core areas may be chosen as electives.
- Graduate level courses from outside of the department (at most two) may be chosen as electives.
- Any CS graduate course not included in the core areas may be chosen as electives.

These courses include:

CS 6273 Performance Evaluation of Computer Systems
 CS 6643 Computer Vision & Scene Analysis
 CS 6673 Neural Network Computing
 CS 9013 UNIX Systems (Perl)
 CS 9053 Introduction to Java
 CS 9073 Human & Computer Interaction
 CS 6093 Advanced Database Systems
 CS 9093 Computer Simulation
 CS 9093 Biometrics
 CS 9103 Object Oriented Design with Java
 CS 6923 Machine Learning
 CS 6913 Web Search Engines
 CS 9133 Emerging Technology for IP Development

REQUIREMENTS FOR MASTER OF SCIENCE**Entrance Requirements**

For entrance into the Master of Science degree programs, students are required to have an undergraduate degree in computer science, mathematics, science or engineering, with a superior undergraduate record from an accredited institution. Applicants having degrees in other fields will be considered for admission on an individual basis. Generally, entering students are expected to have knowledge of mathematics through calculus.

Additional Entrance Requirements:

1. At least one year of university level science
2. A working knowledge of a high level general purpose programming language (preferably C++)
3. A basic understanding of computer fundamentals such as computer organization and operation, data structures and computer architecture. It is anticipated that students entering with a bachelor's in computer science or with a bachelor's in a technical area and a strong minor in computer science will satisfy the entrance requirements for the master's degree program. Students having superior academic credentials but lacking sufficient background are admitted with conditional status pending satisfactory completion of several individually specified preparatory courses. In some cases, such students will be invited to an interview to determine the necessary preparatory courses they need to complete. Successful completion of the preparatory courses with a B or better average grade is a necessary condition for transfer to regular status. The demonstrated ability to communicate in written and spoken English is an essential ingredient for success in pursuing graduate studies in computer science and information systems engineering and is required for regular status. Foreign students and others for whom English is a second language may be required to undertake preparatory

work to improve their language skills before admission into the graduate program. Admission with advanced standing is accepted in accordance with Polytechnic regulations published in the catalog. A maximum of 9 credits may be applied to the MS degree from previous graduate work at an acceptable institution.

Preparatory Courses

The Department offers two preparatory bridge courses for students who do not have a working knowledge of a high level, general purpose programming language:

- CS 5303 Introduction to Programming and Problem Solving
 CS 5403 Data Structures and Algorithms

Master's Thesis Exceptional students may elect to write a master's thesis, for which no more than 6 credits may be earned toward the degree. Such students should find an appropriate adviser who has agreed to monitor the thesis research. Such research need not be original, but should adequately demonstrate the student's proficiency in the subject material. An oral defense of the master's thesis with at least three professors in attendance is required.

Ph.D PROGRAM

Graduate students who have exhibited a high degree of scholastic proficiency and given evidence of ability for independent scholarly work may consider extending their goals toward the degree of doctor of philosophy.

The preliminary requirements for admission to the program include the following:

1. A Bachelor's degree in science, engineering or management from an accredited school and a superior academic record, or
2. A Master's degree or one year of graduate work in an analytically based area, and a superior academic record. Applicants must submit GRE general exam scores, at least two letters of recommendation, a statement of purpose, and all relevant academic records, in addition to the completed application form.

The PhD program consists of 4 Parts:

- A) Courses;
- B) Qualifying exams;
- C) Dissertation Proposal;
- D) Dissertation

Courses and Credits

A minimum of 75 credits of graduate work beyond the BS degree, including at least 21 credits of dissertation. A Master of Science degree in Computer Science may be transferred in as 30 credits without taking individual courses into consideration. Other graduate coursework may be transferred in

on a course-by-course basis. This includes courses taken for degrees other than a Master of Science in Computer Science.

Students are required to take at least two courses in each of the following three areas. In the theory area, one of these two courses must be Theory of Computation (CS 6753) unless an equivalent course has already been taken. In selecting these courses, students are not to choose courses having substantial overlap with courses taken previously, at Polytechnic or elsewhere.

Systems Core Area:

CS 6143 Computer Architecture II
 CS 6243 Operating Systems II
 CS 6253 Distributed Operating Systems
 CS 6843 Computer Networking
 CS 6813 Computer Security
 CS 6823 Network Security

Theory Core Area:

CS 6043 Design and Analysis of Algorithms II
 CS 6753 Theory of Computation
 CS 6903 Modern Cryptography
 CS 6703 Computational Geometry

Programming/Software Core Area:

CS 6063 Software Engineering I
 CS 6073 Software Engineering II
 CS 6083 Principles of Database Systems
 CS 6413 Compiler Design and Construction I
 CS 6533 Interactive Computer Graphics
 CS 6613 Artificial Intelligence I
 CS 9163 Application Security

The CIS faculty may modify these area course offerings from time to time. Certain selected topics courses can be used to fulfill these requirements, with prior written permission from the CIS Department.

Students must receive at least a grade of B in each of the six courses; further, the grade point average averaged over these six courses must be at least a 3.5. Full time students must complete these course requirements by the end of their second year.

Additionally, for each of the courses Computer Architecture I (CS 6133), Operating Systems I (CS 6233), Design and Analysis of Algorithms I (CS 6033), Programming Languages (CS 6373), the following rule applies:

The student is required to take the course unless the student has already taken an equivalent course (at either the graduate or undergraduate level) with a grade of B or higher; if the student has taken an equivalent course and received a B grade or higher, he/she will not be permitted to take the course at Poly as part of this Ph.D. program without special permission.

Qualifying Exam

The purpose of the qualifying exam is to as-

sess the student's knowledge of computer science and the student's ability to perform dissertation level research. The student will be evaluated based on two components: a research exam and course work.

Research Exam

After entering the PhD program, each student will work on a research project under the direction of a research adviser. By the end of the second year, the student must take a research exam based on this work. The research exam will be tailored to the individual student's research, and will have the following three parts:

- (1) written report;
- (2) oral presentation;
- (3) answering questions posed by the research exam committee

The written report must be submitted to the research exam committee at least one week before the oral presentation. The oral presentation will be open to the public. Following the presentation, the student will answer questions posed by the research exam committee.

The research exam will be used to assess the student's ability to do dissertation level research. The exact format of the report and presentation can vary depending upon the student's research accomplishments up until that time and the focus area. The student must have the format approved by his/her research adviser. If the student has obtained research results by the time of the research exam, then the report and presentation should focus on those results, and also include a discussion of related work and ideas for future research. If the student has not yet obtained research results or has only preliminary results, then the report and presentation should consist of a survey of related work, a discussion of ideas the student has pursued so far, and ideas for future research.

Students may schedule the research exams during two periods of time in the year; a range of dates around the end of the Fall and Spring semesters shall be announced in advance by the graduate director. In order to take the research exam, a student, in consultation with his/her research adviser, must form a research exam committee which consists of three faculty members, one being the research adviser and at most two from outside the department or from outside the University, at least one month prior to the exam.

Course Component

As part of the qualifying exam process, the student's overall performance in courses will be evaluated. Special emphasis will be given to performance in PhD core courses. Students taking the research exam in their third

semester must complete at least four PhD core courses by the end of the third semester in order for their course performance to be evaluated at the end of the third semester; otherwise, their evaluation will be delayed until the end of the fourth semester (by which time they must have taken all six PhD core courses).

Evaluation of the student's course performance will usually be based on a review of the student's transcript and possible consultation with course instructors. However, in special cases, students may be subject to additional evaluation and/or additional written exams in some core course areas.

Evaluation of Performance on the Qualifying Exam

The overall decision on whether a student passes or fails the qualifying exam will be determined at a meeting of the CIS faculty, based on the result of the research exam and evaluation of the student's performance in courses. The faculty may issue a grade of pass, fail, or conditional pass. The faculty may use the grade of conditional pass to impose additional specific and time restricted requirements on the student. Such a grade will be converted to a pass or a fail based solely on whether the student meets these requirements.

Students who do not pass the qualifying exam on the first attempt may retake it once. The second attempt must be made by the end of the student's fifth semester. Students who do not pass the qualifying exam on their second attempt will be dismissed from the PhD program.

Note: A student can take thesis credits only after passing the qualifying exam. It is recommended that a student entering the PhD program with a Master's degree in CS take the research exam and at least four of the required PhD core courses by the end of the third semester. In this way, the student has the potential to pass the qualifying exam by the end of the third semester, and to begin taking thesis credits in the fourth semester.

Dissertation

The last, and most substantial, aspect of the PhD program is the dissertation. The dissertation must embody a significant original research contribution and must be written in accepted scholarly style. The research should be conducted in close consultation with the student's advisor. It is strongly recommended that at least one paper on the research be submitted to a refereed archival journal or refereed conference. When the adviser feels that sufficiently significant research results have been obtained and that the dissertation has been written in an acceptable way, a public

dissertation defense, consisting of an oral presentation by the candidate and questions by the dissertation committee, will be scheduled.

Additional requirements for the PhD dissertation are available from the office of the Dean of Graduate Studies.

CERTIFICATES IN INFORMATION ASSURANCE

As a National Security Agency designated Center of Academic Excellence in Information Assurance, Polytechnic is offering NSA-approved certificates in information assurance. The certificates are awarded to students who are pursuing a bachelor's or master's degree in computer science, computer engineering, telecommunication or electrical engineering at the University and have completed the following course requirements:

NSTISSI 4011: Information Security Professional

Course Requirements for the Information Security Professional Certificate (27 Credits)

CS 5403 or
 CS 2134 Data Structures and Algorithms
 CS 6133 or
 CS 2214 Computer Architecture
 CS 6233 or
 CS 3224 Operating Systems*
 CS 6373 or
 CS 3314 Programming Languages*
 CS 6843 Computer Networks**
 CS 6813 Information, Security and Privacy or
 CS 392 Computer Security
 CS 6823 Network Management and Security or
 CS 393 Network Security
 EL 5363 or EE 136 Principles of Communication
 Networks*
 CS 6803 Information Security Management

NSTISSI 4013: Information Systems Administration

Course Requirements for the Information Systems Administration Certificate

4011: Information Systems Administration Certificate
 CS 6573 Penetration Testing & System Analysis
 CS 6243 Operating Systems II***

NOTE:

* These courses can be waived if the student has attended a comparable course and has demonstrated proficiency in the required topics/subjects.

** Can be replaced with EL 5373

*** Can be replaced with CS 3254

For more information, contact Professor Nasir Memon at memon@poly.edu.

GRADUATE CERTIFICATE IN CYBER SECURITY

The demand for skilled information security professionals is growing significantly. This graduate certificate allows technical professionals to obtain key bodies of knowledge and specializations in cyber security. Students acquire an understanding of various technologies in emerging areas of security, including computer and network security, digital forensics, cryptography and biometrics. Students are able to immediately apply their knowledge to manage the risk of cyber attacks. Courses are developed and taught by Polytechnic faculty in the Information Systems and Internet Security (ISIS) Laboratory. Those who choose to work toward a master's degree are able, upon admission, to apply all courses taken toward a certificate toward fulfillment of a degree program.

Admission to the certificate program requires a bachelor's degree in an appropriate preparatory discipline from an institution acceptable to Polytechnic.

Course Requirements for the Cyber Security Certificate (15 credits)

Core Courses 9 credits

CS 6803[♦] Information Systems Engineering & Management
 CS 6813[♦] Information, Security & Privacy
 CS 6823[♦] Network Management & Security

Electives 6 credits

CS 9093[♦] Biometrics
 CS 6903 Modern Cryptography
 CS 9163[♦] Application Security
 CS 6963[♦] Digital Forensics

♦ = available online.

For more information, contact Professor Nasir Memon at memon@poly.edu

GRADUATE CERTIFICATE IN SOFTWARE ENGINEERING

The advanced certificate in software engineering consists of a series of five graduate level courses designed to give students the knowledge and skills they need to compete successfully in the software development arena. Students who want to continue in their studies can apply these courses to the MS program in computer science.

In response to the importance of high quality software development and integration industry, Polytechnic offers a certificate program in software engineering. This course module gives the students the knowledge and skills needed to compete successfully in this arena. Topics covered include object oriented software design, software validation and project management.

The software engineering certificate is a

series of five graduate level courses. Three required core courses are designed to prepare the computer science professional for an advanced software development career. In addition, students choose two other courses from a variety of electives offered on a rotating basis. The elective courses cover areas of current interest to the software engineering community and allow students to customize their education.

Core Courses 9 credits

CS 6063 Software Engineering I
 CS 6073 Software Engineering II
 CS 6083 Principles of Database Systems

Electives 6 credits

CS 9963 Advanced Project in Computer Science*
 CS 9103 Object Oriented Design with Java
 CS 9163 Application Security
 CS 6813 Information Security and Privacy

*Highly recommended

Entrance requirements for the certificate program are the same as for the MS program. For students having superior academic credentials but lacking sufficient background in computer science, there are two prerequisite courses (CS 5303 Introduction to Programming and Problem Solving, and CS 5403 Data Structures and Algorithms).

UNDERGRADUATE COURSES

Students are advised to consult the Schedule of Classes for changes in prerequisites in effect after publication of this catalog. Students may not register for any junior or senior level courses until all freshmen requirements are completed. The annotation 3:0:0:3 means that the course meets for 3 lecture hours, 0 laboratory hours and 0 recitation hours each week and that a total of 3 credits are awarded upon successful completion of the course.

CS 205 Assembly Language and Systems Programming 3:0:0:3

Internal representation of numeric and character data. Machine organization and machine language programming. Assembly language, assemblers. Assembly language programming: branching, arrays, lists, arithmetic and bit manipulation, macros, stacks, subroutines, parameter passing, recursion. Linking and loading, position independent and reentrant code. Traps and interrupts. *Prerequisite: CS 2134 (C- or better).*

CS 239 UNIX System Programming 3:0:0:3

Programming and system administration of UNIX systems. Covers shell programming, special purpose languages, UNIX utilities, UNIX programming tools, systems programming and system administration. *Prerequisites: CS 3224 and junior status.*

CS 308 Introduction to Databases 3:0:0:3

This course introduces students to database systems and motivates the database approach as a mechanism for modeling the real world. The course will cover data models (relational, object oriented), physical database design, query languages, query processing and optimization, as well as transaction management techniques. Implementation issues, object oriented and distributed databases will also be introduced. *Prerequisites: CS 2134 and CS 3224.*

CS 391 Java and Web Design 3:0:0:3

Programmers familiar with C or C++ will learn how to develop Java applications and applets. This course will teach students the syntax of the Java language, object oriented programming in Java, creating graphical user interfaces (GIU) using the Java 2 Platform technology event model, Java exceptions, file input/output (I/O) using Java Foundation Class threads and networking. *Prerequisite: CS 2134.*

CS 392 Computer Security 3:0:0:3

Covers the following topics: Cryptographic systems. Capability and access control mechanisms, authentication models, protection models. Database and operating system security issues, mobile code, security kernels. Malicious code, trojan horses and computer viruses. Security policy formation and enforcement, legal aspects and ethical aspects. *Prerequisites: CS 2214 and MA 2312. Corequisite: CS 3224*

CS 393 Network Security 3:0:0:3

Review of topics in networking. Basic notations of confidentiality, integrity, availability; cryptographic systems, coding and decoding messages. cryptographic protocols for privacy, integrity, key exchange and access control. TCP/IP security; Firewalls, IPSec; secure e-commerce. Intrusion detection, prevention, response. Advanced topics. *Prerequisites: CS 3224 and CS 6843, or EE 136, EL 5363 or EL 5373.*

CS 394 Special Topics in Computer Science

A variable credit special topics course designed for juniors and seniors. *Prerequisite: department's permission.*

CS 1114 Introduction to Programming and Problem Solving 3:3:0:4

An introduction to computer programming and problem solving. General topics covered include the fundamentals of programming, good software development practices and solving problems using computer programming. Specific topics include compiling, running and debugging a program, program testing, documentation, variables and data types, assignments, arithmetic expressions, input and output, topdown design and procedures, the random number generator, conditionals and loops functions, arrays, and an introduction to classes and object oriented programming. Grade of C- or better required of undergraduate computer science and computer engineering majors.

CS 1124 ObjectOriented Programming 3:3:0:4

An intermediate level programming course teaching object oriented programming in C++. Pointers, dynamic memory allocation, and recursion. Classes and objects including constructors, destructors, methods (member functions) and data members. Access and the interface to relationships of classes including composition, association, and inheritance. Polymorphism through function overloading operators. Inheritance and templates. The standard template library will be used to introduce elementary data structures and their use. Grade of C- or better required of computer science and computer engineering majors. *Prerequisite: CS 1114 (C- or better).*

CS 2102 Computer Science for Civil Engineers 2:0:0:2

The objective of the course is to introduce Civil Engineering students to computer programming. The course will emphasize engineering problem solving through the use of the Java language. Students will be exposed to the concept of compiling, debugging, and writing Java programs to solve problems. Problems related to Civil Engineering will be emphasized. Credit will not be granted for both CS2102 and CS 1114, *Prerequisite: major in a Civil Engineering discipline*

CS 2113 Programming with VBA/Excel 2.5:0:0:3

This is an introductory course in computer programming and problem solving for undergraduate students in the Biology/Molecular Science program who have no prior experience in programming in any language. The course covers the fundamentals of computer programming and its underlying principles using the programming language Visual Basic for Applications (VBA). Subroutine and function procedures are created to be run within the Excel environment. This course is only for Biology/Molecular Science Students. *Prerequisites: None*

CS 2134 Data Structure's and Algorithms 4:0:0:4

Abstract data types and the implementation and use of standard data structures. Fundamental algorithms and the basics of algorithm analysis. Grade of C- or better required of undergraduate computer science and computer engineering majors. *Prerequisites: CS 1124 (C- or better) and MA 1024. Corequisite: MA 2312/2322.*

CS 2204 Digital Logic and State Machine Design 3:3:0:4

Combinational and sequential digital circuits. An introduction to digital systems. Number systems and binary arithmetic. Switching algebra and logic design. Error detection and correction. Combinational integrated circuits, including adders. Timing hazards. Sequential circuits, flipflops, state diagrams and synchronous machine synthesis. Programmable Logic Devices, PLA, PAL and FPGA. Finitestate machine design. Memory elements. Grade of C or better required by undergraduate computer engineering majors. *Prerequisite: CS 1114 (C- or better).*

CS 2214 Computer Architecture and Organization 3:3:0:4

A topdown approach to computer design. Computer architecture: introduction to assembly language programming and machine language set design. Computer organization: logical modules; CPU, memory and I/O units. Instruction cycles, the datapath and control unit. Hardwiring and microprogramming. The memory subsystem and timing. I/O interface, interrupts, programmed I/O and DMA. Introduction to pipelining and memory hierarchies. Fundamentals of computer networks. *Prerequisites: CS 2204*

and CS 2134 (C- or better for undergraduate computer engineering majors); CS 2134 (C- or better) and MA 2312/2322 for CS students.

CS 3224 Operating Systems 4:0:0:4

This course will study the fundamental concepts and principles of operating systems. Batch, spooling, and multiprogramming systems are introduced. The parts of an operating system are described in terms of their functions, structure and implementation. Basic policies for allocating resources are also discussed. *Prerequisite: CS 2214.*

CS 3254 Introduction to Parallel and Distributed Systems 3:3:0:4

The goal of this course is to give you a solid grounding in the basic issues and techniques of parallel and distributed computing. The material will cover the spectrum from theoretical models of parallel and distributed systems to actual programming assignments. *Prerequisite: CS 2134.*

CS 3314 Design and Implementation of Programming Languages 4:0:0:4

This course covers issues underlying the design of high level programming languages, along with elements of the compiler technology used to translate those languages into executable code. Topics covered include formal description of language syntax, parsing, memory management, attributes of variables and their binding times, control and data abstraction mechanisms, and object oriented language features. The focus is on imperative and object oriented languages, with brief introduction to functional and logic programming paradigms. Substantial programming projects are required. *Prerequisites: CS 2134 (C- or better) and MA 2312.*

CS 3414 Design and Analysis of Algorithms 4:0:0:4

This course covers the fundamental principles of the design and analysis of algorithms. Topics include asymptotic notation, recurrences, randomized algorithms, sorting and selection, balanced binary search trees, augmented data structures, advanced data structures, algorithms on strings, graph algorithms, geometric algorithms, greedy algorithms, dynamic programming, and NP completeness. *Prerequisites: CS 2134 (C- or better) and MA 2312/2322.*

CS 3714 Secure Information Systems Engineering I 4:0:04

An approach to secure information systems engineering is developed consistent with today's vulnerabilities, threats and risks. Grounding is established in the basic security technologies and strategies in use today. A concept of security engineering is constructed for whole elements of the critical infrastructure (e.g., utilities, government services, financial services, etc.) including legacy environments, the Internet, wireless and the coming evolution of ubiquitous computing. *Prerequisite: junior status.*

CS 3734 Scientific and Engineering Computing I 4:0:04

This course takes advantage of the programming skills that students learn in introductory level computer science courses to exploit the broad power of modern computing related to their science and engineering disciplines. Computational techniques are taught in parallel with programming and problem solving methodologies. Students learn how to recognize a good or bad formulation of a problem, select the proper algorithm to solve a given computational problem and interpret the results; thus, learning to become intelligent users, rather than creators, of computational software. *Prerequisites: CS 1114, MA 1124, MA 2012/2132.*

CS 4513 Software Engineering I 2½/11/2:0:3

The first in a two course design project sequence (DP I and DP II) with a focus in software engineering. This course introduces the software engineering techniques to specify, design, test and document medium and large software systems. Design techniques include information engineering, object orientation, and complexity measures. Testing methods such as path testing, exhaustive test models, and construction of test data. An introduction to software tools and project management techniques is presented. Student projects involve team software development and tracking. *Prerequisites: CS 2134 (C- or better), CS 3224 and senior status.*

CS 4523 Design Project II 1:6:0:3

The second course in a two course design project sequence (DP I and DP II). This is a project course in which a student or several students work with a faculty member and/or graduate students on a current topic in computer science. Each term, a project course with a particular theme is offered by the De-

partment of Computer and Information Science. A faculty member will assign individual or group projects to students in the class. The project course will be highly structured and will be under close supervision of the faculty. It is expected that students will make use of the design and project management skills they have learned in CS 4513 Software Engineering. Alternatively, students can work with a faculty member to develop an individual project of mutual interest. A written report and oral presentation are required. *Prerequisite: CS 4513.*

CS 4724 Secure Information Systems Engineering II 4:0:04

The second semester consists of projects, labs and discussions in the area of Applied Secure Information Systems Engineering. Specifically, students build a comprehensive platform for secure computing based on best of breed Open Source components starting with OpenBSD or the like. This platform is then contrasted to Java Security and to the secure computing efforts of Microsoft and its associates. A "Student Hackathon" is conducted to test findings and assumptions. Finally, recommendations are made to support the future security procurement needs for whole elements of the critical Infrastructure.

CS 4744 Scientific and Engineering Computing II 4:0:04

Making use of the knowledge acquired in part I of the course, the second semester focuses on well recognized major computational developments that have the greatest influence on the development and practice of science and engineering in the last century. Course draws upon a variety of computational problems from the breadth of science and engineering to interest students and establish the relevance of the computational problem solving approach. Students will be involved in projects. *Prerequisite: CS 3734.*

GRADUATE PREPARATORY COURSES

The graduate courses listed in this section were formulated to accommodate the needs of students who wish to pursue graduate studies in computer science, but who lack sufficient undergraduate preparation. No credit will be allowed for any of these courses toward graduate degrees in computer science, information systems engineering or other graduate degree programs administered by the Department of Computer and Information Science. Submission of substantial computer programming assignments is required in all these courses.

CS 5303* Introduction to Programming and Problem Solving 3:0:0:3

Provides an introduction to discrete mathematics, computers and programming; running C/C++ programs under Unix; algorithmic language; pseudo code; problem solving and program structure. Topics covered include constants, variable, data types, assignments, arithmetic expressions, input and output; object oriented and topdown design and procedures, selection and loops; functions; enumerated; arrays, structs and searching and sorting. *Prerequisite: graduate status: *online version available.*

CS 5403* Data Structures and Algorithms 3:0:0:3

This course provides an introduction to data structures. Topics include; program specifications and design; abstract data types; stacks, queues; dynamic storage allocation; sequential and linked implementation of stacks and queues; searching methods, sequential and binary; binary trees and general trees; hashing; computational complexity; sorting algorithms: selection sort, heap sort, mergesort, and quicksort; comparison of sorting techniques and analysis. *Prerequisite: CS 5303, graduate status: *online version available.*

GRADUATE COURSES

Graduate courses in computer science are offered on each campus on a regular basis, annually, or in two-or-three year cycles. (3:0:0:3) A total of 3 credits are awarded upon successful completion of the course.

CS 6003 Foundations of Computer Science 3:0:0:3

Logic, sets, functions, relations, asymptotic notation, proof techniques, induction, combinatorics, discrete probability, recurrences, graphs, trees, mathematical models of computation, undecidability, *Corequisite: CS 5303.*

CS 6005-6025 Variable Credit Project/ Course

For students needing .5, 1, 1.5, 2 and 2.5 credit hours to meet graduation requirements, a project or special course is available with Faculty approval.

CS 6033 Design and Analysis of Algorithms I 3:0:0:3

Review of basic data structures and mathematical tools. Data structures: priority queues, binary search trees, balanced search trees. Btrees. Algorithm design and analysis

techniques illustrated in searching and sorting: heapsort, quicksort, sorting in linear time, medians and order statistics. Design and analysis techniques: dynamic programming, greedy algorithms. Graph algorithms: elementary graph algorithms (breadth first search, depth first search, topological sort, connected components, strongly connected components), minimum spanning tree, shortest path. String algorithms. Geometric algorithms. Linear programming. Brief introduction to NP completeness. *Prerequisites: CS 5403 and CS 6003.*

CS 6043 Design and Analysis of Algorithms II 3:0:0:3

Advanced design and analysis techniques: amortized analysis of algorithms. Advanced data structures: binomial heaps, Fibonacci heaps, data structures for disjoint sets, analysis of union by rank with path compression. Graph algorithms: elementary graph algorithms, maximum flow, matching algorithms. Randomized algorithms. Theory of NP-completeness and approach to finding (approximate) solutions to NP-complete problems. Selected additional topics that may vary. *Prerequisite: CS 6033.*

CS 6063 Software Engineering I 3:0:0:3

The emphasis is on understanding the full software engineering approach with alternative approaches. Technical emphasis is on requirements, design, development, and modeling. Management issues include software cost estimating and project management. Understanding the processes applicable to the software development/integration cycle and maintenance along with technology changes on quality and development activities is highlighted. *Prerequisite: CS 5403.*

CS 6073 Software Engineering II 3:0:0:3

Covers modern advanced software engineering approaches of both a theory and practice orientation. Important Design and Management issues are analyzed and evaluated. Technical and management tradeoffs in distributed software systems are emphasized. An extensive number of real world case studies are assessed. A class project is required. *Prerequisite: CS 6063.*

CS 6083 Principles of Database Systems 3:0:0:3

This course aims to give a broad introduction to database systems, including the relational data model, query languages, database design, index and file structures, query processing and optimization, concurrency and recovery, transaction management, and database design. Students will also acquire hands-on experience in working with database systems and in building web accessible database applications. *prerequisites: CS6003 or equivalent. Familiarity with basic data structures and operating system principles.*

CS 6093 Advanced Database Systems 3:0:0:3

This is an advanced course on database systems and data management, and students are assumed to have a solid background in databases. The course typically covers a selection from the following topics: (1) advanced relational query processing and optimization, (2) OLAP and data warehousing, (3) data mining, (4) stream databases and other emerging database architectures and applications, (5) advanced transaction processing, (6) databases and the Web: text, search, and semistructured data, or (7) geographic information systems. Topics are taught based on a reading list of selected research papers. Students have to work on a course project and may have to present in class. *Prerequisites: CS 6083 or CS 308 or equivalent, including experience with a relational database system.*

CS 6133* Computer Architecture I 3:0:0:3

This course provides students with an understanding of computer hardware subsystems, digital design strategies and fundamental computer performance and capacity improvement techniques. Combinational and sequential circuits are developed for the essential building blocks of computers. Binary number systems are presented in both human and computer algorithms. A uniprocessor computer is built up from the blocks developed.

An assembly language and an instruction set are presented. Processor implementation with a data path and hardwired and microprogrammed control is introduced. Performance evaluation of computers is studied. Basic pipelining is introduced to improve the performance of the system. Memory hierarchy alternatives are introduced to improve the capacity of the computing system. **Online version available.*

CS 6143 Computer Architecture II 3:0:0:3

High-speed computer arithmetic. Uniprocessor computer architectures that exploit parallelism: Advanced pipelining, superscalar, VLIW, vector processors. Parallel processing: Interconnection structures, MIMD and SIMD systems. Other selected parallel computing topics, such as parallel algorithms, PRAM machines, and multicore processing. *Prerequisite: CS 6133.*

CS 6183 Fault-Tolerant Computers 3:0:0:3

Introduces a variety of hardware and software techniques for designing and modeling fault tolerant computers. Topics include coding techniques (Hamming, SECDED, SECDED, etc.); majority voting schemes (TMR); software redundancy (Nversion programming); software recovery schemes; network reliability design and estimation. Introduces probabilistic methods for reliability modeling. Examples from space fault tolerant systems, networks, commercial nonstop systems (TANDEM and STRATUS). RAID memory systems. Fault-tolerant modeling tools such as HARP, SHURE and SHARPE. *Prerequisites CS 6133*

CS 6233 Introduction to Operating Systems 3:0:0:3

Introduction to basic issues in operating systems. Threads, Processes, Concurrency, Memory Management, I/O Control and case studies. *Prerequisite: graduate standing*

CS 6243 Operating Systems II 3:0:0:3

Survey of recent important commercial and research trends in Operating Systems. Topics may include virtualization, network server design and characterization, scheduling and resource optimization, file systems, memory management, advanced debugging techniques, data center design, and energy utilization. *Prerequisite: CS 6233.*

CS 6253 Distributed Operating Systems 3:0:0:3

Introduction to distributed networked computer systems. Distributed control and consensus. Notions of time in distributed systems. ClientServer communications protocols. Middleware. Distributed File Systems and Services. Fault tolerance, replication and transparency. Peer-to-peer systems. Case studies of modern commercial systems and research efforts.

CS 6273 Performance Evaluation of Computer Systems 3:0:0:3

This course focuses on modeling and performance analysis of computer systems. In particular this course will concentrate on Testing and Evaluation of three-tiered Distributed Client/Server and WEB-Based Systems and more generally to distributed networking systems. The course will present and evaluate various systems architectures from a macro and micro viewpoint. *Prerequisites: EL 5363 or MA 2212/2222 and instructor's permission.*

CS 6373 Programming Languages 3:0:0:3

The structures, notations, and semantics of programming languages. Issues of scope, type structure, and parameter passing. Control structures, including support for exception handling and concurrency. Abstract data types and object oriented languages. Programming in the large. Implementation issues. Functional, logic programming languages. Examples from a variety of languages. *Prerequisites: CS 5403.*

CS 6413 Compiler Design and Construction 3:0:0:3

Compiler organization. Lexical analysis, syntax analysis, abstract syntax trees, symbol table organization, code generation. Introduction to code optimization techniques. *Prerequisites: CS 5403, CS 6133 and CS 6003*

CS 6533 Interactive Computer Graphics 3:0:0:3

This course introduces the fundamentals of Computer Graphics with hand-on graphics programming experiences. Topics include: graphics software and hardware, 2D line segment scan conversion, 2D and 3D transformations, viewing, clipping, polygon scan conversion, hiddensurface removal, illumination and shading, compositing, texture mapping, ray tracing, radiosity, and scientific visualization. *Prerequisites: CS 5403 (DataStructures) or equivalents, and knowledge of C or C++ programming*

CS 6573* Penetration Testing and Vulnerability Analysis 3:0:0:3

This is an advanced course in computer and network security that focuses on penetration testing and vulnerability analysis. The course introduces various methodologies, techniques, and tools to analyze and identify vulnerabilities in stand-alone and networked applications. *Prerequisites: CS 6823: *Online version available.*

CS 6613 Artificial Intelligence I 3:0:0:3

Artificial Intelligence (AI) is an important topic in computer science that has many diversified applications. It addresses one of the ultimate puzzles human's are trying to solve How is it possible for a slow, tiny brain, whether biological or electronic, to perceive, understand, predict, and manipulate a world far larger and more complicated than itself? And, how do we go about creating a machine (or computer) with those properties? To this end, researchers in the AI field have been trying to understand how seeing, learning, remembering, and reasoning could, or should be done. This course introduces students to the many concepts and techniques in artificial intelligence. *Prerequisite: CS 5403.*

CS 6643 Computer Vision and Scene Analysis 3:0:0:3

An important goal of artificial intelligence is to equip computers with the capability of interpreting visual inputs. Computer vision and scene analysis is an area in AI that deals with the construction of explicit, meaningful descriptions of physical objects from images. It includes many techniques from image processing, pattern recognition, geometric modeling, and cognitive processing. This course introduces students to the many techniques and applications of computer vision and scene analysis. *Prerequisites: CS 5403 and MA 2012 or equivalents or instructor's permission.*

CS 6673 Neural Network Computing 3:0:0:3

An introduction to neural network models and their applications. Discussion of organization and learning in neural network models including perceptrons, adalines, back propagation networks, recurrent networks, adaptive resonance theory and the neocognitron. Implementations in general and special purpose hardware, both analog and digital. Application in various areas with comparisons to nonneural approaches. Decision systems, nonlinear control, speech processing and vision. *Prerequisite: CS 5403. Some familiarity with matrix notation and partial derivatives is recommended.*

CS 6703 Computational Geometry 3:0:0:3

This course will present and introduction to data structures and algorithms for geometric data. Topics will include: intersection, polygon triangulation, linear programming, orthogonal range searching, point location, Voronoi diagrams, Delaunay triangulations, arrangements and duality, geometric data structures, convex hulls, binary space partitions, robot motion planning, quadtrees, visibility graphs, simplex range searching.

CS 6753 Theory of Computation 3:0:0:3

Introduction to the theory of computation. Formal languages and automata theory. Deterministic and non-deterministic finite automata, regular expressions, regular languages, context-free languages. Pumping theorems for regular and context-free languages. Turing machines, recognizable and decidable languages. Limits of computability: the Halting Problem, undecidable and unrecognizable languages, reductions to prove undecidability. Time complexity, P and NP, Cook-Levin theorem, NP completeness. *Prerequisites: CS 6003 or instructor's permission.*

CS 6803* Information Systems Security Engineering & Management 3:0:0:3

The primary goal of this course is to present a system and management view of information security: what it is, what drives the requirements for information security, how to integrate it into the systems design process, and life cycle security management of information systems. A second goal is to cover basic federal government information security policies and methodologies. Topics covered include information security risk management, security policies, security in the systems engineering process, laws related to information security, and management of operational systems. *Prerequisite: CS 392 or equivalent: *Online version available*

CS 6813* Information, Security and Privacy 3:0:0:3

This is an introductory course in Information Systems Security that deals with following topics: Cryptography, capability and access control mechanisms, authentication models, security models, operating systems security, malicious code, security policy formation and enforcement, vulnerability analysis, evaluating secure systems. *Prerequisite: graduate status: Online version available*

CS 6823* Network Security 3:0:0:3

This course first covers attacks and threats in computer networks, including network mapping, port scanning, sniffing, DoS, DDoS, reflection attacks, attacks on DNS, and leveraging P2P deployments for attacks. The course then covers the topics in cryptography that are most relevant to secure networking protocols. These topics include block ciphers, stream ciphers, public key cryptography, RSA, Diffie Hellman, certification authorities, digital signatures, and message integrity. After surveying the basic cryptographic techniques, the course examines a number of secure networking protocols, including PGP, SSL, IPsec, and wireless security protocols. The course also examines operational security, including firewalls and intrusion detection systems. The course involves reading some recent research papers on network security.

The course also has an important lab component, including labs on packet sniffing, network mapping, firewalls, SSL, and IPsec. *Prerequisite: EL 5363: *Online version available*

CS 6843 Computer Networking 3:0:0:3

This course takes a top down approach to computer networking. After providing an overview of computer networks and the Internet, the course covers the application layer, transport layer, network layer and link layers. Topics at the application layer include client server architectures, P2P architectures, DNS, and HTTP and Web applications. Topics at the transport layer include multiplexing, connectionless transport and UDP, principles of reliable data transfer, connection oriented transport and TCP, and TCP congestion control.

Topics at the network layer include forwarding, router architecture, the IP protocol, and routing protocols including OSPF and BGP. Topics at the link layer include multiple access protocols, ALOHA, CSMA/CD, Ethernet, CSMA/CA, wireless 802.11 networks, and linklayer switches. The course includes simple quantitative delay and throughput modeling, socket programming and network application development, and Ethereal labs. *Prerequisite: CS 2134.*

CS 6873 Project in Telecommunication Networks 1/2:0:0:3

A design course where students design, develop, and test communication software. It is expected that the student will work in small groups under the direction of a professor. Students will have access to network resources for their work. *Prerequisites: CS 6843 and instructor's permission.*

CS 6903 Modern Cryptography 3:0:0:3

This course deals with the study of modern cryptography from a theoretical perspective, the emphasis of the course being on "provable security." In particular, we study the cryptographic primitives that are the building blocks of various cryptographic applications. The course involves the study of notions of security for a given cryptographic primitive, its various constructions, and respective security analysis based on the security notion. The cryptographic primitives that we cover include pseudorandom functions, symmetric encryption (block ciphers), hash functions and random oracles, message authentication code, asymmetric encryption and digital signatures. Time permitting; we also study how to build secure cryptographic protocols for authenticated key exchange, using the primitives that we study. We also study various number theoretic assumptions cryptography is based upon.

CS 6913 Web Search Engines 3:0:0:3

This course covers the basic technology underlying web search engines and related tools. The main focus will be on large scale web search engines (such as Google, Yahoo, and MSN Search) and the underlying architectures and techniques. Students will learn how search engines work, and get hands-on experience in how to build search engines from the ground up. Topics are taught based on a reading list of recent research papers. Students have to work on a course project and may have to present in class.

CS 6923 Machine Learning 3:0:0:3

Introduction to the field of machine learning Standard machine learning techniques such as decision trees, nearest neighbor, Bayesian methods, support vector machines, and logistic regression. Basic concepts in computational learning theory including the PAC model and VC dimension. Methods for evaluating and comparing machine learning techniques.

CS 6963* Digital Forensics 3:0:0:3

This course will introduce information technology professionals with the application of forensic science principles and practices to the collection, preservation, examination, analysis, and presentation of digital evidence. The course will include selected topics from the legal, forensic, and information technology domains and utilize lecture, laboratory and written projects to illustrate these topics. **Online version available.*

**CS 9013, CS 9023, CS 9033
CS 9253 Selected Topics in Computer Science** each 3 credits

Topics of current interest in computer science. Recent offerings include software specification and validation, parallel algorithms and architectures, client server systems and advanced object oriented design (Java). Advanced topics in databases, performance analysis, computer simulation, Java programming, Unix programming, human and computer interaction, cryptography with financial applications and biometric identification. *Prerequisites: specified when course is offered.*

CS 9093* Biometrics 3:0:0:3

The course concentrates on the unique advantages that biometrics brings to computer security, but also addresses challenging issues such as security strength, recognition rates, and privacy, as well as alternatives of passwords and smart cards. Students will gain knowledge in the building blocks of this field: image and signal processing, pattern recognition, security and privacy, and secure system design. By the end of the course students will be able to evaluate and design security systems that include biometrics. **Online version available.*

CS 9163* Application Security 3:0:0:3

This course addresses the designing and implementation of secure applications. Concentration is on writing software programs that make it difficult for intruders to exploit security holes. The course will have emphasis on writing secure distributed programs in Java. The security ramifications of class, field, and method visibility and the exploration of important security measures will be emphasized. **Online version available.*

CS 9413/CS 9423 Readings in Computer Science I/II 3 credits each

Intended primarily for advanced graduate students who wish to study in a specialized area under the supervision of a faculty member. Permission of graduate director is required. Regular meetings with the adviser. Examination or term report required. *Prerequisite: graduate status.*

PROJECT AND THESIS

Students may register and get credit for these courses more than once.

CS 9963 Advanced Project in Computer Science 3:0:0:3

This course permits the student to perform research in computer science with a narrower scope than a master's thesis. The acceptance of a student by a faculty adviser is required before registration. An oral examination on the project report is required. *Prerequisite: graduate status.*

CS 9973 Thesis for Degree of Master of Science 3 credits each

Exceptional students may elect to write a master's thesis for which no more than 6 credits may be earned toward the degree. Such research should adequately demonstrate the student's proficiency in the subject material. Oral thesis defense with at least three professors in attendance plus a formal, bound thesis volume are required. Thesis registration must be continuous. *Prerequisites: graduate status and satisfactory grades in prescribed courses.*

CS 9993 Dissertation for Degree of Doctor of Philosophy 3 credits each

Original investigation of computer science problem. Must demonstrate creativity and include features of originality and utility worthy of publication in a recognized journal. Candidate must successfully defend dissertation orally. Registration of 21 credits required (continuous dissertation registration required). *Prerequisites: passing of qualifying examination and approval of the Department of Computer and Information Science.*

Typical Course of Study for the Bachelor of Science in Computer Science

FRESHMAN YEAR

Fall Semester

Course No.	Course Title	Class	Hours/Week			Cr.
			Lab.	Rec.		
CS 1114	Intro. Prog. & Problem Solving ¹	3	3	0		4
CM 1004	General Chemistry	3	2	1		4
EN 1014	Writing & Humanities I ²	4	0	0		4
MA 1024	Calculus I ³	4	0	0		4
SL 1010	Freshman Seminar	1	1	0		0
						16

SOPHOMORE YEAR

Fall Semester

CS 2134	Data Structures & Algorithms	4	0	0		4
MA 2312	Discrete Math. I (½ semester)	4	0	0		2
MA 2322	Discrete Math. II (½ semester)	4	0	0		2
PH 1004	Introductory Physics I	4	1½	1		4
HI 2104	Modern World History	4	0	0		4
						16

JUNIOR YEAR

Fall Semester

CS 3314	Design & Impl. Prog. Languages	4	0	0		4
MA 2012	Linear Algebra I (½ semester)	4	0	0		2
MA 2132	Ordinary Diff. Equ. (½ semester)	4	0	0		2
CS	Elective ⁵					4
HU/SS	Elective ⁴	4	0	0		4
						16

SENIOR YEAR

Fall Semester

CS 4513	Software Engineering I	2½	1½	0		3
PL 4062	Computer Ethics	2	0	0		2
CS	Elective ⁵					3
HU/SS	Elective ⁴	4	0	0		4
Approved	Elective ⁶					4
						16

Spring Semester

Course No.	Course Title	Class	Hours/Week			Cr.
			Lab.	Rec.		
CS 1124	Object Oriented Programming	3	3	0		4
EG 1004	Intro. Engineering & Design	1	3	2		4
MA 1124	Calculus II	4	0	0		4
EN 1204	Writing & Humanities II	4	0	0		4
						16

Spring Semester

CS 2214	Computer Arch. & Organization	3	3	0		4
MA 2212	Data Analysis I (½ semester)	4	0	0		2
MA 2222	Data Analysis II (½ semester)	4	0	0		2
PH 2004	Introductory Physics II	4	1½	1		4
HU/SS	Elective ⁴	4	0	0		4
						16

Spring Semester

CS 3224	Operating Systems	4	0	0		4
CS 3414	Design & Analysis Algorithms	4	0	0		4
CS	Elective ⁵					4
Approved	Elective ⁶					4
						16

Spring Semester

CS 4523	Design Project II	1	6	0		3
CS	Elective ⁵					3
	Technical Elective	4	0	0		3
	HU/SS Elective ⁴	4	0	0		4
	Free Elective ⁸					3
						16

Total credits required for graduation:

128

- Grade of C or better is required in CS 1114, CS 1124 and CS 2134
- Students who are placed by examination or by an adviser into EN 1080 must subsequently register for EN 1034, rather than EN 1014.
- Students who are placed by examination or by an adviser into MA 914 must defer registration for MA 1024.
- Approved HU/SS Electives have the following prefixes: AH, AN, EC, EN, HI, MU, PL and PS. Two courses must be from Level II Elective courses in different disciplines and one from Level III Advanced Elective courses.
- At least two of the four required CS Electives must be chosen from the following: CS 392, CS 6843, CS 308, CS 2204, CS 3254, CS 6613. With departmental approval, certain graduate CS courses may also be used as CS Electives depending on course content and prerequisites.
- A list of Approved Electives is available from the Department of Computer and Information Science.
- Approved Technical Electives courses for computer science majors can be in mathematics, management, industrial engineering, electrical and computer engineering and technical and professional communication provided they contain enough technical (or management) content that does not duplicate materials studied in other courses.
- The Free Elective could be a course offered by any department, provided it does not duplicate material studied in another course.

CONSTRUCTION MANAGEMENT PROGRAM

Program Directors

Fletcher H. (Bud) Griggs
Lawrence Chiarelli

UNDERGRADUATE PROGRAM

The Bachelor of Science in Construction Management is an interdisciplinary program administered by the Center for Construction Management Technology (CCMT) in the Department of Civil Engineering. The program prepares students for a challenging career in the construction industry - as future leaders in a dynamic and ever-changing environment. It concentrates on the essential skills necessary to develop competency in the profession and be competitive in the marketplace. Graduates will be positioned for opportunities with owners, developers, construction managers, contractors, architects and engineers, lenders and others involved in the construction industry.

The Bachelor of Science in Construction Management program covers a broad range of basic through advanced subjects in engineering and construction management, such as planning, cost estimating, scheduling, project management and construction administration. The program also exposes students to the latest applications in construction research and technology. The program teaches students the fundamentals of engineering and construction science, as well as business aspects of construction and the application of traditional and emerging construction methods and technologies. Students also learn basic economics and management, with particular emphasis on their application to the construction industry.

Modern and practical systems integration courses and projects in the program's junior and senior years provide project management knowledge through the utilization of course materials from, and site visits to, actual construction projects led by experienced mentors.

Beyond the classroom, real-world work experience is available through internships and summer and part-time employment and through professional organizations and associated student chapters, including the Construction Management Association of America (CMAA), the American Society of Civil Engineers (ASCE), the Society of American Military Engineers (SAME) and the New York Building Congress (NYBC). Polytechnic's Office of Career Services and Cooperative Education also supports these efforts.

GOALS AND OBJECTIVES

The objective of the Bachelor of Science in Construction Management is to provide the following for its students:

- A solid foundation of knowledge in mathematics and the basic sciences toward application to construction management.
- The knowledge and skills necessary to excel at an entry-level position as a construction professional and/or continue graduate study in construction management or a related field.
- The appropriate communications skills, both written and verbal, to allow graduates to grow into leadership positions in the profession.
- A thorough understanding of state-of-the-art techniques and tools in construction management involving three-dimensional computer modeling, building information modeling (BIM), integration of information technology, and the application of innovative planning, design and construction administration methodologies.
- A broad education in preparation for lifelong learning and individual growth. Students are required to take courses in history, writing and the humanities, and electives allow students to further customize their education to enhance their individual interests.

PEDAGOGY

Construction management courses are taught using a variety of pedagogical models. These include theory-led teaching, case-method education and project-based/team-based teaching.

Teaching based on exposition of theory is applied to engineering and construction science. Fundamentals in math and physics, statics and dynamics, mechanics of materials, estimating, scheduling, planning, and construction operations are necessary prerequisites to the development and application of construction management skills.

Case-method teaching utilizes real-world business experiences in order to demonstrate the application of general principles and to apply them to specific problems posed in the course of instruction. This pedagogy is used in the teaching of construction contracts and administration, safety and business law.

Project-based and team-based education is experiential; students learn by doing, much as they would in a natural sciences laboratory class. Project-based education also provides students an opportunity to learn how to assemble and coordinate necessary

information, assert authority and delegate responsibility. This is particularly important in construction management, in which the essential tasks are the management of people and information.

It is very common in construction management courses for all pedagogical approaches to be employed. The construction management faculty brings together theory-based instruction and an intimate understanding of state-of-the-art construction management practices.

The City of New York provides a universe of projects of all types that are readily available to students to serve as a virtual laboratory. Drawings and specifications are made available to students for classroom study and before visiting project sites. Faculty who are actively involved in those projects discuss the many unique and special problems encountered on these projects, as well as potential solutions. Field visits to project sites are an essential part of the educational process.

PROGRAM CONTENT

The construction management curriculum incorporates the following subject areas:

	Credits
General Education	24
Mathematics and the Sciences	22
Business and Management	21
Construction Science	26
Construction	24
Other	11
Total:	128

CURRICULUM

The Bachelor of Science in Construction Management program is establishing a Technical Advisory Group, made up of leaders of the construction profession to assist in assessing and continually updating the program curriculum. The general requirements of the curriculum accommodate the continually expanding requirements of the profession, advancements in knowledge and the contributions of related disciplines. Its offerings exceed the American Council for Construction Engineering (ACCE) Standards and Criteria for Accreditation.

Table 1 summarizes the Construction Management Curriculum by subject category. A typical four-year schedule for the program is included at the end of this section of the catalog.

TABLE 1: CURRICULUM FOR THE B.S. (CONSTRUCTION MANAGEMENT)

Course No.	Course Title	Credits	Sem ¹
Required Courses in Mathematics			
MA1054	Calculus I w/ Precalc	4.0	F1
MA	Mathematics Elective ²	4.0	F2
MA2054	Applied Data Analysis	4.0	So2
Total Required Credits in Mathematics		12.0	
Required Courses in the Physical Sciences			
CM 1004	General Chemistry	4.0	F1
PH 1004	Introductory Physics I	4.0	F2
Total Required Credits in Physical Sciences		8.0	
Required Courses in Humanities and Social Sciences			
EN 1014	Writing and the Humanities I ³	4.0	F1
EN 1204	Writing and the Humanities II	4.0	F2
HI 2104	Modern World History	4.0	So1
PL	Philosophy Elective ⁴	4.0	So2
HU/SS	Level II Elective ⁵	4.0	J2
HU/SS	Level III Elective ⁵	4.0	S2
Total Required Courses in Humanities and Social Sciences		24.0	
Required Courses in Management and Economics			
MG 2204	Financial Accounting	4.0	So1
EC 2504	Basic Economics	4.0	So2
MG/EC	Level II Elective ⁶	4.0	J1
MG/EC	Level II Elective ⁶	4.0	J2
MG/EC	Level III Elective ⁶	4.0	S1
Total Required Courses in Management and Economics		20.0	
Required Courses in Civil Engineering			
CE 2114	Statics and Dynamics	4.0	So1
CE 2124	Mechanics of Materials	4.0	So2
CE	Elective ⁷	3.0	S2
Total Required Courses in Civil Engineering		11.0	
Required Courses in Construction Management			
CE 1504	Leadership and Foundations of Construction	4.0	F2
CE 2504	Construction Modeling and Data Structures	4.0	So1
CE 3503	Cost Estimating	3.0	J1
CE 3513	Construction Scheduling	3.0	J1
CE 3544	Site Planning, Design, and Surveying	4.0	J1
CE 3523	Contracts and Specifications	3.0	J2
CE 3553	Non-Structural Building Systems	3.0	J2
CE 4523	Structural Building Systems	3.0	S1
CE 4513	Construction Project Administration	3.0	S1
CE 4533	Construction Law ⁸	3.0	S2
CE 4543	Construction Management Project	3.0	S2
CE 4503	Construction Engineering	3.0	S2
Total Required Courses in Construction Management		39.0	
Other Required Courses			
EG 1004	Introduction to Engineering and Design	4.0	F1
CS 2102	Computer Concepts and Applications	2.0	J1
Total Other Courses = 14.0			
Total Credits for Degree = 128.0			

Footnotes for Table 1

1. Sem = semester usually taken; F= Freshman, So=Sophomore, J=Junior, S=Senior, 1=Fall, 2=Spring;
2. The department recommends that all students take MA1054 Calculus I with Precalculus, which contains an additional two hours per week of pre-calculus review. It believes that this review is valuable, even for good math students. Students may take a placement examination to place out of this course in favor of MA 1024 Calculus I, or may be advance-placed based upon AP or college math credit earned in high school. The department also recommends that students take MA 1154 Calculus II with Precalculus as the MA Elective.
3. All students take a writing placement examination. Students with an ESL background may be placed in EN 1034, which includes additional hours of language education. Students may also be placed in a remedial section based upon the exam results, which does not carry degree credit.
4. PL electives include: PL 2054, PL 2064, PL 2084, PL 3054, or other approved courses containing at least 1 credit of ethics.
5. Approved HU/SS electives are courses with the following prefixes: AH (Art History), AN (Anthropology), EC (Economics), EN (English Literature), HI (History), MU (Music), PL (Philosophy), or PS (Psychology). A level II course has a 2xxx number, while a level III course has a 3xxx number. Level III electives generally have a prerequisite of a related level II elective. Students who take up to two courses with an EC prefix in fulfillment of the MG/EC requirement may substitute a course with a CE (civil engineering) prefix and not more than one course with a TC (technical communications) prefix.
6. Approved MG electives include MG 2004, MG2014, MG 2104, MG 2304, MG 3204, and MG 3404. Approved EC electives include EC 2514, EC 2524, EC2534, EC 3254 and EC 3264. FIN and FRE courses approved by a Construction Management Program Director will also satisfy the MG/EC elective requirement. A level II course has a 2xxx number, while a level III course has a 3xxx number. Level III electives generally have a prerequisite of a related level II elective.
7. CE elective is any course with a CE prefix for which the student has appropriate prerequisites.
8. Also listed as LW 4533 Construction Law.

PART-TIME STUDENTS

Students can register as part-time students (less than 12 credits per semester). Such students must be advised, however, that the department no longer offers many undergraduate courses in the evening, and part-time students are required to take most of their courses during the day. Part-time students should maintain close contact with their academic advisers to plan an effective and efficient course sequence.

GRADUATE PROGRAMS

Polytechnic University offers a Master of Science degree program in Construction Management and two graduate certificate programs: one in executive construction management (Exec 21) and the other in construction management.

THE EXEC-21 PROGRAM: GRADUATE CERTIFICATE PROGRAM IN EXECUTIVE CONSTRUCTION MANAGEMENT

The Exec 21 Certificate Program in Executive Construction Management (Exec 21) is offered by the Department of Civil Engineering and administered by CCMT. It is directed toward individuals with significant professional experience in construction, and it is focused primarily on the construction industry.

Exec 21 is a leadership program for construction professionals who do not wish to commit themselves to the full Master of Science program, but seek some formal certification in construction management. This may include students with a bachelor's degree who wish to specialize in construction management or those who may have previously completed an advanced degree and wish to develop additional skills.

Recognized throughout the construction industry as a vital and innovative educational experience (recipient of the CMAA Academic Achievement Award), Exec 21 courses are taught by eminently qualified construction industry professionals and faculty members.

Students without significant work experience in the industry should enroll in the Certificate Program in Construction Management, which is jointly offered by the Department of Civil Engineering and the Department of Technology Management. That program includes general management courses in addition to construction management courses, and it does not require any prior work experience for full participation.

Admission

Students seeking admission to the Exec 21 Certificate Program should have earned a bachelor's degree in an appropriate discipline, and should have a minimum of three to five years of related professional experience. Undergraduate backgrounds in engineering, mathematics, science, management and/or the liberal arts are appropriate with the requisite work experience for admission.

Curriculum

Students must complete 15 credits of coursework to earn a certificate. A minimum of 9 credits must be selected from the Exec 21 Core Courses, and up to 6 credits may be selected from a list of approved electives or other courses approved by a Construction Management Program Director.

The Exec 21 Core Courses are as follows:

CE 8703	Managing and Leading in the 21st Century
CE 8713	Construction & the Law
CE 8723	How to Succeed in Construction
CE 8733	Infrastructure Financing
CE 875X	Employer-Focused Residency
CE 8763	Capital Program Management/ Program Development
CE 8773	Dispute Avoidance and Resolution
CE 8783	Construction Management and Planning
CE 8803	Infrastructure Planning for Public Works

Approved Elective Courses for Exec 21 are as follows:

CE 7983	Special Topics in Construction I
CE 7993	Special Topics in Construction II
CE 8203	Project Management
CE 8243	Construction Modeling Techniques
CE 8253	Project Management for Construction
CE 8263	Construction Cost Estimating
CE 8273	Contracts and Specifications
CE 8283	Risk Analysis
CE 8293	Construction Operations Analysis
CE 8303	Information Systems in Project Management
CE 8313	Engineering for Construction I: Methods and Technologies
CE 8323	Engineering for Construction II: Design
CE 8333	Marketing for Construction Management and Engineering Services
CE 8343	Construction Site Safety

Grade Requirements

Students must maintain a B (3.0) cumulative average in all graduate courses taken at Polytechnic University.

GRADUATE CERTIFICATE IN CONSTRUCTION MANAGEMENT

The Department of Civil Engineering, in conjunction with the Department of Technology Management, offers a graduate certificate to students completing 15 credits of course-work in construction management. The certificate program provides engineers and other professionals in the construction industry with the knowledge necessary to understand relevant managerial and physical technological developments, and to effectively apply such knowledge in the construction management profession.

Admission

Applicants for the Certificate in Construction Management must hold appropriate bachelor's degrees. Appropriate backgrounds include engineering, math, science, management, architecture, economics, law and the liberal arts. The undergraduate degree must be from an acceptable institution.

Curriculum

Students can select any five courses (15 credits) from the following cluster of courses. All courses are 3 credits.

CE/MG 8203	Project Management
CE 8243	Construction Modeling Techniques
CE/MG 8253	Project Management for Construction
CE/MG 8263	Construction Cost Estimating
CE/MG 8273	Contracts and Specifications
CE 8283	Risk Analysis
CE 8293	Construction Operations Analysis
CE 8303	Information Systems in Project Management
CE 8313	Engineering for Construction I: Methods and Technologies
CE 8323	Engineering for Construction II: Design
CE 8333	Marketing for Construction Management and Engineering Services
CE 8343	Construction Site Safety
MG 6243	Organizational Development; or
MG 6313	Organization Theory and Design
MG 6303	Operations Management; or
MG 6353	Managing for Quality

Grade Requirements

Students must achieve a B (3.0) cumulative average in all graduate courses taken at Polytechnic University.

MASTER OF SCIENCE IN CONSTRUCTION MANAGEMENT

The Master of Science in Construction Management program requires 30 credits of course work. Courses include those in the Exec 21 and Construction Management certificate programs, the Master of Science in Civil Engineering program courses in construction management, and elective courses from other Polytechnic University graduate programs.

Courses taken as part of the Exec 21 Certificate Program in Executive Construction Management and the Graduate Certificate Program in Construction Management may be applied toward the Master of Science in Construction Management.

Objectives

The Master of Science in Construction Management program is intended to prepare students for leadership positions in the construction industry. Specifically, the program seeks to provide a thorough understanding of:

- Basic management principles as applied to the construction industry
- Principles of leadership in the construction industry
- Integration of modern technology in construction
- Innovative management tools for the analysis and control of construction projects
- Principles and methods of planning and

financing construction projects

- Fundamental tools for communication with diverse employee, client-and public groups

Admission

Students seeking admission to the Master of Science in Construction Management program must hold a bachelor's degree in an appropriate field from a reputable undergraduate institution. Students should have a minimum undergraduate grade point average of 2.75, although this requirement can be waived for candidates with sufficient professional experience in the field of construction management. Appropriate undergraduate backgrounds include engineering, mathematics, science, business, management, and the liberal arts. All candidates are expected to have sufficient background in college-level mathematics to allow for successful completion of the program. This requirement will be evaluated by a Construction Management Program Director.

Transfer Credits

The residency requirement for the Master of Science degree is 21 credits. This is the minimum number of graduate credits that students must take at Polytechnic University to be awarded a Master of Science degree.

Students may transfer up to 9 credits of acceptable coursework toward the Master of Science in Construction Management. To be transferred, the course(s) must be relevant to the student's degree program and be taken at an acceptable institution, and the student must earn a grade of "B" or better. No transfer credit is awarded for courses in which a grade less than "B" was earned. Pass/fail courses will not be considered for transfer unless accompanied by a detailed written evaluation by the course instructor.

All transfer credit requests must be accompanied by an official transcript from the transferring institution. Applications for transfer credits are not considered until the candidate has earned a minimum of 12 graduate credits at Polytechnic University.

Validation credits by examination cannot be used toward fulfillment of the requirements of any graduate program.

CURRICULUM

A minimum of 15 credits (5 courses) must be selected from the following courses:

CE 7983	Selected Topics in Construction I
CE 7993	Selected Topics in Construction II
CE 8203	Project Management
CE 8243	Construction Modeling Techniques
CE 8253	Project Management for Construction
CE 8263	Construction Cost Estimating
CE 8273	Contracts and Specifications

CE 8283	Risk Analysis
CE 8293	Construction Operations Analysis
CE 8303	Information Systems in Project Management
CE 8313	Engineering for Construction I: Methods and Technologies
CE 8323	Engineering for Construction II: Design
CE 8333	Marketing for Construction Management and Engineering Services
CE 8343	Construction Site Safety
MG 6013	Organizational Behavior

The following Exec 21 courses may be applied to the above core requirement by a student who is enrolled in or has completed the Exec 21 Program, or by any other student with the consent of a Construction Management Program Director:

CE 8703	Managing and Leading in the 21st Century
CE 8713	Construction and the Law
CE 8723	How to Succeed in Construction
CE 8733	Infrastructure Financing
CE 875X	Employer Focused Residency
CE 8763	Capital Program Management/ Program Development
CE 8773	Dispute Avoidance & Resolution
CE 8783	Construction Management and Planning
CE 8803	Infrastructure Planning for Public Works

Any courses satisfactorily completed by a student who is enrolled in or has completed the Exec 21 or Construction Management Graduate Certificate Program may be applied toward the Master of Science in Construction Management, as follows:

- Courses with a CExxxx designation shall be applied to the above core course requirements;
- Courses with only an MGxxxx designation may be applied to the below minor concentration of study requirement or as a free elective; and
- Any course with a dual (CE/MG) designation shall be considered to be a CE course.

All students are required to complete a minor concentration of study, which shall consist of a minimum of 9 credits (3 courses) selected from courses in any single graduate academic program offered by the University, or any other concentrated area of study approved by a Construction Management Program Director. The selection of the minor concentration of study shall be made with the advisement and consent of a Construction Management Program Director.

A student may complete an up to three (3)-credit independent project in satisfaction of core credit requirements:

CE 993X Project for the Master of Science in Construction Management

The remaining courses needed to fulfill the 30-credit requirement shall be selected from the Civil Engineering or Construction Management Programs (bearing a CExxxx designation), unless otherwise authorized by a Construction Management Program Director. However, if the minor area of study is from the Civil Engineering Program, the remaining courses may be selected from any other electives offered by the University.

Note that some electives involve prerequisites that not all program enrollees may have completed. Students cannot register for a course for which they have not satisfied the stated prerequisites unless they have the written permission of both the course instructor and a Construction Management Program Director.

GRADE REQUIREMENTS

To earn a Master of Science in Construction Management, students must maintain a B (3.0) cumulative average) in all graduate courses taken at Polytechnic University.

REGISTRATION FOR EXEC 21 CORE COURSES

Students not enrolled in the Exec 21 Program must obtain the prior approval of a Construction Management Program Director in order to register for Exec 21 Core Courses.

CAMPUS

Graduate courses may be offered at Polytechnic University's main campus in Brooklyn, its Westchester campus, or at other satellite locations, including 2 Broadway in downtown Manhattan.

APPLICANTS FROM FOREIGN INSTITUTIONS

Applicants to any graduate program in Construction Management from universities outside the United States must achieve a minimum score of 650 on the quantitative section of the Graduate Record Examination (GRE) and a minimum score of 550 (PBT), 213 (CBT), or 80 (IBT) on the Test of English as a Foreign Language (TOEFL). A Construction Management Program Director may waive the GRE and/or TOEFL requirement after examination of an applicant's transcripts or an interview with the candidate.

Foreign candidates who meet all admission requirements, except fail to satisfy the TOEFL requirement, may be required to take one or more remedial courses in English before admission.

GRADUATE MANUAL

The Department of Civil Engineering publishes a Graduate Student Manual. As changes in curricula sometimes occur more frequently than this catalog is printed, students should consult the manual each year to be informed of the most recent changes. Requirements published in the Civil Engineering Graduate Manual supersede all other requirements.

UNDERGRADUATE COURSES

CE 1504 Leadership and Foundations of Construction 4:0:0:4

Course provides a basic understanding of construction science, including basic introduction to fundamental blue-print reading, specifications reading, contract forms, estimating and scheduling, construction mechanics, structural analysis, soil mechanics, rigging and temporary construction.

CE 2504 Construction Modeling and Data Structures 3:3:0:4

This course is an introduction to architectural drafting and computer graphics. It takes advantage of advances in state-of-the-art computer applications in the management of construction. The course familiarizes the student with two-dimensional construction drawings that represent the current standard in the industry, and it propels the student towards the future by teaching the basics of three dimensional computer modeling. This course also introduces the student to the use of the 3-D model with associated databases utilized in the management of construction.

CE 3503 Cost Estimating 3:0:0:3

Classification of work and quantity surveying techniques and basic estimating principles applied to simple construction projects. Also addressed are contracts, specifications and other construction documents; and the identification and allocation of direct and indirect project costs, overhead and profit. Introduction to computer-based estimating techniques and software. *Prerequisite: CE 1504.*

CE 3513 Construction Scheduling 3:3:0:3

Students learn to apply the Critical Path Method (CPM) to construction projects, using precedence diagram networks. Course covers sequencing, cost allocation, updating, cash flow, resource constraints and scheduling, manpower leveling and distribution, time scale networks, lead and lag time constraints, time-cost tradeoffs, overlap and other specific leading edge scheduling techniques. Students direct an entire project from planning through scheduling and control, both manually and through applicable software. *Prerequisite: CE 1504.*

CE 3523 Contracts and Specifications 3:0:0:3

This course will cover the documents used in the design and construction of a building, including design and construction agreements, drawings and specifications, general and special conditions and others used for procurement and construction administration. The course will also examine the relationships among the owner, designers, contractors and suppliers. In addition, students will have the opportunity to consider and discuss issues of quality, safety, and business and professional ethics. *Prerequisite: CE1504.*

CE 3544 Site Planning, Design and Surveying 3:3:0:4

This is a comprehensive course that studies surveying and its practical applications regarding site design and planning. The first portion of the course concentrates on the fundamentals of land surveying, including mathematics, horizontal and vertical control and special survey methods. The second portion of the course familiarizes the students with site planning and design, including concepts of grading, drainage, and utility considerations.

CE 3553 Non-Structural Building Systems 3:0:0:3

Course introduces the students to the mechanical, electrical and vertical transportation systems for buildings. It will examine the fundamental aspects of the design, procurement and construction of heating, ventilating and air conditioning (HVAC), supply and sanitary plumbing, fire detection and suppression, high-and low-voltage electrical, security, elevator and escalator, and building management systems. *Prerequisite: CE 1504 and junior standing.*

CE 4503 Construction Engineering 3:0:0:3

Course covers both traditional engineering fundamentals and developing trends relating to the planning and utilization of excavating and earth-moving equipment, trucks, pumps, drilling and blasting equipment, and cranes. Also considered: will shoring and bracing and other temporary site construction operations. *Prerequisite: CE 1504 and junior standing.*

CE 4513 Construction Project Administration 3:0:0:3

The course examines the roles of the project participants in the execution of a construction project focusing on the delegation of administrative duties and responsibilities, the management and coordination of the physical work, and administrative control of project information and records. Utilization of computer-based project administration techniques and software. *Prerequisite: CE 3523 (or permission of Program Director) and junior standing.*

CE 4523 Structural Building Systems 3:0:0:3

This course introduces the general principles of loads on buildings and the design and analysis of conventional structural building systems in steel, concrete, wood and masonry. It will also address the construction of such systems. *Prerequisite: CE 1504, CE 2114, CE 2124 and CE 2504.*

CE 4533 Construction Law 3:0:0:3

The course is intended to introduce students to the areas of the law that they are most likely to encounter in construction. Following an introduction to the legal system and form of legal analysis, areas to be addressed will include contracts, procurement, scope definition, delays and acceleration, site conditions, warranties, termination, tort claims, dispute resolution and ethics. Also listed as LW 4533. *Prerequisite: junior standing.*

GRADUATE COURSES

CE 7983/CE 7993 Selected Topics in Construction I/II 3:0:0:3

Topics of special interest in current areas of construction management announced in advance of each semester's offering.

CE 8203 Project Management 3:0:0:3

Management of technology-based projects ranging from individual research and development to large-scale and complex technological systems. Feasibility and risk analyses. Project selection and portfolio optimization. Functional and administrative structures, coordination and scheduling of activities, personnel planning, negotiations and contracts, cost estimation, capital budgeting, cost controls, effective matrix management. Also listed as MG 8203.

CE 8243 Construction Modeling Techniques 3:0:0:3

The course deals with various construction modeling techniques, including the development of two-dimensional (2D) and three-dimensional (3D) design documents. Students will also be introduced to the development of building information models (BIM) and their associated databases utilizing state-of-the-art design and management systems.

CE 8253 Project Management for Construction 3:0:0:3

Course deals with topics specific to the development and coordination of large projects, including organizational structures, management functions, pricing and estimating project costs, bidding and contracting, risk allocation, scheduling, time and cost control, labor relations, quality management and project life-cycle activities. Also listed as MG 8253.

CE 8263 Construction Cost Estimating 3:0:0:3

Estimates and costs from the view point of contractor or construction engineers; details of estimating with emphasis on labor, materials, equipment, and overhead costs. Also listed as MG 8263.

CE 8273 Contracts and Specifications 3:0:0:3

Principles of contract law as applied to the construction industry and legal problems in preparing and administering construction contracts. Also listed as MG 8273.

CE 8283 Risk Analysis 3:0:0:3

A thorough investigation of the ever-rising importance of risk analysis in project management. Analysis of qualitative and quantitative risk. Techniques in probability analysis, sensitivity analysis, simulation of risk and utility theory. Computational methods for calculating risk. An exposure to real-world corporate and public problems through case investigations.

CE 8293 Construction Operations Analysis 3:0:0:3

This course will examine the evaluation and model development of productivity, safety, quality, and materials handling in construction operations. Topics will include the principal methods for analysis and pre-planning work activities, including the use of three-dimensional (3D) building information models (BIM), four-dimensional (4D) and fully integrated and automated project processes (FIAPP), logistics animation, monte carlo scheduling, stochastic simulation and queuing theory. Students will also be introduced to the utilization of financial models for task, activity, project and program analyses. *Prerequisite: Construction Management Program Director's approval.*

CE 8303 Information Systems in Project Management 3:0:0:3

The course will examine the use of contemporary tools for managing the vast array of information over the life of a project. Information handling is reviewed from the perspectives of both knowledge acquisition and knowledge presentation. The course focuses on the application of three-dimensional (3D) building information models (BIM) and four-dimensional (4D) and fully integrated and automated project processes (FIAPP) which integrate 3D computer models, simulation, cost estimating, scheduling, procurement, and information technology (with emphasis on the implementation of 3D computer models and relational databases as information systems for project information handling and project automation). *Prerequisite: Construction Management Program Director's approval.*

CE 8313 Engineering for Construction I: Methods and Technologies 3:0:0:3

Planning, design, and equipment for new construction and for infrastructure rehabilitation; engineering fundamentals of earth moving, soil stabilization and compaction; methods for tunneling through rock and

earth, as well as rock blasting, foundation grouting, piles and pile driving equipment; dewatering systems and pumping equipment; factors affecting the selection of construction equipment; review of conventional construction equipment and trends in robotics.

CE 8323 Engineering for Construction II: Design 3:0:0:3

In-depth analysis of design methods for construction operations. Earth pressure analysis and structural analysis. Design for sheet pile walls, cofferdams, underpinning systems, tieback systems and pipejacking systems. Details of a dewatering system design. Special studies in constructability and value engineering. *Prerequisite: CE 8313 or Construction Management Program Director's approval.*

CE 8333 Marketing for Construction Management and Engineering Services 3:0:0:3

This course focuses on the process of procurement of construction management and engineering services. It will incorporate a primarily hands-on approach to current industry practices. The materials will address the following: identifying leads; researching and evaluating competition through various sources; reviewing and critiquing requests for qualifications (RFQ) and requests for proposals (RFP) and responses; developing a marketing resume; developing project profiles; evaluating presentations; and selecting successful candidates. Students will prepare their own proposals and presentations.

CE 8343 Construction Site Safety 3:0:0:3

This course is designed for individuals who are interested in construction safety and the realities of a construction project and for those who are seeking to obtain certification as a Site Safety Manager from the New York City (NYC) Department of Buildings (DOB). You will learn about the comprehensive Subchapter 19 of the New York City Building Code and the City's Rules and Regulations pertaining to construction site safety projects. The course curriculum includes the necessary content approved by the NYC DOB to prepare you for the Site Safety Manager exam.

CE 8703 Managing and Leading in the 21st Century 3:0:0:3

Today's mega projects require the formation of large multidisciplinary teams including engineers, constructors and financial, legal and business experts. Success in this challenging environment requires up-to-date and proven leadership and management skills. This course covers the basic components of management planning, organizing, directing, controlling, and decision-making. It defines the engineering and construction team and discusses leadership styles. This course also addresses the management of change, external factors that shape decisions, the development of a personal leadership profile and, ultimately, 21st century leadership requirements. *Prerequisite: Admission to the Exec 21 Program or permission of a Construction Management Program Director.*

CE 8713 Construction and the Law 3:0:0:3

Construction industry executives need not be legal experts, but they must be aware of the legal issues affecting their industry and their bottom line. This course uses the case study method to lead students through the concepts of design and construction law. The course focuses on the interface of legal, business and technical issues and their resolution. It includes the design and organization of construction documents; the legal aspects of bidding, subcontracting, bonds, insurance, mechanic's liens, etc; and the implication of delays, changes and charged conditions. Alternative dispute resolution (ADR) methods are introduced. *Prerequisite: Admission to the Exec 21 Program or permission of a Construction Management Program Director.*

CE 8723 How to Succeed in Construction 3:0:0:3

Course leads students through the how-to's of running a successful, large, complex construction company. It analyzes how the industry actually works, including contractual relationships with clients in all types of projects from design/build to privatization. It covers the business fundamentals of running a construction company, including issues such as surety and insurance: various types of construction organizations, domestic and international; and company culture - inner-workings of a business that can mean the differences between success and failure. *Prerequisite: Admission to the Exec 21 Program or permission of a Construction Management Program Director.*

CE 8733 Infrastructure Financing: Structuring of a Deal 3:0:0:3

Course examines what it takes to structure a deal from a credit perspective, legally and financially, for both domestic and international projects. In the domestic sector, the course focuses on transportation projects, examining the peculiarities and the uniqueness of the capital market. Examples are studied and recent changes are discussed in areas such as financing transportation projects and the dramatically changing nature of financing these projects. In the international sector, the course covers new and innovative financing techniques. *Prerequisite: Admission to the Exec 21 Program or permission of a Construction Management Program Director.*

CE 875X Employer Focused Residency
Up to 3 credits

The scope of this course is for students to define a proposal for a project, the subject of which may be related to their employment. Students work one-on-one with an adviser throughout the semester. There is no formal classroom work; however, students must provide weekly updates to their advisers. The project will run no longer than one semester. Students present their projects' findings formally to invited guests at the end of the semester. *Prerequisite: Admission to the Exec 21 Program or permission of a Construction Management Program Director.*

CE 8763 Capital Program Management / Program Development 3:0:0:3

The course examines the process of capital program management and development. Depending upon the instructor and project used for illustration, the course will analyze how either the public or private sector looks at a project and develops it, and the internal workings of an organization in determining how a project is selected, funded, and managed. The course will examine various contracting strategies, as well as the concepts of risk allocation, funding and project finance. *Prerequisite: Admission to Exec 21 Program or permission of a Construction Management Program Director.*

CE8773 Dispute Avoidance and Resolution 3:0:0:3

The course analyzes the basic causes for construction disputes and introduces methods for dispute avoidance through proper risk allocation, management, and control, as well as other techniques such as partnering. It uses the case study method to address litigation and provides an understanding of the process of arbitration and other alternative dispute resolution (ADR) methods such as negotiation, mediation, mini trials, and dispute review boards. *Prerequisite: Admission to the Exec 21 Program or permission of a Construction Management Program Director.*

CE 8783 Construction Management and Planning 3:0:0:3

Strategic planning is indispensable to achieving superior management. This course in business planning provides practical advice for organizing the planning system, acquiring and using information, and translating strategic plans into decisive action. This is an invaluable resource for top and middle-level executives. *Prerequisite: Admission to the Exec 21 Program or permission of a Construction Management Program Director.*

CE 8803 Infrastructure Planning for Public Works 3:0:0:3

This course concerns the planning of routine and special infrastructure projects. The focus will be on the prioritization, stewardship, management, and decision-making roles within the engineering division of a large public works agency. Various infrastructure planning concepts and case studies will be reviewed and discussed, including current planning issues in engineering feasibility, sustainability, environmental and social impact assessments, and financial and economic analyses. *Prerequisite: Admission to the Exec 21 Program or permission of a Construction Management Program Director.*

CE 9933 MS Project in Construction Management 3 credits

A capstone, individually-advised project resulting in a substantial report in an appropriate area of construction management.

Typical Course of Study for the Bachelor of Science in Construction Management

FRESHMAN YEAR

Fall Semester

Course No.	Course Title	Hours/Week			
		Class	Lab.	Rec.	Cr.
CM 1004	General Chemistry	3	2	1	4
EN 1014	Writing and Humanities I ³	4	0	0	4
MA 1054	Calculus I with Precalculus ²	6	0	0	4
EG 1004	Intro. to Engineering and Design	1	3	2	4
SL 1010	Freshman Seminar	1	1	0	0
					16

Spring Semester

Course No.	Course Title	Hours/Week			
		Class	Lab.	Rec.	Cr.
PH 1004	Introductory Physics I	4	1.5	1	4
CE 1504	Leadership & Found. of Const.	4	0	0	4
EN 1204	Writing and Humanities II	4	0	0	4
MA1154	Calculus II with Precalculus ²	6	0	0	4
					16

SOPHOMORE YEAR

Fall Semester

CE 2114	Statics & Dynamics	4	0	0	4
HI 2104	Modern World History	4	0	0	4
CE 2504	Const. Modeling & Data Struct. I	3	3	0	4
MG 2204	Financial Accounting	4	0	0	4
					16

Spring Semester

CE 2124	Mechanics of Materials	3.5	1.5	0	4
EC 2504	Basic Economics	4	0	0	4
PL	Philosophy Elective ⁴	4	0	0	4
MA 2054	Applied Data Analysis	4	0	0	4
					16

JUNIOR YEAR

Fall Semester

CE 3503	Cost Estimating	3	0	0	3
CE 3513	Construction Scheduling	2	3	0	3
CE 3544	Site Planning, Design & Surveying	3	3	0	4
CS 3xx2	Computer Concepts & Apps	2	0	0	2
MG/EC II	Level II Mgt/Economics Elective ⁶	4	0	0	4
					16

Spring Semester

CE 3523	Contracts & Specifications	3	0	0	3
CE 3553	Non-Structural Building Systems	3	0	0	3
MG/EC II	Mgt/Economics Elective ⁶	4	0	0	4
HU/SS II	Level II Hum./Soc. Sci. Elective ⁵	4	0	0	4
	Free Elective	4	0	0	4
					18

SENIOR YEAR

Fall Semester

CE 4513	Construction Project Administration	3	0	0	3
CE 4523	Structural Building Systems	3	0	0	3
MG/EC III	Level III Mgt/Economics Elective ⁶	4	0	0	4
	Free Elective	4	0	0	4
					14

Spring Semester

CE 4503	Construction Engineering	3	0	0	3
CE 4533	Construction Law ⁸	3	0	0	3
CE 4543	Construction Management Project	3	0	0	3
CE	Civil Engineering Elective ⁷	3	0	0	3
HU/SS III	Level III Hum./Soc. Sci. Elective ⁵	4	0	0	4
					16

Total credits required for the degree:

128

- Not used;
- The department recommends that all students take MA1054 Calculus I with Precalculus, which contains an additional two hours per week of pre-calculus review. It believes that this review is valuable, even for good math students. Students may take a placement examination to place out of this course in favor of MA 1024 Calculus I, or may be advance-placed based upon AP or college math credit earned in high school. The department also recommends that students take MA 1154 Calculus II with Precalculus as the MA Elective.
- All students take a writing placement examination. Students with an ESL background may be placed in EN 1034, which includes additional hours of language education. Students may also be placed in a remedial section based upon the exam results, which does not carry degree credit.
- PL electives include: PL 2054, PL 2064, PL 2084, PL 3054, or other approved courses containing at least 1 credit of ethics.

- Approved HU/SS electives are courses with the following prefixes: AH (Art History), AN (Anthropology), EC (Economics), EN (English Literature), HI (History), MU (Music), PL (Philosophy), or PS (Psychology). A level II course has a 2xxx number, while a level III course has a 3xxx number. Level III electives generally have a prerequisite of a related level II elective. Students who take up to two courses with an EC prefix in fulfillment of the MG/EC requirement may substitute a course with a CE (civil engineering) prefix and not more than one course with a TC (technical communications) prefix.
- Approved MG electives include MG 2004, MG2014, MG 2104, MG 2304, MG 3204, and MG 3404. Approved EC electives include EC 2514, EC 2524, EC2534, EC 3254 and EC 3264. FIN and FRE courses approved by a Construction Management Program Director will also satisfy the MG/EC elective requirement. A level II course has a 2xxx number, while a level III course has a 3xxx number. Level III electives generally have a prerequisite of a related level II elective.
- CE elective is any course with a CE prefix for which the student has appropriate prerequisites.
- Also listed as LW 4533 Construction Law.



ELECTRICAL ENGINEERING PROGRAM

Undergraduate Program Director
Ivan Selesnick
Graduate Program Director
Yao Wang

The Department of Electrical and Computer Engineering offers an Electrical Engineering Program for the degrees Bachelor of Science, Master of Science, and Doctor of Philosophy.

ELECTRICAL ENGINEERING PROFESSION

Electrical engineering is a rapidly growing profession that has evolved from its early beginnings in electric power generation and distribution through the development of radio, television, control, materials, computers, telecommunications and health care. Because of the advances electrical engineers have brought about in power distribution, computers and communications, the world is a far different place than it was 100 years ago. Their inventions have made the world a smaller, safer place, and allow for immediate reporting and images from distant places, making world events part of daily life.

While undergraduate and graduate students in electrical engineering concentrate on areas of electrical science, graduates eventually apply their training to such diversified fields as electronic design, bioengineering, city planning, astronautics, radio astronomy, system engineering, image processing, telemetry, the Internet, computer design, management and patent law. As students mature and realize their abilities, their professional lives may center on engineering, government, sales or education.

The electrical engineering faculty at Polytechnic covers a wide range of fields. Principal areas of teaching and research are microelectronic devices and systems; computer engineering and computer science; telecommunications; speech and image processing; electro-optics and electroacoustics; microwave engineering; wireless personal communications; power systems and energy conversion; plasma science and engineering; and systems and control engineering.

Additional information about electrical engineering careers can be found online at www.ieee.org/organizations/eab/studentcareers.htm.

UNDERGRADUATE PROGRAM

The BS program in Electrical Engineering gives student a broad-based background in electrical engineering, preparing them for immediate employment in industry or government or for graduate study.

GOALS AND OBJECTIVES

The Bachelor of Science program in Electrical Engineering achieves the following objectives for students:

- Instills in them a broad-based understanding of the fundamental technical subject areas associated with electrical engineering
- Requires them to achieve technical depth in at least one area of specialization and allows them to take electives in other areas
- Develops their problem-solving skills with modeling, analysis, design, and computer simulation as tools
- Provides them with a broad educational component that complements the technical content of the electrical engineering discipline, including multidisciplinary experience, humanistic and societal issues, with particular emphasis on the development of effective oral and written communication skills

The BS program includes analysis and design courses in the major areas of electrical engineering that build on fundamental courses in mathematics and science. Many of the Electrical engineering courses include hands-on laboratory components. A variety of electives are available to undergraduates to provide depth and specialization, many in commercially viable areas such as local area networks, wireless communication, and deregulated power systems.

Since most current engineering design is computer facilitated, the department includes computer-aided design (CAD) programs in many undergraduate courses to emphasize possibilities for large-scale design, corrections for unmodeled complexities, trade-offs among performance criteria and real-time simulations. The senior design project challenges each student to integrate analytical and design concepts from earlier courses to design a device or system to meet specified performance requirements.

The program recognizes that communication and interpersonal skills are essential to a successful career in any profession. Students in the program are required to take courses in history, writing, and literature, as

well as elective courses in the areas of humanities and social sciences. Those skills are also developed in team projects in design courses.

Students are taught by faculty familiar with current issues through sponsored research programs, such as those coordinated by Polytechnic's Center for Advanced Technology in Telecommunications (CATT), a World Wide Web lab and many research grants awarded to individuals or groups of professors.

The Electrical Engineering Program keeps abreast of market changes through the CATT Industrial Affiliates Program, hiring of professors and part-time adjunct teachers having industrial experience, frequent contacts with alumni, review of professional journals and encouraging faculty to work in industry part-time or while on sabbatical. Where possible, classroom work challenges students to apply their knowledge to current design situations. Students are also able to apply broad technical knowledge to practical problems through interdepartmental cooperation. Industry's need for the system approach in engineering is also reflected in the curriculum by senior projects in areas such as control and robotics, advanced hardware design, imaging, wireless communications, power electronics and areas mentioned above. The economic aspects of engineering are addressed by allowing undergraduates to choose electives, such as macro/micro economics, psychology, ethics and management process. Cost evaluation is required in the design projects for EG 1004 Introduction to Engineering Design. Senior projects emphasize time management and planning.

Exceptional undergraduate students are given the opportunity for advanced study in two programs: (1) the BS/MS Honors Program, which requires students to work on a research project equivalent to complete the MS option of the MS degree, and (2) the summer junior research internship program, which allows undergraduates to work on research projects with graduate students and their advisers. Up-to-date information about program requirements, course offerings, senior project topics and research projects is available online from the Department of Electrical and Computer Engineering at www.poly.edu/ece

UNDERGRADUATE DEGREE REQUIREMENTS

The undergraduate program in electrical engineering gives students broad-based preparation for a career in electrical engineering in any of its specializations and readies them for immediate employment in industry, business and government, or for further graduate education. The program is accredited by the Accreditation Board for Engineering and Technology (ABET).

The table at the end of this section outlining the Typical Course of Study for a BS shows a typical semester-by-semester program for students who enter as freshmen in fall 2005 or later. The notes identified by superscript numbers are an essential part of the table. Students are responsible for making themselves aware of changes that might be made in this program after the publication of this catalog. Those changes are posted outside the department advising offices and on the department's Web page. (Students who started their studies before fall 2005 should consult the previous edition of this catalog or the department's Web page for program and course requirements applicable to them.)

SENIOR DESIGN PROJECT

The two-semester senior Design Project allows each student to focus on one aspect of electrical engineering. In the first semester, students develop skills using specialized laboratory equipment and computer design packages, are introduced to techniques for planning projects and making effective presentations, and they learn to balance design requirements such as performance, safety, reliability, and cost effectiveness.

In the final semester, students design, build or simulate and test a device or system to meet prescribed engineering specifications.

Informal and formal written and public oral presentations help prepare students for professional careers. Design project students frequently work in groups or pairs to develop interaction skills essential to good engineering.

GRADUATION REQUIREMENTS

The University requires a 2.0 GPA in all courses taken and specifies other general requirements in the section "University Degree Requirements," which describes the core curriculum for all engineering majors, including placement procedures in writing, mathematics, and programming, course credits by transfer and advanced placement, and credit by examination.

To graduate, students must (1) have a C-grade or better in CS 1114, CS 2204, EE 2013, EE 2024 and EE 3054 and (2) have a technical GPA of 2.0 based on all courses

prefixed EE, CS or EL. Seniors may elect graduate courses labeled EL 5XX3, but not CS 5XX3. To enroll in other graduate courses, seniors must have a 2.7 GPA or better in related courses and adviser approval.

Students are expected to meet the degree requirements in effect at the time when they first enrolled in a Polytechnic program. Those requirements apply as long as the student remains in good standing and less than eight years have elapsed since entering the program. The period for unchanged requirements is proportionately less for a transfer student. (Students who started their studies before fall 2005 should consult the department's Web page for program and course requirement applicable to them.)

GOOD STANDING, PROBATION AND DISQUALIFICATION

Students who fail to meet University GPA requirements or other conditions of adequate progress toward completing a degree are put on probation. (See the "General University Requirements" section in this catalog for more details.) Students on final probation may not register for courses in one semester until grades are available from their previous semester's courses, and they are limited to a reduced number of credits per semester. Students who improve their academic performance are removed from probation and returned to good standing. Continued poor academic performance can lead to final probation and, eventually, disqualification from the University.

To remain in good standing in the Undergraduate Electrical Engineering Program, students must:

- (1) maintain, term-by-term and cumulatively, a technical GPA (based on EE, EL and CS courses) and a University GPA of 2.0 or better;
- (2) earn a C- or better in each of the four courses specified above;
- (3) fulfill all course pre-/co-requisites; and
- (4) remove any incomplete I grades within 30 days of the last day of final exams. Occasionally an adviser may permit a third enrollment in a course for which a C-grade is required. In such cases, the student must earn a grade of a C or better in that course.

Students facing difficulties, whether educational or personal, should consult their instructor or a departmental adviser at the earliest possible time.

Students who do not meet program conditions are placed on departmental probation. Probation conditions may require students to:

- (1) repeat courses, including courses where they received transfer credit and courses

where they received a C grade or less at Polytechnic;

- (2) specify their credit load and permissible withdrawals; or
- (3) take other remedial programs.

Students who do not meet departmental probation requirements, fail twice to earn the required grade in any one course or do not conform to the University Student Code of Practice are subject to being disqualified from working toward a bachelor's in electrical engineering or taking any further electrical engineering courses. Actions taken depend on individual cases. Students who are disqualified may appeal in writing. Students may also apply for readmission after two terms (fall, spring or summer) have passed if they show evidence of an improved chance of success.

DUAL UNDERGRADUATE MAJORS

With departmental permission, students may earn a single bachelor's degree in electrical and computer engineering. This degree requires a total 142 credits rather than the usual 128 required for individual bachelor's degrees.

TRANSFER STUDENTS

Transfer credits for courses taken at other schools are based on evaluation of content and level. Students completing the same program at another school, but in different years, may receive different amounts of transfer credits. They should consult an electrical engineering undergraduate adviser for current information.

Transfer students must arrive and present their records for evaluation at least one week before the regular registration period of their first semester at Polytechnic. Transfer credits are awarded only for courses completed with C grades or better.

Qualified students from two-year preengineering programs, such as those at liberal arts and community colleges, may fulfill the requirements for the BS in Electrical Engineering in two additional years. Since pre-engineering programs vary, a prescribed program is not possible; consequently, students should consult with a Polytechnic undergraduate adviser at the beginning of their pre-engineering program.

Graduates of technology programs may be able to fulfill the requirements for the BS in Electrical Engineering in two to three and a half years, depending on the scope and level of their previous education. Consult with an undergraduate adviser for details.

SENIOR THESIS

Undergraduate EE and CompE students wishing to do a Senior Thesis (BS thesis) instead of Design Project (DP) must:

1. Complete 6 total credits of Senior Thesis (EE 397).
2. Need not register for DP-1 or DP-2.
3. Must complete the “ECE Professional Development” component of DP-1 (the project management component will contribute to the EE 397 grade, as is case for DP-1).
4. Make a presentation to their thesis advisor that is open for other students and faculty to attend.
5. The thesis must be bound following the university guidelines for MS and PhD theses.

Before registering for Senior Thesis, the student must find a faculty member agreeing to serve as thesis advisor. In addition, students must have a 3.0 GPA in order register for Senior Thesis instead of Design Project.

Additional notes:

1. The Senior Thesis must be design oriented.
2. The 6 credits of DP-1 and DP-2 are replaced by 6 credits of Senior Thesis (EE 397).
3. It is advised that the 6 credits of Senior Thesis not all be taken during a single semester.
4. Students in the Honors College are required to complete a Senior Thesis for graduation, with the following exception: Honors College students who complete an MS thesis as part of the BS/MS program need not do a Senior Thesis.

MINOR IN EE

Students may obtain a minor in electrical engineering by taking 15 credits of EE prefixed courses. The courses may be any EE courses subject only to the prerequisite requirements. A grade of C- or better is required in EE 2013 and a GPA of 2.0 or better in the entire minor is required.

A minimum of 8 credits in the minor must be taken at Poly. The EE minor is not open to CompE students.

THE BS/MS ACCELERATED HONORS OPTION

The BS/MS Accelerated Honors Option leads to the simultaneous awarding of a bachelor's and master's degree. Depending on the student's preparation and objective, the two degrees may be completed in as few as four years of study. Each program is individually designed in cooperation with the departmental BS/MS Accelerated Honors Option adviser to allow varied transfer and AP credits, coop program participation, professional summer jobs and other goals consistent with the Honors Option.

Possible BS/MS combinations include

BS in Electrical Engineering with a MS in Electrical Engineering, Telecommunications Networks or Computer Engineering. (See also the Computer Engineering Program section in this catalog.)

Incoming freshmen with superior admissions qualifications are invited to participate in the Accelerated Honors Program. Later admission may be considered after the student completes no more than one year at Polytechnic.

Students must complete 16 to 20 credits each semester, maintain a 3.5 GPA overall and technical average, particularly in key courses, and display a record free of course repetitions and withdrawals.

The required courses for the two degrees include all courses required for the individual BS and MS degrees, except for the senior Design Project II, and all curriculum footnotes apply. Required credits are the sum of the credits for the two degrees minus the 3 credits of senior Design Project II. Students in this program must complete a Master's Thesis for 6 credits (generally optional for other MS students).

Acceleration may be achieved through summer course work, extra course loads, careful course sequencing or credit by examination. Students may also achieve acceleration through advanced placement credit in such courses as calculus, computer science or physics.

SENIOR HONORS STUDENTS

Each spring, the Department of Electrical and Computer Engineering selects senior honors students with high GPAs who will complete their degree requirements in the following academic year. Such students are listed as honor students in that year's commencement program and are given special permission to make substitutions in their selection of senior courses. Most often this takes the form of substituting more advanced graduate courses in place of usual requirements in the same area of study. Transfer students are eligible for this designation after they complete half of the credits needed to satisfy degree requirements at Polytechnic (e.g., 64 of 128 total credits).

GUIDANCE FOR UNDERGRADUATE STUDENTS

Instructors provide help for students in their courses during hours posted on their doors or by appointment. Students taking project or thesis courses work closely with faculty project advisers. Electrical engineering advisers in the undergraduate ECE office are glad to advise on courses and program adjustments resulting from academic needs or personal problems.

The Office of Special Services sponsors a

peer tutoring program. The Learning Center provides drop-in tutoring in mathematics and physics. Personalized career counseling is available.

SL 1010 Freshman Seminar introduces students to Polytechnic and its curricula. Fellow students are an excellent source of advice on adjusting to the University environment and the demands of an engineering program. In addition to meeting students in class, students are urged to meet students who can provide experienced advice by joining clubs such as the student branch of the Institute for Electrical and Electronics Engineers (IEEE) professional society, or religious or ethnic clubs.

Students are advised to meet with other students to study and to do homework. In this way they benefit both from explanations provided by others and by the deeper understanding they get when they explain a concept or technique to someone else.

INFORMATION

Undergraduate advising information is available on the Department of Electrical and Computer Engineering's Web page, www.poly.edu/ece. Students should consult that page for further details on honors, probation, approved electives, projects, elective concentrations, course offerings, senior project topics and other matters of interest. Curriculum and prerequisite changes, new courses, special sections and other last minute announcements are also posted on the bulletin boards outside both the undergraduate and graduate Office of Electrical and Computer Engineering Advising. All students are responsible for keeping informed about the latest procedures and regulations.

Descriptions of undergraduate courses in electrical engineering are found after the description of the graduate programs in EE.

GRADUATE PROGRAMS

The Department of Electrical and Computer Engineering offers a Graduate Electrical Engineering Program leading to graduate certificates and degrees Master of Science, Master of Engineering and Doctor of Philosophy degrees

The requirements for graduate degrees in electrical engineering are quite general. Each student may follow a program in any one of a variety of fields, including those described in the following paragraphs. For up-to-date information, students should refer to the Department of Electrical and Computer Engineering Graduate Student Manual, which is revised annually and is available from the department's graduate office and online at www.poly.edu/ece/graduate/menu.php.

Outstanding students should apply for fi-

financial aid in the form of research fellowships, teaching fellowships or partial tuition remission.

GOALS AND OBJECTIVES

The Master of Science program in Electrical Engineering prepares graduates for a professional career as a practicing engineer in industry, business or government at an advanced level or to pursue the PhD degree in electrical engineering. The three core courses, two one-year sequences and electives provide students with the opportunity to achieve both breadth and depth across a number of subdisciplines within electrical engineering.

The Doctor of Philosophy program in Electrical Engineering prepares graduates for a research career in electrical engineering and/or teaching at the university level. The program provides students with a strong fundamental knowledge in several disciplines of electrical engineering, skills required to perform independent research activities in one of the sub disciplines and the ability to prepare and defend a dissertation representing an original and significant contribution for publication in a recognized scientific or engineering journal.

CONCENTRATIONS

Wireless Communications

Wireless communication has experienced explosive growth since the introduction of cellular telephones. Personal Communication Services (PCS) and other services such as wireless PBXs, wireless LANs, wireless local loops, Bluetooth, and HomeRF have also become popular. Major paradigm shifts from exclusive reliance on wired networks to an era of tetherless communications and from a fixed computing environment to a mobile computing environment is underway in the world of communications. The merging of Internet and mobile communications is igniting unprecedented growth and a revolution in information technologies.

Computer Engineering

Computer Engineering deals with various systems, devices and chips for computing, control, security, and communication purposes. Computer engineers are involved in designing supercomputers, ubiquitous personal and portable computers, communication equipments, security hardware, networking units, intelligent control modules, and various embedded hardware-software devices.

Telecommunications and Networking

Telecommunications and networking manages various communications systems such as telephone, television, radio transmission,

radar, space communications and networks, including data networks, local area networks and the Internet. The range of the program's interests include the design of components, such as switches and routers, the design of systems and networks, performance, analysis, modeling, and protocols.

Image and Video Processing

This area deals with compression of image and video signals for efficient storage and transmission, contrast enhancement, deblurring, denoising, feature extraction, etc. Applications include digital television, video streaming, medical imaging and teleradiology; multimedia databases, and object recognition and tracking for surveillance.

Signal Processing

Signal processing handles the generic problem of extracting the useful/desired information (signal) from the received data in the presence of uncertainties such as noise and other distortions. The techniques are applicable to any information processing situation and involve analysis and design of signals, channels, and receiving systems as well as task-oriented signal processing algorithms.

Systems and Control

System engineers are concerned with modeling and predicting the behavior of large systems from knowledge of the component parts. Examples include air traffic control systems, health-care delivery systems, and systems to monitor and control pollution of the environment. Control engineers are concerned with all aspects of automatic regulation of system performance. Together with the system engineer, they are trained in the fields of automation and system theory. Typical examples of control systems are automatic guidance systems for aircraft and space vehicles, electric motor control, and chemical process control.

Electronics and VLSI

The discipline involves the design and implementation of circuits used in microcomputers, telecommunications, signal processing, and control systems. Such circuits are being designed at Polytechnic using state-of-the-art computer facilities and design tools, and the circuits are being fabricated with modern technologies such as CMOS, bipolar, and GaAs. This discipline also involves the emerging area of nanoscale electronics, circuits and architectures and associated design tools.

Fields and Waves

Studies in fields and waves include electromagnetic and acoustic wave radiation and propagation under a variety of conditions,

including non-linear, anisotropic, and periodic media. Such studies include microwave waveguides and antennas, optical fibers and integrated optics diffraction and scattering effects. Applications include radar, microwave and optical communications and wireless technology.

Plasma and Atmospheric Physics

This area is involved with the breakdown and ionization of gases and the interaction of the resultant plasma with electromagnetic waves. Such studies have application to the propagation of high-power radio waves in the atmosphere and the ionosphere.

Power Systems and Energy Conversion

Studies in power and energy include not only the traditionally important generation, conversion, and distribution of electrical power, but also such modern topics as power electronics, ion plasmas for the generation of electrical energy, and the realization of electromagnetic propulsion.

REQUIREMENTS FOR THE MASTER OF SCIENCE

Entrance Requirement:

Admission to the Master of Science in Electrical Engineering Program requires a bachelor's in electrical engineering from an accredited institution, with a superior undergraduate academic record. Students not meeting all these requirements will be considered for admission on an individual basis and may be admitted subject to the completion of appropriate undergraduate courses to remove deficiencies in preparation.

Applicants who lack a BS in Electrical Engineering but are otherwise sufficiently prepared for admission without undergraduate deficiencies may be required to take specified undergraduate and introductory level graduate electrical engineering courses. Only graduate courses count toward the master's degree.

A student with a BS in a field other than electrical engineering may also want to consider the departmental master's programs in computer engineering, electrophysics, system engineering, telecommunication networks, or the Master of Engineering in Interdisciplinary Studies in Engineering program, described elsewhere in this catalog, or the several Graduate Certificate programs described here.

DEGREE REQUIREMENT:

To obtain the MS in Electrical Engineering degree, students must complete a total of 30 credits of courses, as described below.

GROUP 1: Core Courses

Three courses (3 credits each) from the following:
EL 5373 Internet Architecture and Protocols
EL 5473 Introduction to VLSI System Design

EL 5613 Introduction to Electric Power Systems	
EL 6113 Signals, Systems and Transforms	
EL 6253 Linear Systems	
EL 6303 Probability theory	
EL 6413 Analog and High Frequency Amplifier Design	
EL 6713 Electromagnetic Theory and Applications	
Total in Group 1	9 Credits

The core courses cover fundamental material and should be taken as early as possible. An advanced course subsequent to a core course may be taken in lieu of the core course, upon approval by an ECE graduate adviser.

GROUP 2: Two sequences each containing two courses, one course in each sequence may be a core course in Group 1. Both sequences must be in EL or CS courses and at least one must be an EL sequence. Approved course sequences are provided in the ECE Graduate Student Manual.
Total in Group 2 6-12 Credits

GROUP 3: Approved electives, which may include up to 6 credits of graduate courses offered by any science, engineering or management department.
Minimum Total 30 Credits

Out-of-department Courses: At least 24 credits must be in EL prefixed courses. A 3-credit course in other science or engineering disciplines may be used to substitute an EL course upon approval by an ECE graduate adviser. Remaining credits can be from any graduate courses in science, engineering or management.

Thesis, Project, and Reading: A master's thesis (EL 997X, minimal 6 credits) or an MS project (EL 9953 or EL 9963, 3 credits each) or a reading course (EL 9933 or EL 9943, 3 credits each) may be included as part of the elective courses in group 3. Oral defense of the master's thesis with at least three professors in attendance is required. The total credits for thesis, projects, and readings should not exceed 9 credits within the 30 credits required for the MS degree. At most 3 credits can be taken for reading.

GPA Requirements: An overall GPA of 3.0 in all graduate courses taken at Polytechnic is required. In addition, a 3.0 average is required in the combination of the five to seven courses offered to satisfy groups 1 and 2.

Transfer Credits: The 9 credits of transfer credits allowed in accordance with Polytechnic regulations can be applied only toward the electives. Transfer credits may not be used to satisfy the core or sequence course requirements.

Repetition of Courses: A student may register no more than three times for the same course, including registration for which a W

was earned. A course will not be allowed for degree credit if it was taken in violation of this rule. Students should consult the Department of Electrical and Computer Engineering Graduate Student Manual for detailed rules and procedures, including student status, recommended course sequences, recommended electives, current areas of research, repetition of courses, and disqualification for low grades. The manual also contains announcements of changes in degree requirements, if any, adopted by the faculty after the publication of this catalog.

REQUIREMENTS FOR THE DOCTOR OF PHILOSOPHY

General: Graduate students who have exhibited a high degree of scholastic proficiency and have given evidence of ability for conducting independent research may consider extending their goals towards the doctorate. The PhD is awarded to students who complete the program of studies and research (described below) and prepare and defend a dissertation representing an original and significant contribution for publication in a recognized scientific or engineering journal. For a more complete description of the topics summarized here, please refer to the department's Graduate Student Manual.

Admission to Programs: Entrance into the doctoral program of study and research is contingent on candidates passing the departmental qualifying examination and forming a guidance committee (both described below). Students entering the doctoral program at the baccalaureate level must meet the entrance requirement listed above for the master's program. Students entering at the master's level for the PhD in Electrical Engineering are normally expected to have a master's in electrical engineering. Students holding a master's degree from Polytechnic in computer engineering, systems engineering, electrophysics or telecommunications networks can also enter the program. Applicants with BS or MS in other disciplines may be admitted depending on his/her academic background and record.

Qualifying Examinations: The PhD qualifying examinations are offered once each year. These examinations are divided into two sections: (1) a written examination requiring preparation through the first year graduate level in several areas related to the student's principal area of interest and (2) an oral examination concentrating mainly on this principal area. Principal areas of concentration are communications, signal processing, systems and control, electro-optics, electromagnetics, networks, computer

and network architecture, and power electronics and systems.

Details regarding allowed subject areas, recommended background courses, sample examination questions, and the precise format for the coming year are available in the department's Graduate Office.

Guidance Committee: Upon passing the qualifying examination, Ph.D students must find a faculty member in their area of major interest who is willing to serve as the dissertation adviser. Students work with their dissertation advisers to find an adviser for a minor area outside of electrical engineering and a guidance committee of at least three faculty members, with the dissertation adviser usually acting as chairman. At least one other guidance committee member must be in the student's area of major research interest; this member may be from outside of Polytechnic.

The minor adviser may be a member of the guidance committee. Students must submit the names of these guidance committee members to the Office of Graduate Programs for approval. The dissertation adviser approves the program of study in the student's major, and the minor adviser approves the program of courses in the minor.

When the requirements for minor or major are completed, students should have the appropriate adviser certify this in writing to the Office of Graduate Affairs, with copies to the Department of Electrical and Computer Engineering's Graduate Office.

The guidance committee conducts the area examination and dissertation defense and approves the final dissertation.

Course and Thesis Requirements: A minimum of 75 credits of academic work beyond the bachelor's degree, including a minimum of 21 credits of dissertation research at Polytechnic, is required. A minimum of 42 credits in formal courses (as distinct from independent study credits such as reading, project, or thesis) are required. A student entering with a MS from a reputable graduate program may transfer 30 credits. PhD students are required to take a minimum of 9 credits of courses in a minor area outside of electrical engineering. The minor must be taken in an area that is both distinct from and yet consonant with the student's major area of study. Approval of the minor program is described in the preceding paragraph. Students work with their thesis adviser to develop their major program of study. The major program should constitute a coherent, in-depth study of the most advanced knowledge in the student's area of concentration.

Average GPA among all courses must be 3.5 or above.

Seminar Attendance: PhD students are required to register for a 0-credit Research Seminars course for at least 4 semesters. Satisfactory grade is given only if the student attends more than 2/3 of the seminars offered in a semester.

Area Examination: The area examination consists of a presentation or review of the general background in the problem area of the student's dissertation. The purpose of the examination is to demonstrate that the student understands the fundamental prior research in the field of the thesis work. The examination should be taken early in the PhD program. The examination may be in the form of an open seminar attended by other interested faculty and students. The guidance committee evaluates the student's performance and determines whether the depth of knowledge and understanding necessary to carry out research in the chosen area has been demonstrated.

Submission of the Dissertation and Final Examination: After completing the doctoral dissertation, candidates undergo oral defense of the thesis. The examination is conducted by the guidance committee, but is open to all members of the faculty and to such other persons as may be invited. Copies of the dissertation should be made available to prospective examiners at a reasonable time in advance. Students are advised to consult the Office of Graduate Programs regarding how to submit, reproduce and bind the final manuscript.

Publication Requirement: To be granted the PhD degree, a PhD candidate must have at least one submitted journal paper on the thesis research subject.

GRADUATE CERTIFICATES (12 CREDITS)

The Department of Electrical and Computer Engineering offers the following Graduate Certificates, each requiring four courses (12 credits). A GPA of 3.0 or higher is required in the four courses to receive the certificate.

- * Computer Engineering
- * Image Processing
- * Telecommunication Network Management
- * Wireless Communications

GRADUATE CERTIFICATE IN COMPUTER ENGINEERING

Computer engineering is a rapidly growing profession and computer engineers are in the midst of exciting times with unlimited opportunities in all walks of life. For instance,

computer engineers interact with and design large supercomputers as well as the ubiquitous personal and portable computers. Furthermore, computer engineers play a key role in networking computers with other computers and intelligent devices. Computer engineers are also involved in such varied projects as designing specialized computer hardware to reconstruct the human genome; monitoring and controlling industrial plants and the environment; computer graphics and robotics; and designing biomedical devices and computer networks. Finally, computer engineers design and develop hardware and embedded hardware-software systems. The graduate certificate in computer engineering is designed for working professionals who seek to acquire an in-depth understanding of the field. The program consists of three required courses and one elective course.

Required Courses: (choose 3)

Course	Title	Credits
EL 5493	Advanced Hardware Design (VHDL)	3
EL 5363	Principles of Communication Networks	3
EL 5473	Introduction to VLSI Systems Design	3
CS 6133	Computer Architecture I	3

Recommended Elective Courses (choose 1):

Course	Title	Credits
EL 5483	Real-Time Embedded Systems	3
EL 6493	Digital VLSI System Testing	3
EL 6443	VLSI System Architectures	3
EL 6453	VHDL-Based Behavioral Synthesis	3
EL 6413	Analog & High Frequency Amplifier Design	3
EL 6433	Digital Integrated Circuit Design	3
CS 6143	Computer Architecture II	3
CS 6183	Fault-Tolerant Computers	3
Unchosen one from Group 1		3

Certificate Coordinator: For additional information regarding the Computer Engineering Certificate, contact Professor Ramesh Karri at 718-260-3596 or send e-mail to rkarri@poly.edu.

GRADUATE CERTIFICATE IN IMAGE PROCESSING

Image processing covers some of the fundamental technology behind applications such as digital television; medical imaging and telerradiology; and multimedia database and communications. All make use of digital image enhancement, filtering, analysis and compression techniques. This certificate is designed for working professionals who seek to acquire an in-depth understanding of image processing and communication technology. The program consists of three required courses and one elective course.

Required Courses:

Course	Title	Credits
EL 5123	Image Processing	3
EL 6123	Video Processing	3
CS 6643	Computer Vision & Scene Analysis	3

Recommended Elective Courses (choose 1):

EL 5823	Medical Imaging I	3
EL 6183	Digital Signal Processing Lab	3
EL 6113	Signals, Systems & Transforms	3
EL 6303	Probability Theory	3
EL 6313	Applied Stochastic Processes	3
EL 7133	Digital Signal Processing I	3
EL 7163	Multiresolution Signal Decomposition	3
EL 9953	Advanced Project I	3

Certificate Coordinator: For further information regarding the Image Processing Certificate, contact Professor Yao Wang at 718-260-3469 or yao@poly.edu.

GRADUATE CERTIFICATE IN TELECOMMUNICATION NETWORK MANAGEMENT

The explosive growth of data networks has brought with it the need for effective network management. The widespread deployment of standards-based solutions (e.g., SNMP) is but a first step in dealing with the complexity of network management. A thorough knowledge of network protocols and network management standards is necessary for any practitioner in this area. The program consists of four required courses. This Certificate can be finished completely online.

Course	Title	Credits
EL 5363	Principles of Communication Networks	3
EL 5373	Internet Architecture and Protocols	3
or		
CS 6843	Network Protocols I	3
EL 6373	Local and Metropolitan Area Networks	3
CS 6813	Information, Privacy and Security	3
or		
CS 6823	Network Management and Security	3

Certificate Coordinator: For further information regarding the Telecommunication Network Management Certificate, contact Professor Yong Liu at 718-260-3959 or yongliu@poly.edu.

GRADUATE CERTIFICATE IN WIRELESS COMMUNICATIONS

Wireless communication has experienced remarkable growth since the introduction of cellular telephones. With the licensing by the FCC of spectrum for Personal Communication Services (PCS) and other services such as wireless LANs, wireless Internet, and wireless Personal Area Networks the rate of growth is expected to increase even further. In order to give those with an electrical engineering background the specific knowledge needed to work in this expanding market, Polytechnic has structured a series of four graduate level courses that cover the knowledge needed to compete successfully in this industry. The program consists of one required course and three recommended elective courses. This certificate can be finished completely online.

Required Course:

Course	Title	Credits
EL 6303	Probability Theory	3

Recommended Elective Courses (choose 3):

EL 5013	Wireless Personal Communication Systems	3
EL 5023	Wireless Information Systems Lab I	3
EL 5033	Wireless Information Systems Lab II	3
EL 6013	Principles of Digital Communications: Modulation & Coding	3
EL 6023	Wireless Communications: Channel modeling and receiver design	3
EL 6033	Modern Wireless Communication Techniques and Systems	3
EL 6063	Information Theory	3
EL 6073	Error Control Coding	3
EL 6753	UHF Propagation for Wireless Systems	3
EL 7023	Space-Time Wireless Communications	3
EL 90X3	Selected Topics Courses in Wireless	3

Certificate Coordinator: For further information regarding the Wireless Communications Certificate, contact Professor Frank Cassara at 631-755-4360 or cassara@rama.poly.edu.

UNDERGRADUATE COURSES

Students should consult departmental adviser postings, handouts and the department's web page for changes in required courses, course contents, and prerequisites in effect after the publication of this catalog.

General prerequisites: students may not register for any junior- or senior-level courses until all freshman and most sophomore requirements are completed. Knowledge of computer programming at the level of CS 1114 and of computational mathematics packages used in calculus courses are assumed in all EE courses.

Note: Elective courses whose identifiers have three numerical digits (e.g., EE 107) are listed after the courses having identifiers with four numerical digits. Courses with identifiers of the form EL XYZ that are available as senior electives are located in the list of graduate EE courses.

EE 2013 Fundamentals of Electric Circuits I 3:0:1:3

Passive DC circuit elements. Kirchoff's laws. Electric power calculations. Analysis of DC circuits, Nodal and Loop analysis techniques. Voltage and current division, Thevenin's and Norton's theorems. Source free and forced responses of RL, RC and RLC circuits. Minimum of C- required to take other EE courses. *Corequisites: MA 2012, MA 2132 and PH 2004. ABET competencies a, b, c, e, g, k.*

EE 2024 Fundamentals of Electric Circuits II 3:1:1:4

Continuation of EE2013. Sinusoidal steady-state response. Complex voltage and current and the phasor concept. Impedance, admittance. Average, apparent, and reactive Power. Polyphase circuits. Node and mesh analysis for AC circuits. Use of Matlab for solving circuit equations. Frequency response; parallel and series resonance. Operational Amplifier circuits. Alternate-week laboratory. Minimum of C- required to take other EE courses. *Prerequisites: EE2013 with C or better grade. ABET competencies a, b, c, e, g, k.*

EE 3054 Signals and Systems 3½:1½:1:4

Linear system theory for analog and digital systems. Linearity, causality, time invariance. Impulse response, convolution, stability. The Laplace and z- transforms and applications to Linear Time Invariant (LTI) systems. Frequency response, analog and digital filter design. Fourier Series, Fourier Transforms, the sampling theorem. There are weekly computer laboratory projects using analysis and design computer packages. Objectives: establish foundations of linear systems theory needed in future courses; use of math packages to solve problems and simulate systems; analog and digital filter design. *Prerequisites: EE 2024 (C- or better), MA 2012 and MA 2132. ABET competencies a, c, e, k.*

EE 3064 Feedback Control 3½:1½:0:4

Introduction to analysis and design of linear feedback control systems. Modeling of physical systems, performance specifications, sensitivity, and steady-state error, Routh-Hurwitz and Nyquist Stability tests. The use of Root Locus and frequency response techniques to analyze system performance, and design compensation (lead/lag and PID controllers) to meet performance specifications. Analysis and design of control systems using math packages in alternate-week computer laboratory. Objectives: Establish foundation of feedback control theory for use in more advanced courses; introduce control systems design concepts and practices; develop facility with computer design packages for design and simulation. *Prerequisites: EE 3054 (C- or better) and PH 2004. ABET competencies: a, b, c, e, g, i, k.*

EE 3114 Fundamentals of Electronics I 3½:1½:1:4

Circuit models and frequency response of amplifiers. Op-amps, difference amplifier, voltage-to-current converter, slew rate, full-

power bandwidth, common-mode rejection, frequency response of closed loop amplifier, gain-bandwidth product rule. Diodes, limiters, clamps, semiconductor physics. Bipolar Junction Transistors, small-signal models, cut-off, saturation and active regions, common emitter, common base and emitter follower amplifier configurations. Field-Effect Transistors (MOSFET and JFET), biasing, small-signal models, common-source and common gate amplifiers, integrated circuit MOS amplifiers. Alternate-week laboratory experiments on OP-AMP applications, BJT biasing and large signal operation, and FET characteristics. Objectives: to study design and analysis of operational amplifiers, small signal bipolar junction transistor and field effect transistor amplifiers, diode circuits, differential pair amplifiers and the fundamentals of semiconductor device physics. *Prerequisites: EE 2024 (C- or better) and PH 2004. ABET competencies a, c, e, g, k.*

EE 3124 Fundamentals of Electronics II 3½:1½:0:4

Differential and multistage amplifier, current mirrors, current sources, active loads. Frequency response of MOSFET, JFET and BJT amplifiers: Bode plots. Feedback amplifiers, gain-bandwidth rule, effect of feedback on frequency response. Class A, B, and AB output stages. Op-amp analog integrated circuits. Piecewise-linear transient response; determination of state of transistors. Wave shaping circuits. MOS and bipolar digital design: noise margin, fan-out, propagation delay; CMOS, TTL, ECL. Alternate week laboratory experiments. Objectives: to study design and analysis of analog integrated circuits, frequency response of amplifiers, feedback amplifiers, TTL and CMOS digital integrated circuits. *Prerequisite: EE 3114. ABET competencies a, c, e, g, k.*

EE 3193 Introduction to Very Large Scale Integrated Circuits 3:0:0:3

Overview of integrated circuit design process: planning, design, fabrication, and testing. Device physics: PN junction, MOSFET, and Spice models. Inverter static and dynamic behavior and power dissipation. Interconnects: cross talk, variation, transistor sizing. Logic gates and combinational logic networks. Sequential machines and sequential system design. Subsystem design: adders, multipliers, static memory (SRAM), dynamic memory (DRAM). Floorplanning, clock distribution, power distribution, and signal integrity. Input/Output buffers, packaging, and testing. IC design methodology and CAD tools. Implementations: full cus-

tom, application-specific integrated circuit (ASIC), field programmable gate arrays (FPGA). Objectives: to provide students with the foundations of VLSI design and expose them to a custom VLSI design methodology and state-of-the-art CAD tools. *Prerequisites:* CS 2204 (C- or better) and EE 3114. *ABET competencies:* a, c, e, k.

EE 3404 Fundamentals of Communication Theory 3½:1½:0:4

Bandpass signal representation and quadrature receivers. Noise in communication systems. Digital Modulation Schemes, coherent and noncoherent receivers. Fundamentals of coding. Block codes and convolutional codes. Higher order modulation schemes, QAM, M-PSK. Intersymbol interference and equalization techniques. Carrier and symbol synchronization. Alternate-week computer laboratory projects using analysis and design computer packages. Objectives: learn principles of various modulation and coding techniques and their relative effectiveness under the constraints of various transmission environments; use of math packages to analyze and simulate communication systems. *Prerequisite:* EE 3054 (C- or better); *computer engineering students may register with instructor's approval. Co-requisite:* MA 3012. *ABET competencies* a, c, e, k.

EE 3414 Multimedia Communication Systems I 4:0:0:4

Part I of an approved University Sequence in Multimedia Communications. Topics: speech and audio sampling and quantization, frequency domain characterization and processing of speech signals, speech and audio coding standards. Wired and wireless telephone systems, color perception and representation, basic image processing tools, image coding standards, basics of packet switching networks, and Internet technology. Requires one term project on a topic related to the course content by a team of two or more students. Objectives: to understand basic techniques for speech, audio and image processing and principles of wired and wireless telephone systems and the Internet. *Prerequisites:* CS 1114 and MA 1024. *ABET competencies:* a, b, d, g, h, k.

EE 4144 Introduction to Embedded Systems Design 3½:1½:0:4

Architecture and operation of embedded microprocessors; microprocessor assembly language programming; address decoding; interfacing to static and dynamic RAM; Serial I/O, Parallel I/O, analog I/O;

interrupts and direct memory access; A/D and D/A converters; sensors; microcontrollers. Alternate-week laboratory. Objectives: to provide students with foundations of embedded systems design and analysis techniques; expose students to system level design; and teach integration of analog sensors with digital embedded microprocessors. *Prerequisites:* CS 2204 (C- or better) and EE 2024 (C- or better). *ABET competencies:* a, c, d, e, g, j, k.

EE 4414 Multimedia Communication Systems II 4:0:0:4

Part II of an approved University Sequence in Multimedia Communications. Topics: analog and digital video format, properties of human visual systems, multiplexing of separate color components, video coding methods and standards, analog and digital TV systems. Policy and business issues in TV system development. Video conferencing systems, video streaming over the Internet, Internet protocols for real-time applications. Requires one-term project on a topic related to the course content by a team of two or more students. Objectives: to understand basic techniques for video processing and principles of television systems and real-time services over the Internet. *Prerequisites:* EE 3414 or 3054, or sufficient knowledge of Fourier Transforms. *ABET competencies:* a, b, d, g, h, k.

EE 3604 Electromagnetic Waves 3½:1½:0:4

Electromagnetic wave propagation in free space and in dielectrics is studied starting from a consideration of distributed inductance and capacitance on transmission lines. Electromagnetic plane waves are obtained as a special case. Reflection and transmission at discontinuities are discussed for pulsed sources, while impedance transformation and matching are presented for harmonic time dependence. Snell's law and the reflection and transmission coefficients at dielectric interfaces are derived for obliquely propagation plane waves. Guiding of waves by dielectrics and by metal waveguides is demonstrated. Alternate-week laboratory. Objectives: Establish foundations of electromagnetic wave theory applicable to antennas, transmissions lines, and materials; increase appreciation for properties of materials through physical experiments. *Prerequisites:* EE 2024 (C- or better) and MA 3112. *ABET competencies:* a, b, c, e, g, k.

EE 3824 Electric Energy Conversion Systems 3½:1½:0:4

Introduction to electric energy sources, energy storage devices, energy economics, environmental issues, and electrical hazards. Principles of electric power systems transmission and distribution. Basic electromechanical conversion systems pulse and distribution transformers, induction rotating machines. Principles of electric energy conversion static power supplies, static controllers and electric power quality. Fundamentals of power management heat-sinks and cooling systems. Alternate-week experiments with basic electrical machines. Objectives: become familiar with energy sources, storage devices, and their economical and environmental management; analysis and design of transmission and distribution systems, basic electrical machinery, and power electronic converters. *Prerequisite:* EE 2024 (C- or better). *Corequisite:* EE 3604. *ABET competencies:* a, b, c, e, g, k.

Electrical Engineering Design Project I (EE DP I)

The design project, required of all students, consists of two three-credit courses. The first course, EE DP1, is one of a number of specialty lab/project courses offered by the department in various subdisciplines such as electronics, machinery, robotics, imaging, communications, etc. (EE 4113-4183, below).

The purpose of DP1 is to provide students with a significant amount of background laboratory experience in their chosen area of concentration, to have students begin their independent project work by finding an adviser and initiating the independent project work, and to exercise their oral presentation and written communication skills. *Prerequisite:* completion of all junior-level technical courses. *ABET competencies:* a, b, c, e, f, g, k.

EE 4113 EE DP I- Control and Robotics 0:6:1:3

Additional prerequisite: EE 3064.

EE 4123 EE DP I- Electrical Power and Machinery 1:3:1:3

Additional prerequisite: EE 3824.

EE 4133 EE DP I Electromagnetic Waves and Applications 1:3:1:3

Additional prerequisite: EE 3604.

EE 4143 EE DP I- Integrated Circuit Design 1:3:1:3

Additional prerequisite: EE 3124.

EE 4153 EE DP I- Multimedia (also listed as EL 5143) 0:6:1:3

EE 4163 EE DP I-Digital Signal Processing Lab (also listed as EL 6183)
1:3:1:3

EE 4173 EE DP I-Telecommunication Networks (also listed as EL 5373) 1:3:1:3
Additional prerequisite: EE 3404. Additional co-requisite: EE 136.

EE 4183 EE DP I-Wireless Communication (also listed as EL 5023)
1:3:1:3
Additional prerequisite: EE 3404.

EE 4223 Electrical Engineering Design Project II 0:6:1:3

In this concluding phase of the Design Project, students continue working with an adviser on the independent project begun in the previous semester. The final project will build upon the analytical and laboratory skills developed in the previous required and elective courses. The project may be an individual project, or may be carried out by a team of students working in conjunction with a faculty group adviser. The final Capstone Project may also be a multidisciplinary project carried out together with students from other departments. *Prerequisite: EE 41X3. ABET competencies: a, b, c, d, e, f, g, h, i, j, k.*

EE 4313 Computer Engineering Design Project I 1:3:1:3

Lectures and experiments will provide an introduction to computer hardware organization, assembly language programming and interfacing computer hardware to physical devices. This course will exercise the student's oral presentation and written communication skills and provide the background necessary for the student to begin independent project work by finding an adviser and a project for the DP II course. *Prerequisite: completion of all junior level technical courses, including minimum grade requirements. ABET competencies: a, b, c, e, f, g, k.*

EE 4323 Computer Engineering Design Project II 0:6:1:3

This course is the concluding phase of the student's Capstone Project. In this phase the student works with a faculty adviser on an independent project. This project will build upon the analytical and laboratory skills developed in the previous required and elective courses. The project may be an individual project, or may be carried out by a team of students working in conjunction with a faculty group adviser. The project may also be a multidisciplinary project carried out together

with students from other departments. Students will be required to make oral and written presentations. *Prerequisites: EE 4313 or CS 4513. ABET competencies: a, b, c, d, e, f, g, h, i, j, k.*

EE 107 Control System Design 3:0:0:3

Topics on the design of linear feedback control systems, selected from the following: lag-lead compensators; pole placement controllers; state-variable feedback and observers; linear quadratic optimal control, stochastic systems, sampled-data and computer-controlled systems; and phase-plane and describing function techniques for non-linear systems. *Prerequisite: EE 3064. ABET competencies: a, b, c, e, k.*

EE 116 Communication Electronics 3:0:0:3

Design and analysis of small-signal and large-signal tuned amplifiers, sine-wave oscillators, mixers, AM modulators and demodulators, FM modulators and demodulators, phase-locked loops. *Prerequisite: EE 3124. ABET competencies: a, c, e, k.*

EE 136 Communication Networks 3:0:0:3

This course develops the basic techniques used in communication networks. After protocol layering is introduced, algorithms and protocols are discussed for use in each of the five layers: physical, data link, network, transport, and application. Specific protocols such as TCP/IP, ATM, SS7 will be included. *Prerequisite: junior status in electrical engineering, computer engineering, or computer science. Corequisite: MA 222 or MA 223. ABET competencies: a, c, e, j, k.*

EE 164 Electromagnetic Fields and Radiation 3:0:0:3

Review and mathematical interpretation of Maxwell's Equations; basic antenna theory and radiation; antenna parameters and arrays; rectangular metal waveguides; dielectric waveguides; and applications at radio and optical frequencies are discussed. *Prerequisite: EE 3604. ABET competencies: a, c, e, k.*

EE 210 Summer Honors Research Laboratory 0:9:0:3

An individual or small-group intensive 11-week research-oriented project, often related to current faculty research projects. Offered in the summer following the junior year. Students may use this course to satisfy the Technical Elective requirement or the Design Project II. A limited number of students are

selected for this program based on application forms submitted in the preceding spring. (See \Research on the Web page: www.ece.poly.edu). *Prerequisite: ABET competencies: a, b, c, e, f, g, i, j, k.*

EE 371-6 Guided Studies in EE
1,2,3,4,5,6 credits, respectively.

EE 381-6 Guided Studies in CompE
1,2,3,4,5,6 credits, respectively.

EE 397 Senior Thesis as arranged

GRADUATE COURSES

EL 5013 Wireless Personal Communication Systems 3:0:0:3

Introduction to the underlying principles of wireless communications and practical systems. Science and technology including radio signal propagation, interference-limited communications, multiple access, radio resources management, and mobility management. Building blocks of wireless networks. Essential functions of cellular telephone systems and wireless local area networks. Details of the most important technologies including GSM, CDMA, wideband CDMA, and WiFi (IEEE802.11). *Prerequisite: EE 3404 or equivalent.*

EL 5023 Wireless Information Systems Laboratory I 1½:4½:0:3

This course will include hands-on experience including a combination of laboratory experiments, lectures, and projects relating to spread spectrum code division multiple access (CDMA) wireless communication systems. Among the specific topics addressed include pseudo-noise code generation, transmitters and receivers for direct sequence and frequency hopping systems, acquisition and tracking, CDMA wireless computer communications, UHF channel propagation characteristics including multipath time delay profiles and attenuation measurements, bit error rate measurements, phase locked loops, and spectrum sharing with existing narrowband users. *Prerequisite: Graduate status or EE 3404.*

EL 5033 Wireless Information Systems Laboratory II 1½:4½:0:3

This course will include hands-on experience including a combination of laboratory experiments, lectures, and projects relating to basic and advanced topics in wireless communications. Among the specific topics addressed include mixers, IQ modulation, phase locked loops, receiver design, PN code ac-

quisition, smart antennas, and RFID.
Prerequisite: EL 5023.

EL 5123 Image Processing 3:0:0:3

Image formation and perception; image acquisition, representation and display; image sampling and resizing; contrast enhancement; two-dimensional Fourier transform and other unitary transforms; frequency domain and spatial domain linear filtering; median and morphological filtering; image smoothing, sharpening, and edge detection through linear and nonlinear filtering; color image representation and processing; lossless and lossy image coding techniques and standards, image deblurring; imaging geometry, image registration and geometric transformation. C- or MATLAB implementation of selected imaging processing algorithms. Co-listed as BE 6223. *Prerequisites: Graduate student status or EE 3054 and MA 3012.*

EL 5143 Multimedia Laboratory
1½:4.5:0:3

This course provides students with hands-on experience in processing and communication of speech, audio, image and video signals. Topics include sampling and quantization, sampling rate conversion, lossless and lossy compression, basic techniques in speech, audio, image and video coding, multimedia conferencing, video on-demand, video multicasting, multimedia document creation. Students will be exposed to popular software and hardware for multimedia signal processing and document creation. Each week includes a lecture and a lab. *Prerequisites: graduate status or EE 3054 or equivalent.*

EL 5213 Introduction to Systems Engineering 3:0:0:3

Introduction to fundamentals of systems engineering process. Multi-disciplinary systems methodology, design, and analysis of complex systems. Brief history of systems engineering. Mathematical models. Objective functions and constraints. Optimization tools. Topics to be covered include identification, problem definition, synthesis, analysis, and evaluation activities during conceptual and preliminary system design phases. Decision analysis and utility theory. Information flow analysis in organizations. Elements of systems management, including decision styles, human information processing, organizational decision processes, and information system design for planning and decision support. Basic economic modeling and analysis. Requirements development, life-cycle costing, scheduling, and risk analysis. Application of

computer-aided systems engineering (CASE) tools. *Prerequisite: Graduate status.*

EL 5223 Sensor Based Robotics 3:0:0:3

Robot mechanisms, robot arm kinematics (direct and inverse kinematics), robot arm dynamics (EulerLagrange, Newton-Euler, and Hamiltonian Formulations), six degree-of-freedom rigid body kinematics and dynamics, quaternion, nonholonomic systems, trajectory planning, various sensors and actuators for robotic applications, end-effector mechanisms, force and moment analysis, introduction to control of robotic manipulators. Co-listed as ME 6613 *Prerequisites: Graduate status. Pre/co-requisite EE 3064 Co-requisites: EE 3064.*

EL 5253 Applied Matrix Theory 3:0:0:3

In-depth introduction to theory and application of linear operators and matrices in finite-dimensional vector space. Determinants, eigenvalues and eigenvectors. Theory of linear equations. Canonical forms and Jordan canonical form. Matrix analysis of differential and difference equations. Singular value decomposition. Variational principles and perturbation theory. Numerical methods. *Prerequisites: Graduate status, MA 2012, MA 2132, MA 2112 and MA 2122.*

EL 5363* Principles of Communication Networks 3:0:0:3

This course covers all the fundamental aspects of communications networks. Topics being discussed are: protocol architecture, data transmission and signal encoding, multiplexing, spread spectrum, data link control, local area networks, wireless LAN, circuit switching, packet switching, routing, traffic control, Internet protocol, transport layer protocol, application design and the basics of network security. *Prerequisites: MA 3012 or instructor's permission: *Online version available.*

EL 5373* Internet Architecture and Protocols 3:0:0:3

This course introduces the student to some basic local area networking technologies and protocols in a set of lectures and laboratory experiments. Link level protocols. Local area networks: CSMA/CD, Token Ring, IEEE standards and protocols. The Internet protocol suite: IP, ARP, RARP, ICMP, UDP and TCP. LAN Interconnection: bridges, routers and gateways. Application protocols: SNMP, FTP, SMTP and NFS. *Prerequisite: EL 5363 or EE 136: *Online version available.*

EL 5463* Introduction to RF/Microwave Integrated Circuits 3:0:0:3

Review of transmission lines and smith chart. Introduction of signal graphs technique. Noise in microwave circuits. Introduction to active devices for RF and microwave circuits. S-parameter modeling. Design of amplifiers, stability analysis and examples. Oscillators and mixers. Transistor and dielectric resonator oscillators. Design considerations and examples. Introduction to microwave systems. *Prerequisite: EE 3604: *Online version available.*

EL 5473* Introduction to VLSI System Design 3:0:0:3

This course will cover CMOS processing technology, MOS transistor theory, static/dynamic circuit and logic design techniques, circuit performance estimation, standard cells and gate arrays, clocking strategies, input/output structures, datapath, memory, and control logic design. Advanced VLSI CAD tools will be used for schematic capture, layout, timing analysis, and simulations for functionality and performance. *Prerequisite: Senior or Graduate Status, CS 2204 & EE 3114 or equivalent: *Online version available.*

EL 5483 Real Time Embedded Systems 3:0:0:3

This course is designed to provide students with an overview of the unique concepts and techniques needed to design and implement computer systems having real-time response requirements in an embedded environment. It will contrast the concepts and techniques of real time and embedded systems with those of more traditional computer systems. Topics include: Basic concepts of real time and embedded systems, hardware features, programming languages, real time operating systems, synchronization techniques, performance optimization, and current trends in real time and embedded systems such as incorporating internet connectivity. *Prerequisite: Knowledge of \C", Pascal or other programming language and a basic understanding of computer architecture.*

EL 5493 Advanced Hardware Design 3:0:0:3

This course will show how a hardware description language (for example, VHDL) can be used for computer hardware modeling, logic synthesis, register-level synthesis and simulation. The resulting design with hundreds or thousands of gates is then ready to be downloaded to form FPGA chips or sili-

con cells. We plan to use programs such as QuickVHDL, modeling and simulation tools from Mentor Graphics or similar large-scale programs. A design project is required, and students will make a written and oral presentation. *Prerequisite: Graduate status.*

EL 5513 Electro-Optics I 3:0:0:3

This course describes the phenomena of and introduces the analyzing techniques for wave propagation in optical systems. Topics covered include: Review of Maxwell equations; propagation of plane waves: polarization, reflection, refraction, interfaces, and multilayers; Fourier optics and diffraction; Ray and Gaussian beams; Optical cavities; Guided optical beams, optical fibers and guiding layers; Dispersion and mode distortion in fibers. *Prerequisites: graduate status, EE 3604 or equivalent.*

EL 5523 Electro-Optics II 3:0:0:3

This course focuses on active optical systems. Topics covered include: Resonant optical cavities; Laser oscillation and amplification; General characteristics of lasers, laser excitation; Semiconductor lasers; Detection of optical radiation. *Prerequisite: EL 5513.*

EL 5533 Physics of Nanoelectronics 3:0:0:3

Limits to the ongoing miniaturization (Moore's Law) of the successful silicon device technology imposed by physical limitations of energy dissipation, quantum tunneling, and discrete quantum electron states. Quantum physical concepts and elementary Schrodinger theory. Conductance quantum and magnetic flux quantum. Alternative physical concepts appropriate for devices of size scales of 1 to 10 nanometers, emphasizing role of power dissipation. Tunnel diode, resonant tunnel diode, electron wave transistor; spin valve, tunnel valve, magnetic disk and random access memory; single electron transistor; molecular crossbar latch, quantum cellular automata including molecular and magnetic realizations. Josephson junction and rapid single flux quantum' computation. Photo- and x-ray lithographic patterning, electron beam patterning, scanning probe microscopes for observation and for fabrication; cantilever array as dense memory, use of carbon nanotubes and of DNA and related biological elements as building blocks and in self-assembly strategies. Colisted as PH 5493. *Prerequisites: PH 2004 Introductory Physics II.*

EL 5553 Physics of Quantum Computing 3:0:0:3

Limits to the performance of binary computers, traveling salesman and factorization problems, security of encryption. The concept of the quantum computer based on linear superposition of basis states. The information content of the qubit. Algorithmic improvements enabled in the hypothetical quantum computer. Isolated two-level quantum systems, the principle of linear superposition as well established. Coherence as a limit on quantum computer realization. Introduction of concepts underlying the present approaches to realizing qubits (singly and in interaction) based on physical systems. The systems in present consideration are based on light photons in fiber optic systems; electron charges in double well potentials, analogous to the hydrogen molecular ion; nuclear spins manipulated via the electron nuclear spin interaction, and systems of ions such as Be and Cd which are trapped in linear arrays using methods of ultra-high vacuum, radiofrequency trapping and laser-based cooling and manipulation of atomic states. Summary and comparison of the several approaches. Co-listed as PH 5553. *Prerequisites: PH 2004 Introductory Physics II.*

EL 5613 Introduction to Electric Power Systems 3:0:0:3

Basic concepts: single-and-three-phase circuits, power triangle; transmission lines parameters: resistance, inductance, capacitance, transformers, and generators; lumped-component piequivalent circuit representation; perunit normalization; symmetrical phase components; load-flow program. *Prerequisite: EE 2024 or equivalent.*

EL 5663 Physics of Alternative Energy 3:0:0:3

Non-petroleum sources of energy include photovoltaic cells, photocatalytic generators of hydrogen from water, and nuclear fusion reactors. The advanced physics of these emerging technical areas will be introduced in this course. Semiconductor junctions, optical absorption in semiconductors, photovoltaic effect. Energy conversion efficiency of the silicon solar cell. Single crystal, polycrystal, and thin film types of solar cells. Excitons in bulk and in confined geometries. Excitons in energy transport within an absorbing structure. Methods of making photocatalytic surfaces and structures for water splitting. Conditions for nuclear fusion. Plasmas and plasma compression. The toroidal chamber

with magnetic coils as it appears in recent designs. Nuclear fusion by laser compression (inertial fusion). Small scale exploratory approaches to fusion based on liquid compression and electric field ionization of deuterium gas. Co-listed as PH 5663. *Prerequisites: PH 2004 Introductory Physics II.*

EL 5673* Electronic Power Supplies 3:0:0:3

Review of power relationships. Power semiconductor switching devices. Rectifiers. Basic PWM dc-dc switching cells. Non-isolated and isolated PWM dc-dc converters. Control of PWM converters. Resonant and softswitching converters. Low drop-out (LDO) voltage regulators. Switched capacitor charge pumps. PWM inverters. Applications to computer equipment, portable units, distributed power systems, uninterruptible power supplies, and electric drives. Power quality and EMI issues. American and International standards. *Prerequisite: EE 3824 or equivalent: *Online version available.*

EL 5683 Electric Drives Characteristics and Controls 3:0:0:3

Conversion of load (resistive) torque, inertia, mass, and force to a rotating shaft; Acceleration and deceleration times; motor power-rating selection; thermal consideration at different duty cycles; load diagram construction; four-quadrant speed control operation for DC and AC motors; Worked examples. *Prerequisite: EE 3824 or equivalent.*

EL 5713 Microwave Engineering Laboratory/Project 1½:4½:0:3

Design, fabrication, testing of passive circuits (couplers and filters), active circuits (amplifier and oscillator) and antennas using printed circuits. Design and stimulation using microwave CAD tools (ADS, HFSS, PCAAMT), HP-8510 automated network analyzer measurement, frequency and time domain measurement, printed circuit layout and photo etching. *Prerequisite: EE 3604 Co-requisite: EL 5733 or EL 6713.*

EL 5733 RF and Microwave Systems Engineering 3:0:0:3

Review of electromagnetic theory and transmission lines. Printed transmission lines. S, Z, Y, ABCD parameters, network theory, signal flow graphs, CAD methods. Excitation of waveguides. Single and multisection impedance transformer, power divider, directional coupler, hybrid circuits. Microwave resonator: series, parallel resonators, stubs

and cavities. Filter theory and designs, coupled-line filters, Kuroda identities, Chebyshev and maximally flat filters. *Prerequisite: graduate status or EE 3604.*

EL 5753 Introduction to Plasma Engineering 3:0:0:3

Basic plasma concepts and applications; parameters describing the plasma; motion of charged particles in electromagnetic fields; effect of particle collisions on plasma transport: diffusion and mobilities. Plasmas as dielectric media; plasma dielectric response functions for collective plasma oscillations and for electromagnetic wave propagation in plasma. Plasmas for practical applications. *Prerequisite: graduate status or EE 3604.*

EL 5813 Biomedical Instrumentation 3:0:0:3

This course, intended for graduate students in the Bioengineering Program, introduces them to the principles of some of the most commonly used instruments in neuroscience research, particularly in electrophysiology and imaging. Theoretical considerations in choice of appropriate techniques as well as practical issues in choice of materials and design of experiments will be discussed. Co-listed as BE 6503. *Prerequisite: adviser's approval.*

EL 5823 Medical Imaging I 3:0:0:3

This course introduces the physics, instrumentation, and signal processing methods used in X-ray imaging (projection radiography), X-ray computed tomography, nuclear medicine (SPECT/PET), ultrasound imaging, and magnetic resonance imaging. Co-listed as BE 6203. *Prerequisites: Undergraduate-level courses in multivariable calculus (MA 2112, MA 2122), physics (PH 2004), probability (MA 3012). Co-requisites: signals and systems (EE 3054, preferred but not required).*

EL 6013* Principles of Digital Communications: Modulation & Coding 3:0:0:3

Principles of M-ary communication: signal space methods, optimum detection. Fundamental parameters of digital communication systems, various modulation techniques and their performance in terms of bandwidth efficiency and error probability. Efficient signaling with coded waveforms. Block coding and convolutional coding. Joint modulation and coding. Equalization for communication over bandlimited channels. Brief overview of digital communications over

fading multipath channels. *Prerequisites: EE 3404, EL 6303 : *Online version available.*

EL 6023* Wireless Communications: Channel Modeling and Receiver Design 3:0:0:3

Wireless communication channel models and practical techniques for mitigating transmission impairments. Channel Modeling Parameters: Path loss; Fading: long-term vs. short-term fading, flat vs. frequency selective fading, and slow vs. fast fading; Multipath spread parameters: delay spread, angular spread and Doppler spread, Matrix Channel Modeling for Multiple Input and Multiple Output (MIMO) Systems. Channel Parameter Estimation: training sequence and blind approaches. Mitigation: Mitigation of path loss and fading; Diversity, handoff and power control; Mitigation of intersymbol interference: rake receiver and equalizer; Mitigation of time variation: pilot symbols and dynamic tracking. Processing Techniques: LS, zero forcing, MMSE, LMS, etc. *Prerequisites: EE 3404, MA 3012: *Online version available.*

EL 6033* Modern Wireless Communication Techniques and Systems 3:0:0:3

Multiple Access and Multiplexing Techniques; Spread spectrum and Code division multiple access (CDMA) techniques: Direct sequence, Frequency hopping; Multicarrier Techniques: Orthogonal frequency division (OFDM) and Multicarrier CDMA (MC-CDMA); New Wireless Communication Systems: Ultra Wideband communications, Wireless Fidelity (Wi-Fi), Radio Frequency Identification (RFID), Bluetooth, etc. *Prerequisites: EE 3404 and EL 6303: *Online version available.*

EL 6063 Information Theory 3:0:0:3

Mathematical information measures: entropy, relative entropy and mutual information. Asymptotic equipartition property, entropy rates of stochastic processes. Lossless source encoding theorems and source coding techniques. Channel capacity, differential entropy and the Gaussian channel. Lossy source coding rate distortion theory. Brief overview of network information theory. *Prerequisite: Graduate Status, EL 6303.*

EL 6073 Error Control Coding 3:0:0:3

General theory of linear codes. Galois fields. Coding and error correction methods. Linear block codes. Convolutional codes. Parallel and serial concatenated codes. Iterative

decoding algorithms. Low density parity check codes. *Prerequisites: EL 6303.*

EL 6113* Signals, Systems and Transforms 3:0:0:3

Continuous and discrete linear systems, system function. Fourier transforms, periodic functions, Z transforms, discrete Fourier series, fast Fourier transforms. Magnitude Characteristics of LTI systems, All-pass Systems and Properties. Analog and digital filters, finite order system functions. Digital processing of analog signals. Sampling theorems. Co-listed as BE 6403, *Prerequisites: Graduate status : *Online version available.*

EL 6123 Video Processing 3:0:0:3

Fourier analysis of video signals, properties of the human visual system, video signal sampling and sampling rate conversion, motion modeling and estimation, video compression techniques and standards, stereo video processing and compression, error control in networked video applications, analog and digital video systems. C- or Matlab implementation of selected algorithms. A mini-project is required. *Prerequisites: EL 5123 or EL 5143, EL 6303.*

EL 6183 Digital Signal Processing Laboratory 1½:4½:0:3

This course includes hands-on experience with a set of laboratory experiments, lectures and projects relating to real-time digital signal processing (DSP) systems using a DSP microprocessor. Students will gain experience in the implementation of common algorithms used in a variety of applications, and will learn tools and functions important for the design of DSP-based systems. Students are required to complete a project and provide an oral presentation. This course is suitable for students interested in DSP and Embedded Systems. Co-listed as BE 6483, *Prerequisites: EL 6113 or Equivalent, C/C++.*

EL 6213 System Modeling, Analysis and Design 3:0:0:3

Introduction of basic system concepts such as system state, inputs, outputs, and disturbances. Modeling methods and Computer Aided Systems Engineering (CASE) formal structures. CASE tools for solving practical systems-related problems. Quantitative techniques including linear programming, network flow analysis, integer and nonlinear programming, Petri nets, basic probabilistic and stochastic tools, Markov processes, queueing theory, and Monte Carlo tech-

niques for simulation. Fundamentals of decision and risk analysis. *Prerequisites:* EL 5213. *Co-requisites:* 6303 recommended.

EL 6223 Nonlinear and Sampled-Data Control Systems 3:0:0:3

Introduction to nonlinear systems. Phase plane analysis, nonlinearities, linearization, limit cycles, and averaging. Stability techniques: describing function, Lyapunov functions, Popov locus ad circle criterion. Analysis and design of sampled-data systems by Z-transforms and state variable methods. Semiglobal and global stabilization of nonlinear sampled-data systems. Co-listed as ME 6613. *Prerequisites:* Graduate status and EL 6253.

EL 6233 System Optimization Method 3:0:0:3

Formulations of system optimization problems. Elements of functional analysis applied to system optimization. Local and global system optimization with and without constraints. Variational methods, calculus of variations, and linear, nonlinear and dynamic programming iterative methods. Examples and applications. Newton and Lagrange multiplier algorithms, convergence analysis. *Prerequisites:* Graduate status and EL 5253 or EL 6253.

EL 6243 System Theory and Feedback Control 3:0:0:3

Design of single-input-output and multivariable systems in frequency domain. Stability of interconnected systems from component transfer functions. Parameterization of stabilizing controllers. Introduction to optimization (Wiener-Hopf design). *Prerequisites:* Graduate status and EE 3064.

EL 6253 Linear Systems 3:0:0:3

Basic system concepts. Equations describing continuous and discrete-time linear systems. Time domain analysis, state variables, transition matrix, and impulsive response. Transform methods. Time-variable systems. Controllability, observability and stability. SISO pole placement, observer design. Sampled data systems. *Prerequisites:* Graduate status and EE 3054 or EL 5253.

EL 6303* Probability Theory 3:0:0:3

The axiomatic definition of experiment and probability. Conditional Probability. Bayes' Theorem, Notion of independence. Repeated trials. Bernoulli trials and their limit-

ing forms. The concept of a random variable. Probability distribution and density functions. Probability mass functions. Examples of random variables: Normal(Gaussian), Poisson, Gamma, Exponential, Laplace, Cauchy, Rayleigh, etc. Bayes' Theorem revisited. Functions of one random variable and their density functions. Expected value of a random variable: Mean, Variance, Moments, and Characteristic functions. Two random variables: Joint distribution and joint density functions of two random variables, Independence. One function of two random variables. Two functions of two random variables. Order statistics. Joint moments, Uncorrelatedness, Orthogonality, Joint characteristic function. Jointly Gaussian random variables. Conditional distribution and conditional expected values. The central limit theorem. The principle of maximum likelihood. Elements of parameter estimation. Maximum likelihood estimation for unknown parameters. Unbiased estimators and their variances. Co-listed as BE 6453. *Prerequisites:* Graduate status and MA 3012: *Online version available.

EL 6313 Stochastic Processes 3:0:0:3

Random Variables, Random vectors and Random processes; Second order characterization of stochastic processes, Autocorrelation and covariance functions, Special processes: Poisson process, Wiener process, and White noise process. Stationary processes, Types of stationarity: Strict sense stationary and Wide sense stationary processes, Gaussian processes, Memory-less processes. Linear Systems with random inputs, Input-output Autocorrelation relations, Input-output Stationarity properties. Ergodicity and related results. Wide sense stationary processes, Autocorrelation function and power spectra. Spectral theory for linear systems. Rational spectra, Hilbert transforms, shot noise, thermal noise. Discrete time processes, Spectral factorization, Matched filters. Integral equations and series representation of stochastic processes: Karhunen Loeve (KL) expansion. Modulation, Band limited processes and sampling theory. Mean square estimation and the orthogonality principle. Linear Prediction and its Geometric interpretation. Levinson Recursion for one step predictors. Mean square estimation and normality. Mean square error for one and multi-step predictors. Smoothing and prediction as applications of orthogonality principle. *Prerequisite:* EL 6303.

EL 6333 Detection and Estimation Theory 3:0:0:3

Detection Theory: Binary Hypothesis Testing: Bayes' Criteria; Likelihood Ratio Test; min-max test; Neyman-Pearson Tests; Receiver Operating Characteristics. Parameter Estimation Theory: Random parameter Estimation. Bayes' Procedure; Minimum Mean Square Error (MMSE) Estimator, Maximum A-Posteriori (MAP) Estimator. Non-random Parameter Estimation: MAP Estimator; Unbiased Estimators and Cramer-Rao(C-R) Bound; Higher Order Bhattacharya Bounds. Uniformly Minimum Variance Unbiased Estimators (UMVUE); Sufficient Statistic; Factorization Theorem; Rao-Blackwell Theorem. Multi-Parameter Estimation; Fisher Information Matrix. Composite Hypothesis Testing; Series Representation of Stochastic Processes with Rational spectra; Detection of distinct signals in white noise and colored noise; Mary Detection and Estimation of signals in white noise and colored noise. Blind Channel Identification. Elements of signal design for white Gaussian noise. M-ary waveform design for two-dimensional signals. *Prerequisites:* Graduate status and EL 6303.

EL 6373* Local and Metropolitan Area Networks 3:0:0:3

The purpose of this course is to introduce students to the fundamental design issues in wireless and wired local and metropolitan area networks, explain the state-of-the-art solutions proposed and deployed in the field by using latest standards and protocols as examples, and discuss the trends in the wireless/wired LAN/MANs. Example wireless technologies covered include the IEEE 802 family of protocols, e.g., WiFi, WiMax, and Bluetooth. Example wireline technologies include those associated with Ethernet, and MAN technologies such as Resilient Packet Ring. *Prerequisites:* EL 5363 or EE 136 or instructor's permission: *Online version available.

EL 6383* High-Speed Networks 3:0:0:3

This course covers the basics, architectures, protocols, and technologies for high-speed networks. Topics to be included are: synchronous optical network (SONET), asynchronous transfer mode (ATM), ATM adaptation layer (AAL), 10/100/1000/10G Ethernet, Ethernet over SONET (EOS), quality of service control, packet scheduling, network processor, buffer management, flow and congestion control, TCP, high-speed TCP and XCP, Routing and IP fast rerout-

ing, WDM networks, MPLS and GMPLS. Each student is also required to complete a project that could be reading, software design, or hardware design. *Prerequisites: Graduate status, EL 5363 or EE 136 or equivalent: *Online version available.*

EL 6393* Advanced Network Security 3:0:0:3

While the recent proliferation of broadband wireline and wireless networking technologies have substantially increased the available network capacity and enabled a wide-range of feature-rich high-speed communication services, security remains a major concern. Network attacks have become common recurring events which increasingly threaten the proper functioning and continual success of the communication infrastructure and services. One key aspect of mitigating such increasing threats is to develop new security/defense architectures, systems, methodologies and algorithms which can scale together with the communications infrastructure in terms of operating speed, operational simplicity and manageability etc. The goal of the course is to understand the theoretical, architectural, system and implementation issues related to all aspects of security in high-speed networks, and study various proposed solutions. Students are required to read research papers, and complete a term project with either simulation programs to evaluate the proposed schemes, or architecture/VHDL designs for the schemes. *Prerequisites: CS 6823 or advisor approval: *Online version available.*

EL 6413* Analog and High Frequency Amplifier Design 3:0:0:3

Basic semiconductor physics, small-signal low frequency models for bipolar junction transistors, biasing, and temperature compensation techniques. Physics, models, and biasing of field effect transistors. High frequency models. Single and multistage broadband small signal amplifiers. Harmonic distortion analysis of amplifiers. Emitter follower analysis at high frequencies. Complete design and analysis of operational amplifiers (Op-Amp) analog integrated circuits. Nonlinear Op-Amp applications. Circuit design techniques to increase Op-Amp slew rate. *Prerequisites: Graduate student status or EE 3114 and EE 3124: *Online version available.*

EL 6423 RF Electronics for Wireless Applications 3:0:0:3

Tuned circuits and impedance transformers, narrowband nonlinear amplifiers. Tuned circuit sine wave oscillators, mixers, AM modu-

lators and demodulators, FM modulators and demodulators, and the phase-locked loop. *Prerequisites: EL 6413.*

EL 6433* Digital Integrated Circuit Design 3:0:0:3

Analysis and design of digital integrated circuits. Circuit analysis of piecewise linear single energy storage element networks. Rules for determining states of diodes and transistors. Bipolar junction and field effect transistors as switches. Basic digital logic gates. Integrated circuit logic and building blocks (TTL, MOS, CMOS, ECL, integrated injection logic). Sweep circuits (constant current, Miller, bootstrap), monostable, astable, and bistable (Schmitt Trigger) switching circuits. Applications (pulse width modulator, triangle wave generator, FM function generator design). *Prerequisites: EL 6413: *Online version available.*

EL 6443 VLSI System and Architecture Design 3:0:0:3

A continuation of EL 5473, this course covers top-down VLSI design using VHDL including structural design, modeling, algorithmic and register level design, synthesis, prototyping and implementation using FPGAs, and methods to design for test (DFT). This course provides students with a solid background and hands-on experiences with the CMOS VLSI design process where custom design techniques (covered in EL 5473) are married with HDL synthesis to produce complex systems. As part of the course requirements, students will complete a project covering design partitioning, placement and routing, automated synthesis, and standard cell design and use. The course will explore how these techniques are used in the design of ASICs, System-on-Chips (SoC), and advanced microprocessors. *Prerequisite: EL 5473.*

EL 6583 Fiber Optic Communications 3:0:0:3

This course deals with the operating principles of optical communications systems and fiber-optic communication technology. The main elements of systems will be presented in block diagrams and discussed individually. The advantages and disadvantages and the applications of Fiber Optic Communications Systems will be discussed. Topics covered include: overview of optical communication systems, review of optics, review of analog and digital communications, the characteristics of optical fibers, optical waveguides, optical sources and transmitters,

optical detectors and receivers, optical amplifiers, noise and detection, impairment in optical communication systems, and optical network design issues. Upon completion of this course, students are expected to be familiar with the principles and technology of optical communication systems, and to be able to design a simple point-to-point optical communications link, including bandwidth, loss, signal to noise ratio (S/N) and bit error rate considerations. *Prerequisite: graduate status or EE 3604.*

EL 6603 Power Electronics 3:0:0:3

Principles of thyristor devices, GTOs, MOSFETs, IGBTs; dynamic characteristics of DC/DC converters; forced commutation circuits; switched-mode power supplies; full-wave and half-wave rectifiers; phase controlled converters; effect of the load characteristics; pulse-width modulated inverters. *Prerequisites: Graduate status and EE 3824 or equivalent.*

EL 6623 Power Systems Economics and Planning 3:0:0:3

Power system economics: revenue requirements, load duration and reserve requirements. Load forecasting: econometric methods. Optimal expansion planning and methodologies: optimal generation expansion computer modeling. Decision analysis techniques. Deregulation of electric power industry. *Prerequisites: Graduate status and EL 5613 or equivalent.*

EL 6633 Transients, Surges and Faults in Power Systems 3:0:0:3

Analysis of lumped-circuit, normal and abnormal transients in power equipment and systems. Short-circuit fault analysis and transient recovery of three-phase circuits. Analysis of traveling-wave surges on transmission lines, windings, and integrated systems. *Prerequisites: Graduate status and EL 5613 or equivalent.*

EL 6643 Relay Fault Protection 3:0:0:3

Protective relay functions and classification. Electromechanical relay types, operating principles and basic characteristics. Communication channels for relaying. Current and voltage transformers, transducers. Protection of busses, transformers, generators, motors, and other station equipment by the zone protection method. Distribution and transmission line relaying systems. Relay setting calculations. Primary and backup protection, application and philosophy with applied relay

engineering examples. *Prerequisites: Graduate status and EL 5613 or equivalent.*

EL 6653 Power System Stability 3:0:0:3

Introduction to the study of power system dynamics: mathematical modeling of prime movers, power plants, synchronous machines, field exciters transmission lines, relay loads and stabilizers. *Prerequisites: Graduate status, EE 3824, EL 5613.*

EL 6663 Distributed Generation Systems 3:0:0:3

Benefits and limitations; classification of small generating systems; principles of operation and electrical equivalent circuits of fuel cells, solar cells, micro-turbines, reciprocating engines, wind turbines and gas turbines; fault conditions; reactive power support; power quality issues. *Prerequisites: EE 3824 and EL 5613 or equivalent.*

EL 6683 Adjustable Speed Drives 3:0:0:3

Electric drives offer enormous potential for energy conservation. This has become universally recognized. Factory automation, transportation (all-electric and hybrid-electric vehicles), and a trend to replace hydraulic drives by electric ones, has increased interest among employers and students for a proper, based on solid theoretical foundations, education in this area. Still the course will require only a basic undergraduate preparation in circuits, electromagnetics, and energy. Advanced topics of special electric machinery and control methods will be introduced on in-time basis. This course complements EL 568 which covers electromechanical aspects of electric drives and EL 660 which is mainly on ac-dc and dc-ac conversion for drives and utility applications. *Prerequisites: Graduate status and EE 3824 or equivalent.*

EL 6713 Electromagnetic Theory and Applications 3:0:0:3

This course introduces Maxwell's equations, wave equation, vector potentials, boundary conditions, and Poynting vector. Time-harmonic fields and phasor approach are introduced. The properties of freely propagating plane waves in uniform and layered media are derived, as well as waves guided by structures, including various transmission lines, hollow waveguides, and dielectric waveguides. A unified treatment of wave propagation is given with general theorems and examples drawn from microwaves, integrated circuits and optics. *Prerequisites: Graduate status and EE 3604.*

EL 6723 Electromagnetic Radiation and Antennas 3:0:0:3

The electromagnetic fields radiated by current elements are derived from Maxwell's equations. From these results, the fields radiated by many types antennas are derived, including various types of dipoles, arrays, aperture, and frequency independent and traveling wave antennas. Concepts such as radiation resistance and pattern, directivity, gain, effective area, reciprocity, bandwidth, noise temperature, mutual coupling, and array scanning impedance are introduced. *Prerequisites: Graduate status and EL 6713, or EL 3604 with grade B or better.*

EL 6753* UHF Propagation for Wireless Systems 3:0:0:3

UHF radio applications for cellular mobile radio telephones, wireless local area networks and personal communications networks, Propagation and reflection of plane waves and spherical waves; antennas for transmitting and receiving; path loss and link budgets; Huygens' principle; Fresnel zone and diffraction of plane and spherical waves; mathematical models of UHF propagation over a flat earth, around buildings in cities and within buildings; influence of propagation on capacity of cellular systems. *Prerequisites: Graduate status and undergraduate electromagnetics course: *Online version available.*

EL 6823 Medical Imaging II 3:0:0:3

This course introduces the mechanisms and concepts related to image acquisition and subsequent image processing and image formation in various biomedical imaging modalities. Building on material covered in Biomedical Imaging I, these courses focus on advanced topics such as functional magnetic resonance imaging (MRI), ultrasound imaging, biomagnetic imaging and optical tomographic imaging (OTI). Co-listed as BE 6213.

EL 7023 Space-Time Wireless Communications 3:0:0:3

Wireless channel overview. Transmit and receive antenna diversity. Capacity of multi-antenna fading channels. Analysis and code design criteria. Space-time block and trellis codes. Spatial multiplexing and receiver design. Layered architectures. Applications to MIMO OFDM systems. *Prerequisites: EL 6303 Co-requisites: EL 6013 or EL 6023.*

EL 7133* Digital Signal Processing 3:0:0:3

Properties and applications of the discrete Fourier transform and FFT. Frequency measurement. Properties and design of linear-phase FIR digital filters by windowing, least-squares, and minimax criterion. Spectral factorization and design of minimum-phase FIR filters. Design of recursive digital filters. Short-time Fourier transform. Finite precision effects. Multirate systems. Basic spectral estimation. Basic adaptive filtering (LMS algorithm). Computer-based exercises will be given regularly. *Prerequisites: EL 6113 or Equivalent: *Online version available.*

EL 7153 Array Signal Processing 3:0:0:3

General sonar and radar array processing concepts. Array performance considerations. Narrowband and broadband signal processors. Classical and high resolution techniques for source direction finding. Eigenstructure-based techniques and spatial smoothing techniques. Performance analysis of eigenstructure-based techniques. Asymptotic distribution of eigenparameters associated with smoothed sample covariance matrices in uncorrelated and coherent scenes. Wiener solution and adaptive algorithms. Least Mean Square (LMS), accelerated gradient search and gradient algorithms with constraints. Direct implementation by inversion of the sample covariance matrix and transient response considerations. Smart antenna design concepts for Rayleigh fading cellular communication channels. Space Time Adaptive Processing (STAP) for ground and air moving target detection. *Prerequisites: Graduate status, EL 6113 and EL 6313.*

EL 7163 Wavelet Transforms and Filter Banks 3:0:0:3

Orthogonal and biorthogonal wavelet bases on the real line. Scaling functions and the dilation equation. Construction of Daubechies wavelet bases. Mallat's algorithm. Digital filter banks and the discrete wavelet transform. Two-dimensional wavelet transform and applications to image processing. Wavelet-based noise reduction. Lattice and lifting structures for implementation of filter banks. Expansive (over-complete) transforms. Additional applications. Students are required to complete a project and provide an oral presentation. Regular computer-based exercises are given. *Prerequisites: EL 7133.*

EL 7253 State Space Design for Linear Control Systems 3:0:0:3

Topics to be covered include canonical forms; control system design objectives; feedback system design by MIMO pole placement; MIMO linear observers; the separation principle; linear quadratic optimum control; random processes; Kalman filters as optimum observers; the separation theorem; LQG; Sampled-data systems; microprocessor-based digital control; robust control, and the servocompensator problem. *Prerequisites: Graduate status and EL 6253.*

EL 7353* Communication Networks I: Analysis, Modeling, and Performance 3:0:0:3

The purpose of this course is to introduce students to the analytical techniques used in the design and performance analysis of networks. Building on their knowledge of networking technology and applied mathematics, especially probability, students will start by learning basic queueing theory. This will be applied to the performance analysis of multiplexers, switches, and multiple access networks. Newer techniques such as the network calculus, the study of non-Poissonian long range dependent traffic sources, and applications to TCP, admission control, advanced packet switches, and IEEE 802.11 networks will be introduced. *Prerequisites: EL 5363 and EL 6303: *Online version available.*

EL 7363 Communications Networks II: Design and Algorithms 3:0:0:3

Network design consists of topology design and traffic routing taking into account dynamics in network states, such as link/node failures and traffic demand variations. Efficient design models and optimization methods are crucial to simultaneously achieve good network user performance and high savings in network deployment and maintenance. This course introduces mathematical models, design problems and optimization algorithms that can be used to guide network design practice. Subjects to be covered include: Network Design Problem Modeling, Optimization Methods, Multi-Commodity Flow Routing, Location and Topological Design, Fair Networks, Resilient Network Design, Robust Network Design, Multi-Layer Networks. *Prerequisite: Graduate status, EL 5363 or equivalent.*

EL 7373* High Performance Switches and Routers 3:0:0:3

This course addresses the basics, the theory, architectures, and technologies to implement high-performance high-speed large-scale routers and switches. The fundamental concepts and technologies of packet forwarding, classification, and switching learned in the class are useful and practical when designing IP routers, Ethernet switches, and optical switches. Topics to be included are: IP Route Lookup, Packet Classification, Packet Scheduling, Buffer Management, Basics of Packet Switching, Output-buffered Switches, Shared-memory Switches, Crosspoint-buffered Switches, Input-buffered Switches, Clos-network Switches, Multi-Stage Buffered Switches, Two-Stage Load-Balanced Switches, Optical Packet Switches, and ASIC for IP Routers. *Prerequisites: EL 5363 or advisor approval: *Online version available.*

EL 8223 Applied Nonlinear Control 3:0:0:3

Stability and stabilization for nonlinear systems; Lyapunov stability and functions, input-output stability, and control Lyapunov functions. Differential geometric approaches for analysis and control of nonlinear systems: controllability, observability, feedback linearization, normal form, inverse dynamics, stabilization, tracking, and disturbance attenuation. Analytical approaches: recursive backstepping, input-to-state stability, nonlinear small-gain methods, and passivity. Output feedback designs. Various application examples for nonlinear systems including robotic and communication systems. *Prerequisites: Graduate status and EL 6253 or EL 7253.*

EL 8233 Optimal Control Theory 3:0:0:3

Optimal control problem for deterministic systems with various constraints. Solution for both continuous and discrete-time systems using the maximum principle and dynamic programming. Singular arcs. Neighboring-optimal solutions. Fuel and time optimal control problems. Computational methods. *Prerequisites: Graduate status, EL 6233 and EL 6253.*

EL 8253 Large-Scale Systems and Decentralized Control 3:0:0:3

Introduction to analysis and synthesis of large-scale systems. System order reduction algorithms, interconnected system stability, series expansion, and singular perturbation. Lyapunov designs. Applications to traffic networks, power systems, and transportation networks. Decentralized control: decentralized fixed-mode, LQR, frequency-shaped cost functionals and overlapping decompositions. Stability of interconnected systems and Vector Lyapunov analysis. *Prerequisites: Graduate status and EL 7253 or instructor's permission.*

EL 90X3 Selected Topics in Wireless Communication (X=1, 2, 9) 3:0:0:3

Selected topics of current interest in wireless communications. (See departmental mailing for detailed description of each particular offering.) *Prerequisite: Specified when offered.*

EL 91X3 Selected Topics in Signal Processing (X=1, 2,...9) 3:0:0:3

Selected topics of current interest in signals and systems. (See departmental mailing for detailed description of each particular offering.) *Prerequisite: Specified when offered.*

EL 92X3 Selected Topics in Control Systems (X=1, 2,...9) 3:0:0:3

Topics of current interest to feedback and control system engineers. (See departmental mailing for detailed description of each particular offering.) *Prerequisite: Specified when offered.*

EL 93X3 Selected Topics in Telecommunications and Networking (X=1, 2,...9) 3:0:0:3

Selected topics of current interest in telecommunications and networking. (See departmental mailing for detailed description of each particular offering.) *Prerequisite: Specified when offered.*

EL 94X3 Selected Topics in Computer Electronic Devices and Systems (X=1, 2,...9) 3:0:0:3

Special topics of current interest to staff in the field of electronic devices, circuits and systems. (See departmental mailing for detailed description of each particular offering.) *Prerequisite: Specified when offered.*

EL 95X3 Selected Topics in Electro-Optics, Quantum Electronics and Material Science (X=1, 2,...9) 3:0:0:3

Topics of current interest dealing with the interaction of matter with electromagnetic fields. (See department mailing for detailed description of each particular offering.) *Prerequisite: Specified when offered.*

EL 96X3 Selected Topics in Power Engineering (X=1, 2,...9) 3:0:0:3

Topics of current interest in electric power engineering. (See departmental mailing for detailed description of each particular offering.) *Prerequisite: Specified when offered.*

EL 97X3 Selected Topics in Electrodynamics, Wave Phenomena and Plasmas (X=1, 2,...9) 3:0:0:3

Aspects of plasmas, electromagnetic and acoustic wave propagation, diffraction and radiation of current interest, including wave interactions with plasmas, materials and special mathematical and numerical techniques. (See departmental mailing for detailed description of each particular offering.) *Prerequisite: Specified when offered.*

EL 9900 Seminar in Electrical and Computer Engineering 0:0:0:0

Recent developments in electrical and computer engineering are presented through lectures given by invited speakers from industry, research, and educational institutions. To receive a satisfactory grade for the semester registered, a student must attend at least two thirds of the seminars during the semester. A PhD student must register and obtain satisfactory grade for at least four semesters. *Prerequisite: none.*

EL 9920 Summer Graduate Internship 0:0:0:0

This course provides graduate students majoring in electrical engineering, computer engineering, electrophysics, systems engineering, telecommunication networks or wireless innovation the opportunity to gain practical training off campus. Such training will enhance and strengthen the students overall educational experience by obtaining practical experience in currently active areas in industry. Adviser approval is required. *Prerequisite: Graduate Status and more than one semester of regular graduate course work.*

EL 9933 Readings in Electrical and Computer Engineering I 3:0:0:3

Reading of advanced literature in a research field relevant to electrical and computer engineering, conducted under guidance of a faculty member who is expert in the field. Oral presentation and a written report required. Not more than 3 credits may be offered toward the master's degree. *Prerequisite: Degree Status*

EL 9943 Readings in Electrical and Computer Engineering II 3:0:0:3

Reading of advanced literature in a research field relevant to electrical and computer engineering, conducted under guidance of a faculty member who is expert in the field. Oral presentation and a written report required. No more than 3 credits may be offered toward the master's degree. *Prerequisite: Degree Status.*

EL 9953 Advanced Projects I 3:0:0:3

Theoretical and/or experimental projects in various research areas in electrical and computer engineering. Projects assigned on basis of specialized interest and preparation of the student and conducted under guidance of a faculty member who is expert in the chosen subject. Oral presentation or a written report is required at the discretion of the adviser. *Prerequisite: Degree Status.*

EL 9963 Advanced Projects II 3:0:0:3

Theoretical and/or experimental projects in various research areas in electrical and computer engineering. Projects assigned on basis of specialized interest and preparation of the student and conducted under guidance of a faculty member who is expert in the chosen subject. Oral presentation or a written report is required at the discretion of the adviser. *Prerequisite: Degree Status.*

EL 997x Thesis for Degree of Master of Science in Electrical Engineering, Computer Engineering, Electrophysics, System Engineering, or Telecommunication Networks Variable Credits

Independent engineering project demonstrating professional maturity, performed under guidance of adviser. Oral thesis defense and formal, bound thesis volume required. Registration of at least 6 credits required (continuous registration required). *Prerequisite: Degree Status.*

EL 999x Dissertation for Degree of Doctor of Philosophy in Electrical Engineering Variable Credits

Original investigation of electrical engineering problem. Must demonstrate creativity and include features of originality and utility worthy of publication in recognized journal. Candidate must successfully defend dissertation orally. Registration of at least 21 credits required (continuous registration required). *Prerequisite: Passing PhD qualifying examination.*

Typical Course of Study for the Bachelor of Science in Electrical Engineering

FRESHMAN YEAR**Fall Semester**

Course No.	Course Title	Class	Hours/Week			Cr.
			Lab.	Rec.	Cr.	
EG 1004	Intro. Engineering & Design	1	3	2	4	
CS 1114	Intro. Prog. & Problem Solving ¹	3	3	0	4	
MA 1024	Calculus I	4	0	0	4	
EN 1014	Writing & Humanities I ³	4	0	0	4	
SL 1010	Freshman Seminar	1	1	0	0	
						16

Spring Semester

Course No.	Course Title	Class	Hours/Week			Cr.
			Lab.	Rec.	Cr.	
PH 1004	Introductory Physics I	4	1½	1	4	
CS 1124	Object-Oriented Programming	3	3	0	4	
MA 1124	Calculus II	4	0	0	4	
EN 1204	Writing & Humanities II	4	0	0	4	
						16

SOPHOMORE YEAR**Fall Semester**

PH 2004	Introductory Physics II	4	1½	1	4	
EE 2013	Fundamentals of Electric Circuits I ¹	3	0	1	3	
MA 2012	Linear Algebra I (½ semester)	4	0	0	2	
MA 2132	Ordinary Diff. Equ. (½ semester)	4	0	0	2	
HI 2104	Modern World History	4	0	0	4	
						15

Spring Semester

CM 1004	General Chemistry	3	2	1	4	
CS 2204	Dig Logic & State Mach Design ¹	3	3	0	4	
MA 2112	Multi. Calculus A (½ semester)	4	0	0	2	
MA 2122	Multi. Calculus B (½ semester)	4	0	0	2	
EE 2024	Fundamentals of Electric Circuits II ¹	3	1	1	4	
						16

JUNIOR YEAR**Fall Semester**

EE 3114	Electronics I	3½	1½	1	4	
EE 3054	Signals & Systems ¹	3½	1½	1	4	
MA 3112	Complex Variables I (½ semester)	4	0	0	2	
MA 3012	Intro. Probability I (½ semester)	4	0	0	2	
	HU/SS Elective ⁴	4	0	0	4	
						16

Spring Semester

EE 3604	Electromagnetic Waves	3½	1½	1	4	
EE	Restricted Elective ⁵	3½	1½	1	4	
EE	Restricted Elective ⁵	3½	1½	1	4	
	Restricted Elective				4	
						16

SENIOR YEAR**Fall Semester**

EE 4XX3	Design Project I ⁷	1	3	1	3	
EE/EL	Elective ⁸				3	
EE/EL	Elective ⁸				3	
HU/SS	Elective ⁴	4	0	0	4	
	Free Elective ⁹				4	
						17

Spring Semester

EE 4223	Design Project II	0	6	1	3	
EE/CS/EL	Elective ⁸				3	
EE/CS/EL	Elective ⁸				3	
EE/EL	Elective ⁸				3	
HU/SS	Elective ⁴	4	0	0	4	
						16

Total credits required for the degree:**128**

- Grade of C- or better is required.
- Students who are placed by examination or by an adviser into MA 0902, MA 0912 or MA 0922 must defer registration for MA 1024.
- Students who are placed by examination or by an adviser into EN 1080 must subsequently register for EN 1034, rather than EN 1014.
- Choice of HU and SS electives must conform to the established requirements of the HU/SS Dept.
- Restricted Electives must be chosen from the following: EE 3124, EE 3404, EE 3824 and EE 3064.
- A list of approved Sequence Electives is available from the department.
- One first semester Design Project course is selected from the following areas: wireless communication, electrical power and control and robotics.
- Elective courses must include at least one two-semester sequence (beginning and advanced courses) in an approved subject area. The first course may be a Restricted Elective. Any Restricted Elective may be used as an EE Major Elective course. One or two major elective courses may be a CS course.
- Any course for which student has prerequisite.

ELECTROPHYSICS PROGRAM

Program Director: Nirod Das

Polytechnic offers a program of study leading to the degree Master of Science in Electrophysics. Students entering the program typically have an undergraduate background in electrical engineering or physics, a strong interest in physical phenomena and/or applied mathematics and a desire to participate in research.

The Department of Electrical and Computer Engineering administers the Electrophysics Program.

The program comprises basic courses in wave propagation, electromagnetic theory and electro-optics. Traditional areas of active research covered include propagation modeling for wireless communications, propagation and scattering of waves, electromagnetic theory, antennas, microwave circuits, plasmas and solid-state devices. Areas of modern optics covered include lasers and optical communications. Additional areas covered are nonlinear wave propagation, ultrasonic waves in solids and waves in the earth's ionosphere. Polytechnic's electrophysics faculty has made significant contributions to each of the areas cited above. Students in the program are exposed to some of the most current technical developments in each area and can be guided in research at the forefront of these areas. Students wishing to continue graduate study toward a PhD in the area of electrophysics may do so in the PhD in Electrical Engineering Program.

GOALS AND OBJECTIVES

The Master of Science program in Electrophysics is intended to prepare students to work at the interface between electrical engineering and physics, where new engineering applications of various physical phenomena are developed. Emphasis is placed on wave propagation, electrodynamics and plasmas. For students entering the program with an undergraduate degree in physics, the program provides a view of engineering applications and requirement, as well as an advanced view of the physical processes of interest. Students who are interested in furthering their understanding of these topics may do so by continuing in the PhD program in Electrical Engineering.

Students entering the MS program in Electrophysics gain a deep understanding of the basic physical principles in one or more of the following areas: (a) electromagnetic wave propagation, (b) microwave devices and circuits, (c) antennas and radiation, and (d) lasers and electro-optics for

communications.

Students learn the engineering applications and performance measures of the physical principles in the different areas and are able to apply their knowledge to device and system design problems.

For those interested in PhD-level studies, the MS in Electrophysics prepares them for independent research that advances the knowledge of engineering applications of physical principles.

REQUIREMENTS FOR THE MASTER OF SCIENCE

The entrance requirements for a Master of Science in Electrophysics are a bachelor's degree in engineering or science from an accredited institution, with a superior undergraduate record, including undergraduate courses in differential equations, electromagnetic theory, quantum and solid-state physics and linear systems. Students with deficiencies in these areas may be admitted if they take appropriate introductory courses to remedy these deficiencies. Outstanding students are advised to apply for financial aid in the form of research fellowships teaching fellowships or partial tuition remission.

To satisfy the requirements for an MS in Electrophysics, students must complete a total of 30 credits of courses, as described below, and retain a B grade in all graduate courses. In addition, a B average is required in specific groups of courses, as indicated below.

GROUP 1: Core Courses

Three courses (3 credits each) from the following:

EL 5513 Electro-Optics I

EL 5733 RF and Microwave Systems
Engineering

EL 5753 Introduction to Plasma Engineering

EL 6113 Signals, Systems, and Transforms

EL 6583 Fiber Optic Communications

EL 6713 Electromagnetic Theory and
Applications

Total in Group 1

9 Credits

GROUP 2:

Two sequences each containing two courses; one course in each sequence may be a core course in Group 1. Both of these sequences must be in electrical engineering. Approved course sequences for the program are given in the ECE Graduate Student Manual.

Total in Group 2

6-12 Credits

GROUP 3:

Approved electives, which may include up to 6 credits of courses offered by any science or engineering program.

Total in Group 3

9-15 Credits

Minimum Grand Total: 30 Credits

Out-of-department courses: At least 24 credits must be in EL prefixed courses.

A 3-credit course in other science or engineering disciplines may be used to substitute an EL course upon approval by an ECE graduate adviser. Remaining credits can be from any graduate courses in science or engineering.

Thesis, project, and reading: A master's thesis (EL997x, 6 credits) or an MS project (EL9953 or EL9963, 3 credit each) or a reading course (EL9933 or EL9943, 3 credit each) may be included as part of the elective courses in group 3. Oral defense of the master's thesis with at least three professors in attendance is required. The total credits for thesis, projects, and readings should not exceed 9 credits within the 30 credits required for the MS degree. At most 3 credits can be taken for reading.

A complete course of study, including the choice of the course sequences, should be arranged in consultation with an adviser. An overall GPA of 3.0 in all graduate courses is required. In addition, a 3.0 average is required in the combination of five to seven courses offered to satisfy groups 1 and 2 above. Students should consult the Department of Electrical and Computer Engineering's Graduate Student Manual (www.poly.edu/ece/graduate) for more detailed rules and procedures, including student status, transfer credits, recommended electives, one-year sequences, current areas of research, and disqualification for low grades. Descriptions of graduate courses used in the Electrophysics Program are located in the Electrical Engineering Program section of this catalog.



ENVIRONMENT-BEHAVIOR STUDIES PROGRAM

Academic Adviser: Richard E. Wener

The department of Humanities and Social Sciences offers a Master of Science degree (30 credits) and a Certificate in Environment Behavior Studies (12 credits).

This field applies the methods and knowledge of the behavioral sciences to understand the relationship between people and the built or natural environment. This program is aimed at training students to be capable of addressing sociotechnical problems in a variety of research and applied settings. Students with training and expertise in design, technical, or scientific areas are encouraged to apply.

GOALS AND OBJECTIVES

Specific objectives of the Master of Science program in Environment-Behavior Studies are to accomplish the following:

Provide courses for design and planning professionals in human needs in built and natural settings. Students plan individualized programs in consultation with their faculty advisor, based on the core courses (9 credits), program electives (15 credits), and master's thesis (6 credits)

REQUIREMENTS FOR THE MASTER OF SCIENCE

A total of 30 credits are required for the masters degree. To qualify for a degree, a thesis embodying appropriate and substantive research is required. Acceptance of a thesis involves an oral presentation and defense.

Core Courses (9 credits)

PS 9083 Research Methods
PS 9263 Environmental Psychology
Statistics (MA 651 or equivalent)

Thesis (up to 6 units):

SS 997 Master's Thesis (can be repeated once)

Electives (15 Units):

Students take three PS graduate elective courses and two from any department, chosen in consultation with their adviser.

REQUIREMENTS FOR ADVANCED CERTIFICATE

Students may take a four-course sequence for a Certificate in Environment Behavior Studies. The program is available as a minor for students in other programs or for students applying directly for the certificate.

ADMISSION CRITERIA

Students are required to have a bachelor's degree from an accredited institution. Background in psychology (introductory and advanced courses) is useful but not required.

GRADUATE COURSES

PS 9053 Psychology: Applied 3:0:0:3

This course demonstrates how various problems, particularly in work, can be solved through the judicious use of psychological principles. Phenomena addressed include human-machine interaction and other engineering behavior interactions, smoking, study habits, memory, creative thinking, group interaction, raising children, in influencing people, self control and specific problems brought up in class by students. Students learn to employ the method of behavioral analysis in gaining an understanding of various problems. They select a problem, do a behavioral analysis and, finally, modify it as a class project. *Prerequisite: none Co-Requisite: none Notes: none*

PS 9063 Human Cognition and Information Processing 3:0:0:3

Human cognitive capabilities including natural language and information processing. Memory, internal representation of knowledge, concept information, symbol manipulation, language acquisition, reasoning and problem solving. Artificial intelligence approaches to natural language learning and acquisition of cognitive skills. *Prerequisite: none Co-Requisite: none Notes: none*

PS 9073 Human-Computer Interaction 3:0:0:3

This course introduces students to human behavioral issues in the design and use of interfaces for information systems. Basic issues of behavioral research and evaluation methods are discussed. Sensory systems and memory and learning theory relevant to human factors systems are reviewed and related to specific interface issues, such as interaction devices, dialogue design and reference material. The focus is on understanding the issues involved in creating systems amenable to human use. *Prerequisite: none Co-Requisite: none Notes: none*

ENVIRONMENT-BEHAVIOR STUDIES PROGRAM 2

PS 9083 Research methods 3:0:0:3

Theory and methods of measurement of sensory functions in human and animal subjects. Examination of the concept of the threshold and problems of its measurement. Investigation of learning, both motor and verbal, and both simple and complex, including problem solving and creative thinking. Students perform a series of experiments with human and animal subjects. *Prerequisite: none Co-Requisite: none Notes: none*

PS 9093 Experimental Psychology 3:0:0:3

Experimental and descriptive methods including quasi-experimental design and large-scale survey techniques used by social, environmental, and developmental psychologists to assess human behaviors in laboratory and naturalistic settings. The course focuses laboratory and observational methods used to assess environmental effects, attitude measurement, social impact assessment, and theory and psychometric bases of normal personality development and assessment. *Prerequisite: PS 9083 or consent of advisor Co-Requisite: none Notes: none*

PS 9103 Theories of Learning 3:0:0:3

Programmed learning, behavior therapy, attitude function and social interaction. All students are required to perform one experiment on learning under guidance of instructor. Available to undergraduate majors in social science. *Prerequisite: none Co-Requisite: none Notes: none*

PS 9113 Psychology of Language and Communication 3:0:0:3

Methodological problems in analysis of language, verbal behavior in animals, anatomical and physiological aspects of speech apparatus, operant and respondent conditioning of verbal behavior, semantics, statistical approaches and mathematical models, contextual factors and pathology of speech. All students are required to perform one experiment under guidance of instructor. *Prerequisite: none Co-Requisite: none Notes: none*

PS 9123 Sensation and Perception

3:0:0:3

Review of different sensory systems: vision, audition, taste, smell, touch, temperature sensitivity, vestibular and kinesthetic senses and their relations to nonsensory controlling stimuli such as states of the organism, learning and social psychological variables. Techniques for obtaining psychophysical data on each sensory system and relations of these techniques to theories of discrimination. Available to undergraduate majors in social science. *Prerequisite: none Co-Requisite: none Notes: none*

PS 9133 Physiological Psychology

3:0:0:3

Physiological and anatomical bases of behavior. Memory, motivation, emotion, sleep reward mechanisms, psychosurgery and higher cortical functions. *Prerequisite: none Co-Requisite: none Notes: none*

PS 9153 Behavioral and Societal Aspects of Transportation

3:0:0:3

Behavioral analyses of transportation decision-making and travel characteristics. User needs in design of transportation systems: crowding, social isolation, crime, comfort and convenience. Social impacts of transport systems on communities. *Prerequisite: none Co-Requisite: none Notes: none*

PS 9203 Seminar in Psychology

3:0:0:3

Major areas of psychology required of all MS candidates. History and systems, sensation and perception, learning, developmental and abnormal. *Prerequisite: none Co-Requisite: none Notes: none*

PS 9253 Social Impact Assessment

3:0:0:3

How physical changes in urban or rural settings affect social systems and group and individual behavior. Measuring quality of life and social responses to technology; uses of alternative futures paradigms. Students do an analysis of a problem in social impact and report finding to class. *Prerequisite: none Co-Requisite: none Notes: none*

PS 9263 Environmental Psychology

3:0:0:3

Theory and methods of measurement of sensory functions in human and animal subjects. Examination of the concept of the threshold and problems of its measurement. Investigation of learning, both motor and verbal, and both simple and complex, including problem solving and creative thinking. Students perform a series of experiments with human and animal subjects. *Prerequisite: none*

ENVIRONMENT-BEHAVIOR STUDIES PROGRAM 3

PS 9283 Advanced Topics in Environmental Psychology

3:0:0:3

This course varies from year to year depending on the needs and interests of students and instructors. Potential subjects include social impacts of transportation systems; stress and the environment; aversive environmental factors; laboratory assessment of environmental effects on animal learning; effects of pollution; human factors of software design; assessing the built environment including the office; and applied behavioral analysis. May be repeated for total of up to 9 credits

PS 997x Thesis for Degree of Master of Science 6 credits Independent research project demonstrating scientific competence performed under the guidance of advisers. May be repeated for total up to 6 credits, *Prerequisite: consent of advisor*

ENVIRONMENTAL ENGINEERING AND SCIENCE PROGRAM

Academic Advisor: Alan H. Molof

The Department of Civil Engineering offers graduate programs in environmental engineering and environmental science leading to the following degrees with environmental designation:

- Master of Science in Environmental Engineering
- Master of Science in Environmental Science

The department also offers the following graduate programs with environmental engineering majors, but with civil engineering designation:

- Master of Science in Civil Engineering
- Doctor of Philosophy in Civil Engineering

Programs with environmental engineering and environmental science designations are described below. Programs with civil engineering designations are described in the Civil Engineering Program section of this catalog.

Master of Science programs are practice-oriented with a strong foundation in underlying principles and methods. The PhD is intended for students with a strong research interest and a desire to advance the state-of-the-art as a result of that research.

Environmental science and environmental engineering are multidimensional professions dealing with preserving, protecting, and remedying air, water, and soil environments. The programs' emphasis is on preparing graduates to be immediately employed to meet the challenges of this century or to proceed directly to advanced graduate studies.

GENERAL REQUIREMENTS FOR ENVIRONMENTAL PROGRAMS ADMISSION REQUIREMENTS

Applicants for the Master of Science in Environmental Engineering should hold an undergraduate or graduate degree in environmental or civil engineering or equivalent from an acceptable institution. Students may be accepted with other appropriate backgrounds, but should, as a minimum, have one year of chemistry and physics, and basic courses in calculus and differential equations. Such students may be asked to take up to 15 credits of undergraduate courses to complete their preparation. Applicants for the Master of Science in En-

vironmental Science typically have undergraduate or graduate degrees in the physical, chemical, or biological sciences. Undergraduate chemical courses may be recommended or required by the adviser to make up for deficiencies in academic preparation.

Admission to the PhD program requires a suitable MS degree from an acceptable institution. A minimum GPA of 3.5 in master's level work is generally required for admission into the PhD program. For more information concerning the PhD in Civil Engineering, consult the Civil Engineering" program section of this catalog.

GRADE REQUIREMENTS

To earn graduate degrees or certificates, Polytechnic requires that students have a 3.0 GPA or better in all graduate courses and in all guided studies (readings, projects, theses, dissertations). Averages are separately computed for courses and guided studies. Transfer credits from other institutions are not included in this average.

ANALYTIC BACKGROUND

All applicants for MS or graduate certificate programs in environmental programs must show evidence of quantitative analytic ability, generally including a minimum of two years of college mathematics and a college-level course in statistics.

PhD applicants are expected to have a superior quantitative analytic background. In addition, they must take at least one course in graduate level statistics, regression analysis or design of experiments as part of their studies.

ADVISING

Each student in the graduate program is assigned a faculty adviser. It is important that students maintain frequent contact with their adviser throughout the course of their studies. Students must meet with their academic adviser prior to each registration and at any other time they need advice or consultation.

Students must have a detailed program of study formally approved by the adviser prior to registration. Advisers also handle requests for waiver of certain degree requirements where warranted. Such waivers must be approved in writing and must be entered into the student's departmental file.

Where specific courses are waived, permission of the course instructor is also required. When waivers are granted, students may be required to take other specific courses

in their place or to select additional electives.

Students registering for any guided studies (readings, projects, theses, dissertation) are assigned project advisers for each such activity. The project adviser may or may not be the same as the student's academic adviser, depending upon the subject matter selected. To register for any guided study activity, students must submit written proposals for the topic(s) to be covered to an appropriate project adviser before registration. To register, students must obtain the written approval of the project adviser and the academic adviser. Doctoral students may not register for dissertation credits until they have passed the PhD qualifying examination.

In addition to academic and project advisers, students studying under research or teaching fellowships are assigned fellowship advisers. Normally, these would be either the principal investigator of the research effort funding the fellowship or the director of the academic area in which the teaching fellowship is awarded.

While academic advisers consult and give advice to students, it is the student's responsibility to ensure that all degree requirements are fulfilled, and to submit all proper forms and application when necessary.

TRANSFER CREDITS

The minimum number of credits students must take at Polytechnic to be awarded a graduate Polytechnic degree is 24 for an MS degree. All credits for a graduate certificate must be taken at Polytechnic.

Students may transfer up to 6 credits of acceptable courses toward an MS degree, subject to the approval of the academic adviser. To be transferred, the course(s) must be relevant to the program and from an acceptable institution. A grade of B or better is required for granting of transfer credit.

Courses graded on a pass/fail basis are not considered for transfer unless accompanied by a detailed written evaluation by the instructor of the course. All transfer requests must be accompanied by an official transcript from the transferring institution. Application for transfer credits is accepted only after the student has earned 12 credits at Polytechnic.

MASTER OF SCIENCE IN ENVIRONMENTAL ENGINEERING GOALS AND OBJECTIVES

The primary goal of the MS in Environmental Engineering is to prepare professionals to plan, functionally design, control, operate and manage municipal and industrial systems of pollution prevention. Specific objectives of the program are to provide the skills necessary to:

- Fundamentally understand the science and engineering of natural and manmade environmental systems
- Functionally design air, water and waste treatment systems and components
- Control and operate environmental facilities
- Understand the modeling and simulation of environmental systems
- Actively participate in multidisciplinary teams to solve environmental problems
- Students are exposed to a learning atmosphere that provides a meaningful mix of theoretical and practical approaches. Courses include a mix of presentations, project exercises and practical problem solutions.

PROGRAM REQUIREMENTS

Course Title	Credits
CE 7233 Ground Water Hydrology and Pollution	3
CE 7373 Environmental Chemistry & Microbiology I	3
CE 7393 Environmental Chemistry & Microbiology II	3
CE 7423 Water & Wastewater Treatment I	3
CE 7433 Water & Wastewater Treatment II	3
CE 7703 Solid Waste Management and	3
CE 9996* Project for the Master of Science or	3
CE 9997* Master's Thesis	6
Plus 6-9 credits of approved electives Courses**	

Total 30 credits
 * Students may opt for a thesis option instead of the project option
 ** All electives are subject to adviser approval

MASTER OF SCIENCE IN ENVIRONMENTAL SCIENCE GOALS AND OBJECTIVES

The primary goal of the MS in Environmental Science is to prepare professionals to:

- Fundamentally understand the science and applied engineering of natural and man-made environmental systems
- Evaluate the interactions between man and the environment Control adverse impacts of pollution on ecological systems
- Understand the monitoring and laboratory analysis of the environmental systems

- Actively participate in a multidisciplinary team of professionals to solve environmental problems.

PROGRAM REQUIREMENTS

Course Title	Credits
CE 7373 Environmental Chemistry & Microbiology I	3
CE 7393 Environmental Chemistry & Microbiology II	3
CE 7423 Water & Wastewater Treatment I	3
CE 7433 Water & Wastewater Treatment II	3
CE 7513 Environmental Health Engineering	3
CE 7523 Air Pollution	3
CE 7703 Solid Waste Management and	3
CE 9963* Project for the Master of Science or	3
CE 9973* Thesis for the Master of Science Plus 3-6 credits of approved elective Courses**	6

Total 30 credits
 * Students may opt for a thesis option instead of the project option
 ** All electives are subject to adviser approval

GRADUATE CERTIFICATE IN HAZARDOUS WASTE MANAGEMENT

The certificate program is designed to provide practicing engineers and environmental professionals with current engineering practices and management techniques, and to provide the framework to understand and interpret environmental law applicable to hazardous waste management. Students must take two core courses and three elective courses to complete the certificate requirements.

Core Courses

CE 7533 Hazardous/Toxic Waste Management
CE 7543 Hazardous Site Remediation Elective Courses
CE 7223 Hydrology
CE 7233 Groundwater Hydrology & Pollution Control
CE 7553 Environmental Toxicology
CE 7563 Environmental Law
CE 8493 Environmental Geotechnology
CE 7XX3 Approved Special

Topic Courses

Students in certificate programs may apply for transfer to degree programs without any loss of credits assuming they are admitted to the degree program and that the courses are appropriate to the degree. Admission to a certificate program does not guarantee admission to a full degree program.

DOCTOR OF PHILOSOPHY IN CIVIL ENGINEERING

Students who wish to pursue a doctoral degree in the area of environmental engineering and environmental science may do so under the PhD in civil engineering and en-

vironmental science. For detailed information on this program, please consult the Civil Engineering program section of this catalog.

GRADUATE COURSES

CE 7373 Environmental Chemistry and Microbiology I 1½:1½:0:3

Introduction to the chemistry of drinking water, polluted and natural waters, including laboratory application of principles developed.

CE 7393 Environmental Chemistry and Microbiology II 2:1:0:3

Topics in chemistry and microbiology of polluted and natural waste water systems. Prerequisite: CE 7373 or equivalent

CE 7423 Water and Wastewater Treatment I 3:0:0:3

Physical, chemical, and biological principles involved in process design and treatment of water and wastewater. Topics include aeration, filtration, softening, chemical treatment, coagulation, flocculation, desalination, taste and, odor control. Co-requisite: CE 7373.

CE 7433 Water and Wastewater Treatment II 3:0:0:3

Continuation of CE 7423. Topics include sedimentation, adsorption, aerobic and anaerobic biological treatment, sludge treatment and disposal. Co-requisite: CE 7393.

CE 7453 Water and Wastewater Treatment Laboratory 1:2:0:3

Laboratory processes in water and wastewater engineering, dealing with physical, chemical and biological methods and principles. Processes include disinfection, softening, sedimentation, oxygen transfer, coagulation, adsorption, filtration and aerobic and anaerobic biological treatment systems. Warburg analysis of waste. Co-requisite: CE 7433.

CE 7463 Industrial Waste Treatment 3:0:0:3

Sources of industrial wastewaters and their treatability by physical, chemical, and biological processes. Problems and solutions involved in combining municipal and industrial waste treatment. Status of government regulations imposed on industries in prevention of water pollution.

CE 7473 Analysis of Stream and Estuary Pollution 3:0:0:3

Dispersal and decay of contaminants introduced into lakes, streams, estuaries, and oceans. Effects of pollutants on chemical quality and ecology of receiving waters.

CE 7483 Sanitary Engineering Design 1:2:0:3

Design of water supply and wastewater treatment systems. Topics of special interest. *Co-requisite: CE 7433.*

CE 7513 Environmental Health Engineering 3:0:0:3

Theory, methodology, and instrumentation associated with environmental health. Topics include epidemiology, food vectors, radiation, pest control, heating, ventilation, noise, illumination, hazards of home and community environment, and other subjects affecting public health.

CE 7523 Air Pollution 3:0:0:3

Causes and effects of air pollution. Methods of sampling. Interpretation of data. Meteorological aspects. Methods of air pollution control.

CE 7533 Hazardous/Toxic Waste Management 3:0:0:3

Methods in the management of hazardous/toxic waste sites. Topics covered include health and safety, legal aspects, contamination of the environment, treatment processes, toxicology, and risk assessment.

CE 7543 Hazardous/Toxic Site Management 3:0:0:3

Treatment and disposal technologies for hazardous waste site remediation. Insitu and ex-situ processes. Physicochemical processes, stabilization and solidification; biological processes including aerobic and anaerobic systems for degradation and detoxification; thermal processes and incineration; storage, land disposal, and containment. Remediation planning and technology selection for hazardous waste containment and clean up for typical case studies. Decision-making framework and technology selection will be a key course component. The course will also involve case studies and a class project.

CE 7553 Environmental Toxicology 3:0:0:3

This course stresses basic concepts essential to the understanding of the action of exogenous chemical agents on biological systems. The course will cover the principles of absorption and the effects of chemical agents on metabolism. The pathways of metabolism of these compounds and the principles of elimination from biological systems will be discussed. Toxicokinetics, types of toxic responses, and the current experimental methods of toxicity will also be discussed.

CE 7563 Environmental Law 3:0:0:3

This course presents legal principles and issues relating to environmental law. Historical perspectives and case laws will be considered. The Clean Water Act, non-point sources and water quality laws, Clean Air Act and its amendments, the National Ambient Air Quality and National Environmental Policy Act will be covered in this course. The above legislation and its impact on policy and technology will also be discussed.

CE 7583 Air Pollution Engineering Control 3:0:0:3

Pollutant emissions control; analysis of pollutant properties, concentrations and boundary conditions; absorptive and reactive recovery processes for moving and stationary sources; formation and removal of gaseous oxides (NO, SO, CO, etc.) and of aerosols and other particulates. Prerequisite: adviser's approval. Also listed under CH 7523.

CE 7673 Environmental Impact Evaluation 3:0:0:3

An examination of legal and technical requirements in the preparation of environmental impact evaluations. Considerations include legal and technical requirements, the procedure and the interdisciplinary nature of the analysis. Topics include overall impact evaluation, problem definition, quantification of impact, methods used in analysis, field evaluations, mitigations, hearing procedures and management. Practical examples and case studies are used.

CE 7703 Solid Waste Management 3:0:0:3

Engineering aspects of solid waste collection, transport and disposal, including incineration, sanitary landfill, composting, recovery, and reutilization. Economic evaluation of factors affecting selection of disposal methods.

CE 7713/7723 Selected Topics in Environmental Engineering and Water Resources I/II each 3:0:0:3

Current topics including nitrification in natural and treated waters, hazardous and toxic wastes, organic removal from water supplies, water reuse, specialized aspects of biological wastewater treatment, environmental health, solids disposal, and modeling natural waters and treatment systems. *Prerequisite: instructor's permission.*



FINANCIAL ENGINEERING PROGRAM

Program Director

Charles Tapiero, Topfer Chair Professor

Program Administrator

Juliette Acker

GRADUATE PROGRAMS MASTERS IN FINANCIAL ENGINEERING

The Department of Finance and Risk Engineering offers in its Financial Engineering MS Program graduate level courses in Finance, Economics, Financial Markets and Corporate Finance, Quantitative Finance, Financial Econometrics, Financial Technology, Risk Management, Risk Analysis and Assessment in Financial Services, Stochastic Finance Calculus, Stochastic Financial Modeling, and in related applied fields (Fixed Income, Derivatives, Securitization, Investment and Financial Management, Algorithmic Trading, Financial Physics, Environmental Finance, Data Mining and Intelligent Finance, etc.). These courses form a major portion of the coursework for an advanced degree in Financial Engineering, seeking to bridge the gap between theoretical and applied finance. Courses may also be taken by students in other departments (subject to approval by the Finance and Risk Engineering department) to satisfy minor and elective requirements and by qualified pre-degree students who desire further study in graduate-level Financial Engineering.

REQUIREMENTS FOR THE MASTER OF SCIENCE

A Bachelor's degree is required for admission to this program. Students with degrees in other fields may be admitted, possibly with undergraduate deficiencies, at the discretion of departmental advisors. Before beginning graduate studies, students conditionally approved will be required to demonstrate proficiency in basic statistics, probability and mathematics. E-Poly courses will be recommended to this effect but can be waived as well at the discretion of the academic faculty supervisor. *Prerequisites: Economics (EC 2514, EC 2534 or equivalent) Calculus (MA 1124 or equivalent) Probability and Statistics (MA 2212, MA 2322 or equivalent) Linear Algebra (MA 2012 or equivalent)*

Master's in Financial Engineering:

36 credits

All tracks will include in their program:

1. 5 Core courses, each 3 credits
2. 5 Required courses, each 1.5 credits
3. 1 Required Applied Lab, worth 1.5 credits
4. 4 Elective courses, each 1.5 credits
5. 1 Capstone worth 6 credits

Core Courses (Required): 15 credits

FRE 6003	Financial Accounting	3
FRE 6023	Economic Foundations in Finance	3
FRE 6083	Quantitative Methods in Finance	3
FRE 6103	Corporate Finance	3
FRE 6123	Financial Risk Management & Asset Pricing	3

All tracks: core courses = 15 credits.

There are three track options for incoming MS students of Financial Engineering, in each track there are 5 classes worth 1.5 credits each, totaling 7.5 credits.

Financial Markets and Corporate Finance Computational Finance Financial Information Services and Technology

Required Courses Per Track: 7.5 credits

Financial Markets and Corporate Finance

FRE 6091	Financial Econometrics	1.5
FRE 6291	Applied Derivative Contracts	1.5
FRE 6411	Fixed Income Securities & Interest Rate Derivatives	1.5
FRE 6711	Portfolio Theory and Applications	1.5
FRE 6271	Valuation of Equity Securities & Financial Statement Analysis	1.5

Computational Finance Track

FRE 6231	Stochastic Calculus and Financial Modeling	1.5
FRE 6251	Numerical and Simulation Techniques in Finance	1.5
FRE 6311	Dynamic Assets and Options Pricing	1.5
FRE 6331	Financial Risk Management and Optimization	1.5
FRE 6351	Advanced Financial Econometrics	1.5

Financial Information Services and Technology Track

FRE 6131	Clearing and Settlement of Financial Transactions	1.5
FRE 6151	Foundations of Financial Technology	1.5
FRE 6791	Operational Risk Measurement and Management	1.5

FRE 6071	Derivatives, Financial Markets and Technology	1.5
FRE 6431	Electronic Market Design	1.5

Required Labs per Track: 1.5 credits

Students from all tracks must choose one of the following labs each 1.5 credits

FRE 6811	Financial Lab 1, Excel, Risk and Yieldbook
FRE 6821	Financial Lab 2: Eviews and Stata
FRE 6831	Financial Lab 3: Financial Lab Matlab, GAMS and optimization software
FRE 6841	Financial Lab 4: S-Plus and R
FRE 6851	Financial Lab 5: C++

Please note that all students must take one lab, but that additional labs taken do not count towards MS FE electives.

Capstone Options: 6 credits

FRE 7003	Master's Thesis (required for potential Ph.D. candidates)
FRE 7023	Internships (4 Months at least, concluded with a document presented to the faculty.)
FRE 7043	Selected Project, under Faculty supervision.

Credit Allocation

Core Courses: 15
Required Courses: 7.5
Electives Credits: 6
Lab: 1.5
Capstone: 6
Total Credits: 36

All these options require a review by faculty advisors and certification of satisfactory work.

GRADUATE CERTIFICATE PROGRAMS

The Graduate Certificate programs have the same application requirements and prerequisites as the Master of Science Degree. Admission to the program requires a baccalaureate from an accredited institution. Candidates to the Certificate program are not required to take the GRE/GMAT, but should have obtained a minimum GPA of 3.0.

Graduate Certificate Program in Financial Engineering

Program Prerequisites

Calculus	MA 1124 or equivalent
Statistics	MA 2322 or equivalent
Linear Algebra	MA 2012* or equivalent
FRE 6023	Economic Foundations in Finance or its equivalent

*Knowledge of spreadsheets expected. Some exposure to computer programming languages.

Financial Engineering Certificate

	Credits
FRE 6083 Quantitative Finance	3
FRE 6103 Corporate Finance	3
FRE 6411 Fixed Income Securities & Interest Rate Derivatives	1.5
FRE 6291 Options & Derivatives	1.5
FRE 6511 Intermediate Derivatives Valuation and Applications	1.5
FRE 6711 Portfolio Theory and Applications	1.5
Free elective	1.5
Lab	1.5

To satisfy the 1.5 credits of lab required, students choose one of the following labs:

FRE 6811 Financial Lab 1: Excel, Risk and Yieldbook	
FRE 6821 Financial Lab 2: Eviews and Stata	
FRE 6831 Financial Lab 3: Matlab, GAMS	
FRE 6841 Financial Lab 4: S-Plus and R	
FRE 6851 Financial Lab 5: C++	
Total Credits: 15	

Graduate Certificate Program in Risk Management

Program Prerequisites

Economics	EC 2524 or equivalent
Calculus	MA 1124 or equivalent
Statistics	MA 2222 or equivalent
Linear Algebra	MA 2012* or equivalent

* Knowledge of spreadsheets expected. Some exposure to computer programming languages.

Risk Management Certificate

	Credits
FRE 6083 Quantitative Finance	3
FRE 6271 Valuation of Equity Securities & Financial Statement Analysis	1.5
FRE 6411 Fixed Income Securities & Interest Rate Derivatives	1.5
FRE 6291 Options & Derivatives	1.5
FRE 6511 Intermediate Derivatives Valuation & Applications	1.5
FRE 6711 Portfolio Theory & Applications	1.5
FRE 6731 Basel 2 & Value at Risk	1.5
FRE 6751 Credit Risk Measurement & Management	1.5
FRE 6791 Operational Risk Measurement & Management	1.5
Free elective	1.5
Lab	1.5

To satisfy the 1.5 credits of lab required, students choose one of the following labs:

FRE 6811 Financial Lab 1, Excel, Risk and Yieldbook	
FRE 6821 Financial Lab 2: Eviews and Stata	
FRE 6831 Financial Lab 3: Matlab, GAMS	
FRE 6841 Financial Lab 4: S-Plus and R	
FRE 6851 Financial Lab 5: C++	
Total Credits: 18	

Graduate Certificate Program in Financial Technology Management

Program Prerequisites

Financial	
Accounting:	FRE 6003 or equivalent
Economics:	EC 2524 or equivalent
Probability and Statistics:	MA 2222 or equivalent

Financial Technology Management Certificate

	Credits
FRE 6131 Clearing and Settlement of Financial Transactions	1.5
FRE 6151 Foundations of Financial Technology	1.5
FRE 6171 Management of Financial Institutions	1.5
FRE 6103 Corporate Finance	3
FRE 6071 Derivatives, Financial Markets and Technology	1.5
MG 7503 Management of Electronic Business	3
MG 8203 Project Assessment & Management	3
Total Credits: 18	

UNDERGRADUATE COURSES

FIN 2003 Economic Foundations of Finance 3:0:0:3

This course focuses on the fundamental economic concepts underpinning modern financial theory. Material covered includes: consumer behavior, utility theory, analysis of production and costs, competitive markets, monopolistic and monopsonistic markets, time value of money, game theoretic analysis of oligopoly, asymmetric information in markets, externalities, market efficiency, and more. The calculus will be used as appropriate in developing these concepts. *Prerequisites: EN 1204, and 8 credits of calculus.*

FIN 2103 Creating & Understanding Financial Statements 3:0:0:3

This course provides the student with a solid understanding of the creation and interpretation of modern financial statements. Topics covered include: the compelling reasons for financial statements, Sarbanes-Oxley, accounting principles in the US and how they differ abroad, quality of financial information, financial ratios and their uses, cash flow analysis, measurement of corporate performance, credit analysis, and introduction to managing financial risk. *Prerequisites: EN 1204.*

FIN 2203 Corporate Finance and Financial Markets 3:0:0:3

This course covers the fundamentals of corporate finance, valuation, risk, capital budgeting, and market efficiency. Students who complete this class will have acquired a solid foundation for the study of intermediate and advanced topics in finance. This class serves as a prerequisite for all FIN classes at the 3000-level. *Prerequisites: EN 1204, MA 2054 or MA 2212 or MA 3012, 8 credits of calculus.*

FIN 3213 Financial Management and Risk Engineering 3:0:0:3

The purpose of this course is to introduce the student to the elements and techniques of risk engineering spanning: Probabilities and their distributions, data analysis and statistics as well as Monte Carlo simulation. Throughout, these techniques are demonstrated through special problems and cases providing the necessary tools and concepts for dealing with outstanding problems in risk engineering, decision making under uncertainty and financial management and pricing. The course is based on multiple sessions in a Financial Laboratory environment using computational risk software, statistical and financial econometric software as well as simulation programs and software. *Prerequisite: FIN 2203; Co-Registration Requirements: FIN 2003, FIN 2103.*

FIN 3233 Derivatives and the Options Market 3:0:0:3

This course builds on mathematical models of bond and stock prices and covers two major areas of mathematical finance that have a significant impact on the operation of model financial markets, namely, Black-Scholes arbitrage pricing of options as well as other derivative securities and interest rates together with their term structure. The course makes significant use of probability and calculus, covering the material in a mathematically rigorous and complete manner. *Prerequisite: FIN 2203; Co-Registration Requirements: FIN 2003, FIN 2103.*

FIN 3403 Entrepreneurship and Financial Management 3:0:0:3

This course introduces the student to the finance of entrepreneurship and venture capital. The perspectives of both the start-up firm and the venture capitalist are considered, and a framework for understanding the laws, contracts and issues involved in reaching mutually profitable contracts is developed. *Prerequisites: FIN 2203.*

FIN 3503 Operational Risk Modeling and Analytics 3:0:0:3

This course focuses on how to optimize business strategies from both qualitative and quantitative points of view with respect to operational risk. The course is organized around the principle that the analysis of operational risk consists, in part, of the collection of data and the building of mathematical models to describe the risk of failures in human resource, processes and technology. Beginning with a foundation for operational risk modeling and a focus on the modeling process, the course discusses probabilistic tools for operational risk modeling and statistical methods for calibrating models of operational risk. The quantitative assessment of operational risk uses the tools of probability, statistics, and actuarial science. *Prerequisite: FIN 2203; Co-Registration Requirements: FIN 2003, FIN 2103.*

FIN 4903 Special Topics in Finance and Risk Engineering 3:0:0:3

Topics of interest in Finance and Risk Engineering. The specific subject of each offering is generally unique. The course may feature a detailed look at a single topic or a series of focused topical presentations. *Prerequisite: Permission of Department or Instructor.*

REQUIRED GRADUATE COURSES**MS in Financial Engineering/All Tracks**
FRE 6003, Financial Accounting 3:0:0:3

This course provides a solid foundation in the construction and interpretation of financial statements. Topics include: accounting terminology, financial statement preparation and analysis, liquidity and credit risk ratios, depreciation calculations, revenue recognition, accrued liabilities, and asset valuation. Also covered are the effects of equity transactions, cash flows, and various accounting methods on financial statements. *Prerequisite: none Co-Requisite: none Notes: none.*

FRE 6023, Economic Foundations in Finance 3:0:0:3

This course studies the interactions between money, the financial system, and the economy. Topics covered include: supply and demand, consumer theory, theory of the firm, costs of production, and other subject areas such as interest rates and asset returns. This course summarizes key insights from financial economics as the methodological and conceptual basis of financial engineering.

Prerequisite: none Co-Requisite: none Notes: none.

FRE 6083, Quantitative Methods in Finance 3:0:0:3

This course focuses on the use of quantitative methods for construction and application of models in financial engineering. Modern probability, stochastic processes and optimization are the mathematical foundations. Topics covered include probability spaces, conditional probability, densities, distributions, density estimators, multivariate probability, moment generating functions, random walks, Markov processes, Poisson processes, and the Brownian motion process. *Prerequisite: Students are expected to have knowledge in calculus and elementary probability. Co-Requisite: none Notes: none.*

FRE 6103, Corporate Finance 3:0:0:3

The modern corporation, as issuer of financial securities and end-user of financial risk management products, is one of the major participants in financial markets and the economic counterpart to investors and financial intermediaries. Whereas the mechanism of financial markets and the valuation of instruments are studied in further detail elsewhere, in this course the tools of the trade of financial economics and corporate finance are applied to the financial decision-making process of firms. Upon successful completion of this course, students will know how to contribute to optimal financial decisions in a corporation: valuation, capital budgeting, risk, capital structure, dividend policy, long-term financing, risk management, mergers & acquisitions. Increasingly important international factors, which affect corporate finance, will be stressed throughout the course. *Prerequisite: none Co-Requisite: none Notes: none.*

FRE 6123, Financial Risk Management & Asset Pricing 3:0:0:3

This course introduces the students to the techniques and problems of Financial Risk Management and Asset Pricing. Risk finance and attitudes, Value at Risk, risk measurement and principles of decision making under uncertainty, valuation and expected utility and their relevance in the valuation and the pricing of financial investments, insurance, the management of derivatives, risk management etc. are emphasized. Throughout the course, application problems in risk management are treated. In addition, fundamental applications in financial engineering including the Arrow-Debreu risk neutral

pricing framework, Binomial models in option pricing, essential elements of Ito calculus and the Black Scholes model for pricing options is introduced. *Prerequisite: none Co-Requisite: none Notes: none.*

REQUIRED COURSES IN TRACKS**Track: Financial Markets & Corporate Finance****FRE 6091, Financial Econometrics**

1½:0:0:1½

This focuses on the art and science of statistical modeling of processes applied to business, finance, and economics. These may include models of aggregate economic activity, economic behavior of firm or behavior of financial assets. Topics include statistical inference, maximum likelihood estimation, method of moments, Bayesian estimation, least-squares estimation, robust estimation, kernel estimation, copula estimation, analysis of variance, linear regression models, multiple regression, logistic regression, quantile regression, time series estimation, unit root tests, bootstrapping. *Prerequisite: FRE 6083. Students are expected to have knowledge in basic statistics. Co-Requisite: Notes: none.*

FRE 6271, Valuation of Equity Securities and Financial Statement Analysis

1½:0:0:1½

This course provides a detailed examination of the tools and techniques for analyzing financial statements for purposes of credit evaluation, forecasting, identifying merger candidates, enhancing the efficiency of decision making, and diagnosing problem areas within the firm before crises develop. Students will also be taught to use financial ratios to conduct duPont (i.e., decomposition) analysis, a methodology to track down sources of poor performance through interrelationships among a firm's financial ratios. *Prerequisite: FRE 6003, FRE 6103 Co-Requisite: Notes: none.*

FRE 6291 Options and Derivatives

1½:0:0:1½

This course covers derivative contracts including futures, forward contracts, option, and swap contracts. The focus of the course is on the use of these instruments by financial institutions.

Basic valuation concepts and the use of derivatives for speculative purposes, hedging purposes, and arbitrage are discussed, as are the specifics of the contracts and the markets in which they trade. Financial derivatives such as interest rate, currency, and equity

contracts, and some brief discussion of commodity contracts and specialty contracts such as insurance derivatives and credit derivatives are also discussed. *Prerequisite: FRE 6003, FRE 6023, FRE 6103 Co-Requisite: Notes: none.*

FRE 6411 Fixed Income Securities and Interest Rate Derivatives *1½:0:0:1½*

This course examines the body of analytical tools and measures that constitute modern fixed income markets. The valuation of interest-rate sensitive cash flows is the unifying theme. Major topics covered include theories of term structure, institutional aspects of fixed income markets, and analytical techniques for managing interest rate risk. Bond refunding, defeasance, corporate bonds, mortgage-backed securities, forwards, futures, options, and interest rate swaps are discussed. The course also provides an overview of the major classes of fixed income securities and the markets in which they trade. Among the major classes of fixed income instruments discussed are Treasury and agency securities, mortgage-backed securities (including CMOs and Strips), asset-backed securities, municipals, floating and inverse floating rate securities. *Prerequisite: FRE 6023, FRE 6083, FRE 6103 Co-Requisite: Notes: none.*

FRE 6711 Portfolio Theory and Applications *1½:0:0:1½*

This course provides an examination of modern portfolio theory and investment selection. It considers portfolio analysis, single-period risk and return measures, and the process of optimal portfolio selection. The basic portfolio model is extended to consider alternative risk concepts and multiperiod portfolio horizons. Single factor and multifactor models are also discussed. Optimization techniques are applied. The basic portfolio model is extended to explain hedging theory and to build firm-wide risk management models. *Prerequisite: FRE 6411.*

Track: Computational Finance

FRE 6231, Stochastic Calculus and Financial Modeling *1½:0:0:1½*

This course extends the core course FE6083 to Applied Stochastic Calculus in Finance, emphasizing the modeling approach and resolution of important problems in derivatives finance, in pricing assets and complex financial products. In addition, cases highlighting the impact of theoretical finance on practical market trading, portfolio management and

related problems are emphasized. Some of the techniques required and covered in the course include: Markov chains, random walks, stochastic differential equations and Ito Calculus, optimal stochastic control and stochastic dynamic programming as well as Monte Carlo simulation. These techniques are then applied to selected financial engineering models to assess and simulate (using Matlab and other software) essential derivative and related problems of practical importance in finance. *Prerequisite: FRE 6083 Co-Requisite: Notes: none.*

FRE 6251, Numerical and Simulation Techniques in Finance *1½:0:0:1½*

Advanced numerical techniques for the solution of ordinary, partial and stochastic differential equations are presented. These techniques are analyzed both mathematically and using computer aided software that allows for the solution and the handling of such problems. In addition, the course introduces techniques for Monte Carlo simulation techniques and their use to deal with theoretically complex financial products in a tractable and practical manner. Both self-writing of software as well as using outstanding computer programs routinely used in financial and insurance industries will be used. *Prerequisite: FRE 6083 Co-Requisite: Notes: none.*

FRE 6311 Dynamic Assets and Options Pricing *1½:0:0:1½*

The purpose of this course is to focus on inter-temporal assets pricing both in discrete and continuous time. Problems in complete and incomplete markets of both theoretical and practical interest requiring an appreciation of financial economic theories and computational techniques are profusely used and the financial engineering techniques needed are introduced. Problems and cases are presented spanning Fixed Income (Bonds), Stocks and Derivatives (Options of various sorts), Real Asset Pricing and Implied Risk Neutral Pricing. *Prerequisite: FRE 6083, FRE 6123 Co-Requisite: Notes: none.*

FRE 6331 Financial Risk Management and Optimization *1½:0:0:1½*

This course provides solution to the inter-temporal management of portfolios, financial products of various sorts, credit risks, market making etc. Dynamic and stochastic dynamic programming techniques as well optimal control and stochastic control principles of optimality are presented and their financial contexts emphasized. Both theoret-

ical and practical facets of inter-temporal management of financial risks and risk pricing are emphasized. *Prerequisite: FRE 6083, FRE6123 Co-Requisite: Notes: none.*

FRE 6351 Advanced Financial Econometrics *1½:0:0:1½*

Financial econometrics has matured into an important and necessary field providing an opportunity to deal with practical problems in finance. For example, techniques such as ARCH and GARCH and their subsequent development are used to estimate the volatility of underlying financial processes; the analysis of intra-day trading data requires particular mathematic techniques; Memory based and persistent stochastic processes can be used for algorithmic trading and detecting markets incompleteness; Copulas are now applied routinely to model and estimate dependent risks, etc. These financial and risk problems require the application of advanced financial econometric techniques that the course provides from both theoretical and empirical-applied viewpoints. Selected cases are used to provide a real-world sense of financial engineering when it is faced with the reality and the complexity of financial markets. *Prerequisite: FRE 6083 Co-Requisite: Notes: none.*

Track: Financial Information Services and Technology

FRE 6131 Clearing and Settlement of Financial Transactions *1½:0:0:1½*

This course focuses on issues involved in the processing of financial transactions from order execution to final settlement of transactions. The course examines the procedures and market conventions for processing completed transactions, verifying transactions, confirming transactions, resolving conflicts, decisions involved in developing one's own clearing operations or purchasing clearing services, the role played by the clearing houses, and numerous issues associated with cross border transactions. *Prerequisite: none Co-Requisite: none Notes: none*

FRE 6151 Foundations of Financial Technology *1½:0:0:1½*

Every year, financial institutions spend billions to exploit the latest development in information technology. This course introduces a framework with which to understand and leverage information technology. The technology components covered include telecommunications, groupware, imaging and document processing, artificial intelligence and object-oriented analysis and

design. The course also covers the entire technological planning process specifically for financial institutions. *Prerequisite: none*
Co-Requisite: Notes: none.

FRE 6071 Derivatives, Financial Markets and Technology 1½:0:0:1½

This is a half semester course that covers basic derivatives including futures contracts, forward contracts, option contracts, and swap contracts. The principal focus of the course is on the use of these instruments by financial institutions. Basic valuation concepts are discussed. The use of derivatives for speculative purposes, hedging purposes, and arbitrage are discussed. The specifics of the contracts and the markets in which they trade are also discussed. The main focus is to give students in the Financial Technology track a general understanding of the derivatives market and risk management. *Prerequisites: FRE 6003, FRE 6023, FRE 6103*

FRE 6791 Operational Risk Measurement and Management 1½:0:0:1½

The operational difficulties faced by financial institutions have created a need for tools to measure and manage operational risk. An accurate appreciation of risks, exposures, and controls is critical to effectively managing risk in today's dynamic global business environment. This course examines the effects of transaction processing, liquidity management, organizational structure, personnel, and compliance on the nature of operational risk. Qualitative and quantitative measures of operational risk are discussed. *Prerequisite: Co-Requisite: FRE 6711*

FRE 6431 Electronic Market Design 1½:0:0:1½

This course covers topics on the design and analysis of electronic market places. This is an exciting new research area which incorporates ideas from economics (in particular game theory and mechanism design), AI, and theoretical computer science. Electronic markets have many interesting applications, from the obvious ones such as automated negotiation for e-commerce, to more non-obvious applications like resource allocation in grid computing settings. In this course we will focus on computational and game-theoretic questions related to electronic markets, and will look at what it means to design electronic markets with good properties. Course topics include the following: Introduction to game theory and mechanism design, winner determination in combinatorial auctions, bidding languages, approximate single shot

auctions, iterative auctions, preference elicitation and communication complexity, mechanisms for selling digital goods, false-name bids, reputation mechanisms, computationally limited agents, trading agents, and privacy and auctions. *Prerequisite: Graduate status.*

Financial Labs

FRE 6811 Financial Lab 1: Excel, Risk, and Yieldbook 1½:0:0:1½

This course focuses on teaching students to use Excel, Risk, and Yieldbook.

FRE 6821 Financial Lab 2: Eviews and Stata 1½:0:0:1½

This course focuses on teaching students to use Eviews and Stata.

FRE 6831 Financial Lab 3: Matlab, GAMS, and optimization software 1½:0:0:1½

This course focuses on teaching students to use Matlab and GAMS.

FRE 6841 Financial Lab 4: S-Plus and R 1½:0:0:1½

This course focuses on teaching students to use S-Plus and R.

FRE 6851 Financial Lab 5: C++ 1½:0:0:1½

This course focuses on teaching students to use C++.

Capstone Options

FRE 7003 Financial Engineering Capstone: Thesis 6:0:0:6

This course is a research course. The student undertakes proprietary or non-proprietary research and writes a thesis-type research paper. Generally, the student will work under the supervision of a faculty member; however, the course is intended to be largely self-directed within the guidelines established by the supervising faculty member. *Prerequisites: This course should be taken during the student's final semester. Prerequisites will vary depending on the student's track and the nature of the project to be undertaken.*

FRE 7023 Financial Engineering Capstone: Internship 6:0:0:6

This course is an internship course. The student, with the help of the Career Services office secures an internship. The student will work under the supervision of a faculty member; however, the course is intended to be largely self-directed within the guidelines established by the supervising faculty member. A paper based on the student's internship work is required. *Prerequisites: This course should be taken during the student's final semester. Prerequisites will vary depending on the student's track and the nature of the project to be undertaken.*

FRE 7043 Financial Engineering Capstone: Project 6:0:0:6

This course is a project course. Students work with faculty on proprietary or non-proprietary research projects. Generally, the student will work under the supervision of a faculty member; however, the course is intended to be largely self-directed within the guidelines established by the supervising faculty member. A significant written research component is required. *Prerequisites: This course should be taken during the student's final semester. Prerequisites will vary depending on the student's track and the nature of the project to be undertaken.*

Electives

FRE 6031 Money, Banking and Financial Markets 1½:0:0:1½

Financial econometrics has matured into an important and necessary field providing an opportunity to deal with practical problems in finance. For example, techniques such as ARCH and GARCH and their subsequent development are used to estimate the volatility of underlying financial processes; the analysis of intra-day trading data requires particular mathematic techniques; Memory based and persistent stochastic processes can be used for algorithmic trading and detecting markets incompleteness; Copulas are now applied routinely to model and estimates dependent risks, etc. These financial and risk problems require the application of advanced financial econometric techniques that the course provides from both theoretical and empirical-applied viewpoints. Selected cases are used to provide a real-world sense of financial engineering when it is faced with the reality and the complexity of financial markets.

FRE 6051 Insurance Finance and Actuarial Science 1½:0:0:1½

This course highlights essential facets of actuarial science, insurance and the finance-insurance convergence. The course assumes that students are familiar with basic notions of expected utility and stochastic processes and options pricing. Topics covered in the course include: The Insurance Business and Insurance Firms Management; Principles of Actuarial Science and Risk Pricing in Insurance and in Finance (Complete Markets); The Expected Utility Approach to Insurance Risk Pricing and Management; Derivatives and The Financial Approach to Insurance Pricing; Insurance Products (Life Insurance, Casualty, Pension Funds Defined Benefits and so on); Principles of Insurance Management in a Dynamic and Global Setting. Throughout the course, we shall take numerous problems and cases drawn from actuarial and insurance problems and provide a financial perspective to their analysis. In particular, relating to insurance pricing, reserve policies, insurance pension funds, CATBOND and weather (insurance) derivatives and regulation are emphasized. *Prerequisite: FRE 6103.*

FRE 6071 Derivatives, Financial Markets and Technology 1½:0:0:1½

This is a half semester course that covers basic derivatives including futures contracts, forward contracts, option contracts, and swap contracts. The principal focus of the course is on the use of these instruments by financial institutions. Basic valuation concepts are discussed. The use of derivatives for speculative purposes, hedging purposes, and arbitrage are discussed. The specifics of the contracts and the markets in which they trade are also discussed. The main focus is to give students in the Financial Technology track a general understanding of the derivatives market and risk management. *Prerequisites: FRE 6003, FRE 6023, FRE 6103.*

FRE 6111 Investment Banking and Brokerage 1½:0:0:1½

This course provides an introductory overview of Wall Street, Back Office and general brokerage operations, investment banking and capital markets. The subjects covered are essential to the understanding of how products, once created, are actually distributed and sold. The course will rely heavily on The Wall Street Journal, Financial Times and other trade publications. Topics to be covered include: a brief history of Wall Street, an understanding of the major secu-

rities laws and how they have changed over time, basics of equity and debt securities, creation of debt and equity securities, pricing and sale of debt and equity securities. The course will seek to understand how and where opportunities for the creation of new securities arise. *Prerequisites: none.*

FRE 6131 Clearing and Settlement of Financial Transactions 1½:0:0:1½

This course focuses on issues involved in the processing of financial transactions from order execution to final settlement of transactions. The course examines the procedures and market conventions for processing completed transactions, verifying transactions, confirming transactions, resolving conflicts, decisions involved in developing one's own clearing operations or purchasing clearing services, the role played by the clearing houses, and numerous issues associated with cross border transactions. *Prerequisites: none.*

FRE 6151 Foundations of Financial Technology 1½:0:0:1½

Every year, financial institutions spend billions to exploit the latest development in information technology. This course introduces a framework with which to understand and leverage information technology. The technology components covered include telecommunications, groupware, imaging and document processing, artificial intelligence and object-oriented analysis and design. The course also covers the entire technological planning process specifically for financial institutions. *Prerequisites: none.*

FRE 6171 Management of Financial Institutions 1½:0:0:1½

This course focuses on managing institutions from a financial management perspective. By analyzing the factors that define the dynamics of the rapidly changing financial services industry, it explores the normative consequences of financial management decision-making to create shareholder value. *Prerequisites: FRE 6031, FRE 6023.*

FRE 6191 Advanced Topics in Financial Technology 1½:0:0:1½

This course complements the Foundations of Financial Technology by providing in-depth treatment of advanced topics in this rapidly changing field. Students will prepare and present case studies applying the concepts covered in class. *Prerequisites: FRE 6151.*

FRE 6211 Financial Market Regulation 1½:0:0:1½

This course considers the role and forms of regulation in the U.S. financial markets, the role of the Securities and Exchange Commission (SEC), the Commodity Futures Trading Commission (CFTC), the Federal Reserve, the Office of the Controller of the Currency (OCC), self-regulating organizations (SROs) such as the National Association of Securities Dealers, and the National Futures Association are examined. Also examined are the roles of the state insurance commissions, and the Department of Labor. *Prerequisites: FRE 6031.*

FRE 6231 Stochastic Calculus and Financial Modeling 1½:0:0:1½

This course extends the core course FE6083 to Applied Stochastic Calculus in Finance, emphasizing the modeling approach and resolution of important problems in derivatives finance, in pricing assets and complex financial products. In addition, cases highlighting the impact of theoretical finance on practical market trading, portfolio management and related problems are emphasized. To do so, the course introduces the student to the elements of stochastic processes and stochastic calculus as they are applied in financial engineering. Some of the techniques covered include, Markov chains, random walks, stochastic differential equations and Ito Calculus. These techniques are then applied to model, assess and simulate (using Matlab) essential derivative and related problems of practical importance in finance. Parts of the course will be based on the book of Tapiero C.S., Applied Stochastic Models and Control for Finance and Insurance, Kluwer, 1998. *Prerequisites: FRE 6083.*

FRE 6251 Numerical and Simulation Techniques in Finance 1½:0:0:1½

Advanced numerical techniques for the solution of ordinary, partial and stochastic differential equations are presented. These techniques are analyzed both mathematically and using computer aided software that allows for the solution and the handling of such problems. In addition, the course introduces Monte Carlo simulation techniques and their use to deal with theoretically complex financial products in a tractable and practical manner. Both self-writing of software as well as using outstanding computer programs routinely used in industry will be used. *Prerequisites: FRE 6083.*

FRE 6271 Valuation of Equity Securities and Financial Statement Analysis

1½:0:0:1½

This course provides a detailed examination of the tools and techniques for analyzing financial statements for purposes of credit evaluation, forecasting, identifying merger candidates, enhancing the efficiency of decision making, and diagnosing problem areas within the firm before crises develop. Students will also be taught to use financial ratios to conduct duPont (i.e., decomposition) analysis, a methodology to track down sources of poor performance through inter-relationships among a firm's financial ratios. *Prerequisites: FRE 6003, FRE 6103.*

FE 6291 Options and Derivatives

1½:0:0:1½

This course covers basic derivatives including futures contracts, forward contracts, option, and swap contracts. The focus of the course is on the use of these instruments by financial institutions. Basic valuation concepts and the use of derivatives for speculative purposes, hedging purposes, and arbitrage are discussed, as are the specifics of the contracts and the markets in which they trade. Financial derivatives such as interest rate, currency, and equity contracts, and some brief discussion of commodity contracts and specialty contracts such as insurance derivatives and credit derivatives are also discussed. *Prerequisites: FE 6003, FE 6023, FE 6103.*

FRE 6311 Dynamic Assets and Option Pricing

1½:0:0:1½

The purpose of this course is to focus on inter-temporal assets pricing both in discrete and continuous time. Problems in complete and incomplete markets of both theoretical and practical interest requiring an appreciation of financial economic theories and computational techniques are profusely used and the financial engineering techniques needed are introduced. Problems and cases are presented spanning Fixed Income (Bonds), Stocks and Derivatives (Options of various sorts), Real Asset Pricing and Implied Risk Neutral Pricing. Reference Text: Tapiero C.S., *Applied Stochastic Models and Control for Finance and Insurance*, Kluwer, 1998. *Prerequisites: FRE 6083, FRE 6123.*

FRE 6331 Financial Risk Management and Optimization

1½:0:0:1½

This course provides solution to the inter-temporal management of portfolios, financial products of various sorts, credit risks, market

making etc. using dynamic optimization techniques. Dynamic and stochastic dynamic programming techniques as well optimal and stochastic control principles of optimality are presented in financial contexts emphasizing both theoretical and practical facets of the inter-temporal management of financial risks. *Prerequisites: FRE 6083, FRE 6123.*

FRE 6351 Advanced Financial Econometrics

1½:0:0:1½

Financial econometrics has matured into an important and necessary field providing an opportunity to deal with practical problems in finance. For example, techniques such as ARCH and GARCH and their subsequent development are used to estimate the volatility of underlying financial processes; the analysis of intra-day trading data requires particular mathematic techniques; Memory based and persistent stochastic processes can be used for algorithmic trading and detecting markets incompleteness; Copulas are now applied routinely to model and estimate dependent risks, etc. These financial and risk problems require the application of advanced financial econometric techniques that the course provides from both theoretical and empirical-applied viewpoints. Selected cases are used to provide a real-world sense of financial engineering when it is faced with the reality and the complexity of financial markets. *Prerequisites: FRE 6083.*

FRE 6371 Contract Economics

1½:0:0:1½

This course covers advanced material in applied economics for students of financial engineering. The materials discussed in this course are topics important to the development of contractual relationships between parties with dissimilar interests, and include: moral hazard and the design of incentives, adverse selection and market signaling, auction theory and the winner's curse, distributed and integrative negotiation, and more. Students who successfully complete this course will obtain an appreciation for the theoretical and practical challenges in completing contracts that provide satisfactory economic incentives to each party that also satisfy the other party's belief that the terms they require will be met. *Prerequisite: FRE 6023.*

FRE 6391 Advanced Corporate Finance: Mergers and Acquisitions

1½:0:0:1½

In this half-semester course we will examine the theories and empirical evidence related to mergers & acquisitions and other corpo-

rate transactions and reorganizations. We will look at friendly mergers, hostile takeovers (including takeover and anti-takeover tactics), leveraged buyouts, and bankruptcy. Throughout the course, we will pay close attention to the motives behind these transactions and reorganizations. *Prerequisites: FRE 6103.*

FRE 6411 Valuation of Fixed Income Securities and Basic Interest Rate Derivatives

1½:0:0:1½

This course examines the body of analytical tools and measures that constitute modern fixed income markets. The valuation of interest-rate sensitive cash flows is the unifying theme. Major topics covered include theories of term structure, institutional aspects of fixed income markets, and analytical techniques for managing interest rate risk. Bond refunding, defeasance, corporate bonds, mortgage-backed securities, forwards, futures, options and interest rate swaps are discussed. The course also provides an overview of the major classes of fixed income securities and the markets in which they trade. Among the major classes of fixed income instruments discussed are Treasury and agency securities, mortgage-backed securities (including CMOs and Strips), asset-backed securities, municipals, floating and inverse floating rate securities. *Prerequisites: FRE 6023, FRE 6083, FRE 6103.*

FRE 6431 Electronic Market Design

1½:0:0:1½

This course covers topics on the design and analysis of electronic market places. This is an exciting new research area which incorporates ideas from economics (in particular game theory and mechanism design), AI, and theoretical computer science. Electronic markets have many interesting applications, from the obvious ones such as automated negotiation for ecommerce, to more non-obvious applications like resource allocation in grid computing settings. In this course we will focus on computational and game-theoretic questions related to electronic markets, and will look at what it means to design electronic markets with good properties. Course topics include the following: Introduction to game theory and mechanism design, winner determination in combinatorial auctions, bidding languages, approximate single shot auctions, iterative auctions, preference elicitation and communication complexity, mechanisms for selling digital goods, false-name bids, reputation mechanisms, computationally limited agents, trading agents, and privacy and auctions. *Prerequisites: Graduate status.*

FRE 6451 Behavioral Finance, Trading and Investment Strategy 1½:0:0:1½

This course provides a deep discussion of the investors' systematic deviations from the level of financial rationality assumed by modern financial theory. Such biased behavior can lead to market inefficiencies, market opportunities, and market failure. After a brief introduction to the topic and its research history is conducted, the course will focus on major areas including the limits to arbitrage created by decision bias, the equity premium puzzle, market over-reaction and under-reaction, and more. The course will seek to understand how and where opportunities for and threats to wealth accumulation exist as a result of the mismatch between investor behavior and the assumptions about investment behavior inherent in financial theory. *Prerequisite: FRE 6023.*

FRE 6471 Applied Financial Econometrics 1½:0:0:1½

This course builds on the concepts covered in FRE 6091 and addresses the design, estimation and application of both univariate and multivariate time series models that are widely used in finance and risk engineering. Applications include simulation and forecasting. *Prerequisites: FRE 6083, FRE 6091.*

FRE 6491 Municipal and Public Finance 1½:0:0:1½

This course provides an overview and analysis of the market for debt obligations of state and local governments. Topics that will be covered include: the micro structure of the market, including the types of debt issued, as well as the characteristics of the buyers. Federal and state taxation of munis will be discussed, along with the regulatory structure of the industry. Bond structure, risk assessment, and risk management utilizing cash bonds, futures and options will be covered. *Prerequisites: FRE 6411.*

FRE 6511 Intermediate Derivatives Valuation and Applications 1½:0:0:1½

This course covers exchange traded and over-the-counter (OTC) derivatives. The principal focus of the course is on financial engineering and risk management applications. Valuation concepts and the use of derivatives for speculative purposes, hedging, and arbitrage are discussed. *Prerequisites: FRE 6023, FRE 6083, FRE 6103.*

FRE 6551 Accounting for Financial Products 1½:0:0:1½

This course addresses accounting issues as they pertain to innovative financial products, risk management strategies, tax driven strategies, and other manifestations of financial engineering, particularly those in which derivative financial instruments play an important role. Accounting and tax rules are reviewed and applied. *Prerequisite: FRE 6003.*

FRE 6571 Asset-backed Securities 1½:0:0:1½

Asset-backed securities (ABSs) have become a hot topic in today's fixed-income arena, with a potential for returns exceeding that of other investments. This course examines the writings of leaders in this field and provides comprehensive coverage of the major asset-backed securities, structuring issues and relative value analysis. Topics to be covered include: The expanding frontiers of asset securitization; Introduction to ABS accounting; Trends in the structuring of ABSs; Prepayment nomenclature in the ABS market. *Prerequisites: FRE 6411, FRE 6511.*

FRE 6591 Mortgage-backed Securities 1½:0:0:1½

This course takes the student from a general introduction to mortgage-backed securities (MBS) and real estate finance to a detailed treatment of some of the issues that make these instruments some of the most complex. Students will learn the fundamentals of yield curves, mortgage cash flows, prepayments, and analysis. The course will cover passthroughs, CMOs, mortgage derivatives, and ARMs. Asset/Liability management of MBS will be discussed. Students will build a price-yield calculator for MBS pass-throughs (using a spreadsheet) and complete a course project. *Prerequisites: FRE 6411, FRE 6571.*

FRE 6611 Credit Derivatives 1½:0:0:1½

This course is designed as a basic introduction to credit derivatives and Collateralized Debt Obligations (CDO's). The course will review the most important credit instruments, starting with risky bonds and credit default swaps, through basket swaps, structured products, and CDO's. Each instrument will be defined and explained, including its markets, modeling, pricing, and risk management. The class work will be illustrated with both theoretical homework and practical Excel projects. *Prerequisite: FRE 6411, FRE 6511.*

FRE 6631 Applied Derivatives Finance 1½:0:0:1½

This course focuses on applied financial engineering applications using derivative securities, alone and in combination with other financial instruments. The course is taught by a financial engineering practitioner. In addition to complex financial engineering structures, students will also consider reverse engineering of structures. Cases presented will be from recent deals. Examples of applications might include tax arbitrage, the construction of equity collars on restricted stock, the alteration of the investment characteristics of large portfolios, the creation of synthetic financial instruments, and so forth. *Prerequisites: FRE 6411, FRE 6511.*

FRE 6651 Term Structure Modeling and Advanced Interest Rate Derivatives 1½:0:0:1½

This course covers term structure models, the term structure of volatility, interest-rate processes with time dependent volatility and mean reversion, a closer look at path-dependent securities including sinking fund bonds and options with look-back features, multi-factor models, and multinomial methods of discrete numerical implementations. Course readings will be drawn from current literature. *Prerequisites: FRE 6411, FRE 6511. Students are expected to have knowledge in numerical analysis.*

FRE 6671 Global Finance 1½:0:0:1½

This course covers the international dimensions of finance. It focuses on markets, players and instruments. It explores the main theoretical insights into the workings of the foreign exchange, international currency and bond markets, as well as how their integration serves price securities.

While a detailed study of the institutions that frame these markets and international macro-economics is beyond the scope of this lecture series, we must nevertheless examine some of these concepts in order to understand the fundamental determinants of exchange rates and linkages between different countries' interest rates. A number of parity conditions that prevent arbitrage as well as the role of expectations contribute to an understanding of the level and the volatility of international asset prices. Theory and institutional description are complemented by analyzing the mechanics of international financial instruments. The Value-at-Risk methodology will be employed to illustrate pricing and the use of the financial instruments in the context of international risk measurement and management. *Prerequisites: FRE 6411, FRE 6511.*

FRE 6691 Intermediate Credit Derivatives Valuation and Applications 1½:0:0:1½

Credit derivatives have emerged as an area of significant interest in global derivatives and risk management practice. These instruments have the potential to revolutionize the management of credit risk in banking and capital markets. This course introduces students to the full range of products available in today's marketplace, the economic value of credit derivatives, valuation techniques, and guidelines on using them to manage and control risk. *Prerequisites:* FRE 6411, FRE 6511.

FRE 6711 Portfolio Theory and Applications 1½:0:0:1½

This course provides an in-depth examination of modern portfolio theory and investment selection. It considers the mathematics of portfolio analysis, single-period risk and return measures, and the process of optimal portfolio selection. The basic portfolio model is extended to consider alternative risk concepts and multi-period portfolio horizons. Single factor and multi-factor models are also discussed. Optimization techniques, such as linear programming and quadratic programming are applied. The basic portfolio model is extended to explain hedging theory and to build firm-wide risk management models. *Prerequisites:* FRE 6411, FRE 6511.

FRE 6731 Basel 2 and Value at Risk 1½:0:0:1½

This course addresses financial risk management with particular focus on Basel 2 directives and Value at Risk (VaR), a method of assessing risk which uses standard statistical techniques routinely used in other fields. VaR analysis is used by bank and corporate managers, and by financial market regulators. *Co-requisite:* FE 6711.

FRE 6751 Credit Risk Measurement and Management 1½:0:0:1½

This course deals with issues in credit risk measurement, credit risk management, and related areas in which credit considerations are important. These issues arise in credit rating activity, credit extension by banks and other financial services, and in derivative markets where counter party risk is perceived to be an important management issue. *Co-requisite:* FE 6711.

FRE 6771 Financial Optimization Techniques 1½:0:0:1½

The purpose of this course is to illustrate and describe the role of optimization in computational finance, in both their static and dynamic contexts. Throughout the course, theoretical problems are developed and contrasted to real problems drawn from financial engineering practice. *Prerequisites:* FE 6311.

FRE 6791 Operational Risk Measurement and Management 1½:0:0:1½

The operational difficulties faced by financial institutions have created a need for tools to measure and manage operational risk. An accurate appreciation of risks, exposures, and controls is critical to effectively managing risk in today's dynamic global business environment. This course examines the effects of transaction processing, liquidity management, organizational structure, personnel, and compliance on the nature of operational risk. Qualitative and quantitative measures of operational risk are discussed. *Co-requisite:* FE 6711.

FRE 6803 Financial Engineering (research course) 3:0:0:3

This course is a research/case course. It can be handled a number of different ways at the discretion of the faculty supervisor. It may involve a series of cases that are dissected and analyzed, it may involve teaming students with industry personnel for proprietary or non-proprietary research projects, and it may involve thesis-type research. Generally, the student will work under the supervision of a faculty member but the course is intended to be largely self-directed within the guidelines established by the supervising faculty member. A significant written research component is required. *Prerequisites:* This course should be taken during the student's final semester. *Prerequisites will vary depending on the student's track and the nature of the project to be undertaken.*

FRE 6901-6991 Selected Topics in Financial Engineering 1½:0:0:1½

Current topics of particular importance in finance and risk engineering are analyzed and discussed. Selected topics will be emphasized and provide focus for further study. Examples might include urban finance engineering, environmental finance, infrastructure and projects finance, real estate finance, insurance finance and derivatives, macro hedge funds management, among others. *Prerequisites:* advanced standing and instructor's permission.

FRE 7801 Quantitative Topics in Finance & Financial Markets 1 1½:0:0:1½

Current topics of particular importance in finance and risk engineering are analyzed and discussed. Selected topics will be emphasized and provide focus for further study. Examples might include urban finance engineering, environmental finance, infrastructure and projects finance, real estate finance, insurance finance and derivatives, macro hedge funds management, among others. *Prerequisites:* Graduate standing and instructor's permission.

FRE 7811 Quantitative Topics in Finance & Financial Markets 2 1½:0:0:1½

Current topics of particular importance in finance and risk engineering are analyzed and discussed. Selected topics will be emphasized and provide focus for further study. Examples might include urban finance engineering, environmental finance, infrastructure and projects finance, real estate finance, insurance finance and derivatives, macro hedge funds management, among others. *Prerequisites:* Graduate standing and instructor's permission.

FRE 7831 Topics in Financial & Risk Engineering 1 1½:0:0:1½

Current topics of particular importance in finance and risk engineering are analyzed and discussed. Selected topics will be emphasized and provide focus for further study. Examples might include urban finance engineering, environmental finance, infrastructure and projects finance, real estate finance, insurance finance and derivatives, macro hedge funds management, among others. *Prerequisites:* Graduate standing and instructor's permission.

FRE 7851 Topics in Financial & Risk Engineering 2 1½:0:0:1½

Current topics of particular importance in finance and risk engineering are analyzed and discussed. Selected topics will be emphasized and provide focus for further study. Examples might include urban finance engineering, environmental finance, infrastructure and projects finance, real estate finance, insurance finance and derivatives, macro hedge funds management, among others. *Prerequisites:* Graduate standing and instructor's permission.



HISTORY OF SCIENCE PROGRAM

Academic Advisers:

Myles W. Jackson
Romualdus Sviedrys

The master's program in the History of Science was the first of its kind to be offered in the New York City area. The need for advanced study of the growth of science and technology and their interactions with human society and values has become increasingly evident. Intense specialization has further heightened the need for understanding among various branches of science and the humanities.

In considering ideas, time, process, transfer and social changes in the history of science, students are able to explore the elusive connections that exist between science and engineering and the social sciences and humanities. Prospective teachers of science and engineering subjects are able to increase their effectiveness through knowledge of the history of their own and related disciplines. Polytechnic's libraries contain many important and rare works on the history of science, which may be used for original research.

GOALS AND OBJECTIVES

The objectives of the Master of Science in History of Science are:

- To survey the record of scientific discovery, especially in modern times, and to consider the impact of science upon political and economic culture;
- To investigate the complex interactions between science and technology in industrial and preindustrial contexts;
- To help students develop a coherent world view that takes proper account of the role science and technology have played in the shaping of the modern world

REQUIREMENTS FOR THE MASTER OF SCIENCE

A total of 30 credits is required for the master's degree. Normally students start by taking the introductory courses: ST 6003, ST 6013, and ST 6023. These, and ST 6033 are the core courses required of all students for the MS degree.

In all cases, programs are constructed in consultation with advisers, taking into consideration individual backgrounds and interests. The student will be permitted to take 9 credits of approved work in related fields outside the program, for example, in philosophy, mathematical logic, Renaissance history, management or one of the sciences or engineering. Students may transfer up to 9

approved credits from another accredited university.

To qualify for degrees, students may elect to write either a comprehensive examination or a thesis embodying appropriate and substantive research. If students choose the former, examinations may be taken in the term in which courses are completed. The student choosing the thesis option will earn 6 credits toward requirements for the degree. Acceptance of a thesis involves an oral presentation and defense. In addition to these requirements, students must demonstrate reading knowledge of one foreign language, whether French, German, Russian or Spanish. (Another language may be substituted upon approval of the advisor.) Students who follow the examination option may, with the approval of the program's academic advisor, be exempt from this requirement.

SUMMARY OF REQUIREMENTS:

Required core courses: 12 credits

Examination option: 18 advanced credits + MS exam

Thesis option: 12 advanced credits + 6 credits for the MS thesis

GRADUATE COURSES

CORE COURSES

ST 6003 History of Science I: Antiquity to Galileo 3:0:0:3

Biological and physical sciences from antiquity to the Renaissance. Issues, aims and tools of historians of science working in these periods.

ST 6013 History of Science II: Galileo to Einstein 3:0:0:3

Biological and physical sciences from Galileo and the scientific revolution to Einstein. Issues, aims and tools of historians of science working in these periods.

ST 6023 History of Science III: Science and Technology in 20th Century 3:0:0:3

A systematic survey covering the major developments in natural science in the 20th century. Topics include: low temperature physics, quantum mechanics, atomic structure, DNA, genome analytics, advances in cosmological theory.

ST 6033 Research Methods in the History of Science and Technology

3:0:0:3

In this course several techniques of historical research will be reviewed, and a series of exercises done by each student, including review of the sources of an article from ISIS or TECHNOLOGY AND CULTURE, presentation of a document, and a book review, concluding with a research paper to be presented for the review of the instructor and students in the course.

ADVANCED COURSES

ST 6163 Guided Reading in History of Science 3:0:0:3

Independent studies of leading interpretive works and sources in history of science. Regular tutorial sessions and periodic student-teacher colloquia. Course may be taken twice for credit with different topical emphasis and instructor's consent. Comprehensive written examination.

ST 7003 Seminar in History of Science

3:0:0:3

Advanced problems in history of science: development of quantification, historiography of science, history of ecology, science and social thought.

The course topic will be chosen by the instructor. Training in methods of archival research. Required regular reports leading to a major paper. Course may be repeated with different topical emphasis. Permission of the instructor is required.

ST 7253 History of Technology: Antiquity Through Early Industrial Revolution 3:0:0:3

ST 7263 History of Technology: Industrial Revolution to the Present

3:0:0:3

These two courses involve the evolution of techniques and tools used in man's attempts to master the environment. Reciprocal relationships between technology and other facets of society's economic and social structures, political policies; general cultural manifestations. Technological bases of historical changes and interactions of science and technology.

SS 6253 *Prerequisite: SS 6003 or equivalent.*

SS 6263 *Prerequisite: SS 6013 or equivalent.*

ST 7723 Technological Forecasting
3:0:0:3

Introduction to problems associated with technology forecasting. Short-range, intermediate and long-range forecasting methodologies. Forecasting social and economic consequences of adopted innovations. Students will prepare a forecast on a topic of their choice. Prerequisites: HI 2104 and one introductory history of science/technology course or instructor's permission.

ST 7743 Issues in Science and Technology Policy
3:0:0:3

Science policy issues, issues related to scientific and technological innovation; topics such as "brain drain" and the management of big science projects and projects involving national security. Students who take ST 7743 cannot receive credit for ST 8661.

ST 7753 Technology Transfer Among Nations
3:0:0:3

Social, ecological and economic factors in the selection, transfer and use of technology. Mechanisms of technology transfer and criteria of success.

Case studies of successful and unsuccessful technology transfers. Prerequisites: HI 2104 and one introductory history of science/technology course or instructor's permission. Also listed under IE 7573 and MG 7573.

ST 8661 Technology Policy 1½:0:0:1½

This course focuses on the macroenvironment influencing and relevant to technology decision making, strategy and innovation in firms, government agencies, non-for-profit institutions and other organizations. Primary concerns include introducing effective approaches for analyzing and evaluating societal-wide factors that influence innovation; assessing various attempts and policies for stimulating innovation in a city, region, nation or on a global basis; exploring the role of technology and innovation in diverse managerial, economic and social contexts (e.g., advanced economies, rapidly emerging economies and Third World economies); the relationship between business-government and NGOs in promoting and sustaining innovation; the impact of global rivalry and global cooperation in the technology and innovation arena; and the place of technology and innovation in the post-Cold War era and in the early 21st century. Cross-listed with MG8661. Students who take ST8661 cannot receive credit for ST 7743.

ST 987X Thesis for Degree of Masters of Science
3 credits

INDUSTRIAL ENGINEERING PROGRAM

Program Director: Michael Greenstein

The Department of Manufacturing and Industrial Engineering offers a program in industrial engineering at the master's level.

Industrial engineering addresses how systems operate and is concerned with the effective and efficient delivery of quality products and services. The tools applied include analytic modeling, system simulation, queuing systems, work design, project planning, facilities design and quality management and control. Courses are available in each of these topics, many with course projects suited to the practice-oriented degree offered at Polytechnic.

Many students seek a graduate degree in industrial engineering after completing an undergraduate degree in another engineering discipline. Because industrial engineers often work on multidiscipline teams, students are encouraged to use their electives to add strength in some area related to their career interests, such as:

- Mechanical engineering
- Manufacturing
- Operations management
- Construction management
- Management of technology
- Electrical engineering

Graduate advisers work with students to develop a suitable program for either fulltime or part-time study, with a product or service orientation.

There are opportunities in many diverse areas. For example, industrial engineers are called upon to:

- Design quality into products and processes
- Apply the principles of total quality management (TQM)
- Develop efficient work methods
- Locate facilities and design plant layouts
- Improve productivity and competitiveness
- Schedule and manage projects
- Use computers to simulate physical systems and processes
- Apply their knowledge in manufacturing and service industries, including finance, health care, logistics and construction. Industrial engineers seek to allocate limited resources in an effective manner. A unifying theme focusing this body of knowledge and methods into a coherent entity is the systems point of view.

Industrial engineering encompasses the search for similarity among concepts, laws and models of different disciplines; the emphasis on the adaptation, integration and exploitation of existing techniques in areas other than their fields of origin; and, above all, a unique point of view dealing with relationships rather than with components. Industrial engineers are thus in a strategic position to bring about the best integration of people, materials, machines, time and money in any endeavor.

These techniques are applied in a very wide range of organizations. There are industrial engineers in banks, hospitals, government, transportation and communications, construction, social service, facilities design, manufacturing, warehousing, and information processing.

Many industrial engineers move from analyzing and designing productive systems to managing those systems. While engineering and management are different fields, both require the ability to make decisions based on valid information. Industrial engineers are especially trained to obtain and evaluate such information.

GOALS AND OBJECTIVES

The objectives of the Master of Science program in the Industrial Engineering are for students to:

- Develop and apply a systems point of view to the effective supply of quality products and services
- Understand how to adapt, integrate, and exploit existing technologies in manufacturing and services, including the application of analytic modeling, system simulation, queuing systems, work design, facilities design, and quality management and control
- Learn how to measure and allocate the resources of an enterprise optimally
- Become aware of today's industrial drivers and learn tools and techniques to analyze problems and improve performance
- Acquire a broad knowledge base through the choice of a concentration of courses in Industrial Engineering and related fields to suit the career needs of our students

REQUIREMENTS FOR THE MASTER OF SCIENCE

The general Polytechnic requirements for the degree Master of Science are stated in this catalog under "Degree Requirements." Detailed requirements for this degree are shown below.

Admission to the Master of Science Program requires a bachelor's degree in a related discipline from an accredited institution, with a superior undergraduate academic record. Student not meeting these requirements are considered for admission on an individual basis and may be admitted subject to the completion of courses to remove deficiencies. Students are encouraged to seek waivers (and have an appropriate substitute designated) for all required courses in which they can demonstrate competence, so that they can use their time most effectively.

Prerequisite Courses (or equivalent knowledge)

Students must have knowledge of engineering economy and probability and statistics. Prospective students lacking the relevant knowledge, may satisfy the requirement by taking Probability and statistics (MA 6513 or equivalent)

Up to 3 credits of graduate courses in this category of prerequisite knowledge can be counted for degree unit as electives, although the electives needed for the student's concentration must also be satisfied.

Required Core Courses		12 credits
IE 6113	Quality Control and Improvement	
IE 6213	Facility Planning and Design	
IE 6823	Factory Simulation	
MN 7993	Supply Chain Engineering	

Other Courses	18 credits
Total	30 credits

Students should elect other courses in consultation with their adviser. Concentrations in areas suited to students' career interest are encouraged (e.g., manufacturing, mechanical engineering, operations management, construction management and management of technology). Courses from computer science or management may supplement such a concentration.

GRADUATE COURSES

IE 6113 Quality Control and Improvement 3:0:0:3

The goal of this course is to provide the student with a solid foundation in the cost of quality, quality assurance and quality management. Emphasis is placed on the basic tools of quality control such as control charts and their use, the concept of “out of control,” acceptance sampling, variables and attributes charts, and producer’s and consumer’s risk. A unique aspect of this course is the demonstration of the power of teams of people with different expertise to improve quality. A course project is required. *Prerequisite: MA 6513 or familiarity with the concepts of probability and statistics. Also listed under MN 6113.*

IE 6123 Quality Engineering Using Robust Design 3:0:0:3

The goal of this course is to provide a broad review of the procedures involved in improving the quality of manufacturing. By employing both Taguchi techniques, such as the use of signal-to-noise ratio representations, and other techniques less sensitive to parameter interactions, a full spectrum of robust design methods are presented. Applications of these procedures are reviewed including online trouble-shooting methods to assure quality in manufacturing. *Prerequisite: IE 6113. Also listed under MN 6123.*

IE 6193 Production Planning and Control 3:0:0:3

A survey course in basic and advanced manufacturing planning and control systems covering short-term forecasting systems, master production scheduling, material requirements planning, inventory management, capacity management, production activity control, and just-in-time.

IE 6203 Project Planning and Control (Project Management) 3:0:0:3

Discussion of the knowledge and process required to manage a project throughout its life cycle from concept to completion. Topics include engineering analysis, screening and selection, configuration and total quality management, scheduling using PERT and CPM, budgeting and resource management, computer support and software. Case studies are used to illustrate the process. *Also listed under MG 8103 and CE 8283.*

IE 6213 Facility Planning and Design 3:0:0:3

Topics covered include facilities design for global competitiveness, strategic master site planning, site selection, factory layout and design, facility management systems, and materials handling and storage planning. Guidance on selecting alternative facility plans and application of queuing methods and computer modeling for facility design and evaluation are presented.

IE 6453 Productivity Management 3:0:0:3

Modern approaches to productivity measurement, evaluation, planning and improvement in both manufacturing and service industries. Participants will develop productivity models for various types of organizations. *Also listed under MG 6453.*

IE 6823 Factory Simulation 3:0:0:3

Modeling and simulation of complex industrial, commercial and service systems, such as factories and hospitals. Students develop, run and experiment with several simulation models using different software packages. *Prerequisite: computer literacy.*

IE 7763 Manufacturing Resources Planning 3:0:0:3

Computerized systems to effectively run a manufacturing business are discussed as well as the process of software specification, evaluation, selection, and implementation. Topics include MRP logic, enterprise resource planning, manufacturing execution systems, inventory management, and bill of materials. Several different software systems and their features are highlighted. *Also listed under MN 7763.*

IE 7853 Computer Integrated Manufacturing Systems 3:0:0:3

The basic concepts of manufacturing complex products with complex processes relying heavily on computer and data processing technologies are introduced. All aspects relative to products and processes—planning, design, manufacturing, and shipping are addressed from a variety of perspectives. Techniques for managing and optimizing manufacturing productivity are explored. *Also listed under MN 7853.*

IE 7883 Manufacturing Systems Engineering 3:0:0:3

Topics concentrate on contemporary techniques for product design and manufacture, including financials of the manufacturing firm, quality, reliability, Taguchi methods of product and process design, scale-up and partitioning, production flows, modern manufacturing methods such as JIT/TQC, pull and synchronized manufacturing. Cultural factors are also discussed. Also listed under MN 7883.

IE 7923 Design for Manufacturability 3:0:0:3

Concepts and techniques for the economic, functionally sound and high-quality product design for manufacture are introduced. Emphasis is placed on designing for easy assembly, both robotics and manual, and on the effective use of plastics for manufacturing cost reduction.

Managerial and organizational approaches and case studies of successful designs are reviewed. *Also listed under MN 7923.*

IE 9113/9123 Selected Topics in IE each 3:0:0:3

Areas not covered in other courses. Specific topics vary according to instructor, who may be a visiting professor. Topics and prerequisites announced during term prior to offering.

IE 9303/9313 Readings in Industrial Engineering I/II each 3 credits

Individual reading of selected papers and current literature in specialized area of study, guided by faculty member. *Prerequisite: approval of adviser, instructor and department head.*

THE FOLLOWING COURSES ARE OFFERED IRREGULARLY IN RESPONSE TO INDUSTRY DEMAND

- IE 6003 Engineering Economy
- IE 6063 Work Design and Measurement
- IE 6183 Inventory Models
- IE 6273 Operations Research: Deterministic Models
- IE 6283 Operations Research: Stochastic Models
- IE 6503 Queuing Systems I
- IE 6853 System Reliability
- IE 7653 Human Factors in Engineering Design
- IE 7753 Industrial Safety Engineering

INFORMATION SYSTEMS ENGINEERING PROGRAM

Program Director: Robert Flynn

The Masters of Science in Information Systems Engineering (ISE) Executive Program is designed for professionals who want to be leaders in designing, developing and running today's information systems and systems based on information using the latest software tools, middleware, and technologies.

The program provides rigorous training in computer science, management and electrical engineering with an emphasis on the field of information systems engineering.

Much of the infrastructure is in place for today's enterprise information systems. Incompatible software and protocols, however, often separate applications on networked systems. In a web-based world, information systems designers need core skills in understanding machine organization, operating systems and networking. They need enabling training in software engineering, databases and groupware. They need to understand the role of middleware and the role of management.

It is important to understand not just how to design software systems but how to lead the efforts of people who will accomplish the design. The viability of solutions and understanding the associated human interface issues are not luxuries any more.

Students selected to participate in the program are experienced working professionals in computing or telecommunications with two or more years of working experience.

Polytechnic University started this Master of Science program in 1987 as a joint effort between the Department of Computer and Information Science and New York State's Center for Advanced Technology in Telecommunications (CATT). It is a rigorous two-year, four semester program consisting of 13 courses and an independent project.

The program is given in an executive format; classes meet every other weekend for two full days, Friday and Saturday, at Polytechnic's Westchester Graduate Center in Hawthorne, New York. Breakfast, lunch and coffee breaks are provided. All classes are videotaped, with the tapes made available for viewing either at home or on campus.

An all-inclusive fee covers tuition, fees, textbooks and other educational material, meals on class days and access to videotape of classes and lectures. Alternate formats are under consideration.

GOALS AND OBJECTIVES

The ISE Program has as its goal the production of information systems designers and integrators who can lead the development of heterogeneous systems that are aware of new software tools and interfaces. Its objective is to provide people with management and technology skills to facilitate their leadership in the integration of software component into complex systems.

ADMISSION REQUIREMENTS AND APPLICATION INFORMATION

Admission to the program requires a baccalaureate degree with a superior undergraduate academic record and a demonstrated familiarity with and exposure to the issues associated with the development of complex information systems. Applicants must have two years of relevant work experience in the field of computing and/or telecommunications.

Applications are accepted throughout the year, but admission is for the fall semester only. Admission is contingent on an interview with the director or designee. Because enrollment is limited, early application is strongly recommended.

DEGREE REQUIREMENTS AND CURRICULUM

The general requirements for a Master of Science, stated elsewhere in this catalog, apply to this program. The curriculum consists of 13 courses, including two half courses totaling 36 units or 30 credits, plus an independent research project of 3 to 6 credits. The project must be completed by the end of second year and can begin as soon as the first semester.

Courses may change or new courses substituted in response to changes in technology. The courses currently constituting the curriculum appear below:

FALL

First Semester

- CS 6062 Software Engineering
- CS 6132 Computer Architecture
- MG 6902 Management Process & Decision Making

SPRING

Second Semester

- CS 6082 Databases
- EE 5362 Principles of Communications Networks
- MG 6912 Leadership, Motivation & Communications

FALL

Third Semester

- CS 6842 Network Protocols
- CS 6902 Groupware
Two of the following four half-semester courses:
- CS 9141 Usability Engineering
- CS 9191 Selected Topics in Information Systems
- MG 6941 Project Management
- MG 6951 Economics for Business Decisions

SPRING

Fourth Semester

- CS 6232 Operating Systems
- CS 6822 Network Management & Security
- CS 6912 Integrated Development Environments

A project course, CS 9963, is also required for the degree. The project is typically completed at the end of the fourth semester.

The project is generally conducted in cooperation with the student's employer. Its goal is to integrate the techniques and the tools of the program in ways that reward the student and the employer.

The project course can be taken more than once and can begin as early as the first semester.

THE FOLLOWING COURSES ARE OFFERED AS PART OF THE INFORMATION SYSTEMS ENGINEERING PROGRAM:

CS 6902 Groupware 212:0:0:3

Middleware is software that allows different applications on, typically distributed, computer systems to interact. Groupware is middleware that is designed to allow many people to work together. It often incorporates business processes with communication in order to support the policies of enterprises. In dealing with the general issue of group software, one can address the objects of collaboration and sharing. Thus, one may include here a discussion of multimedia interfaces, XML, SOAP, SOA, web services, information sharing and object technologies.
Prerequisite: regular graduate status.

CS 6912 Integrated Development Environment *2½:0:0:3*

This course includes methodologies for systematically developing distributed and centralized information systems. Both two- and three-tier systems are discussed. Relevant standards, such as J2EE, CORBA, Active X, OpenDoc, AJAX, and web-based tools may be covered. The relationship of the standards and tools to the design and the software architecture are considered. Prerequisite: regular graduate status.

CS 9141 Usability Engineering *2½:0:0:1½*

The World Wide Web is both a network and a human interface. The usefulness of the interface it presents can be measured. This course presents the role of cognitive psychology in computer interface design. It combines both human factors and engineering tools in its approach to effective interface design and usability.

MG 6902 Management Process and Decision Making *2½:0:0:3*

Introduction to issues and concepts in organizational and administrative behavior with an emphasis on continually changing organizations in the information sectors. Management processes for flexible and innovative information businesses. The evolution of technology intensive industries and information business organizations. The role of information technology in the growth of the modern firm. Human resource management and organization development in information-intensive firms.

MG 6912 Leadership, Motivation and Communication *2½:0:0:3*

Organizational and individual behavior. Managing technical professionals. Teams, communication and group decision making. Leadership. Conflict and negotiation. Organizational development and culture. Managing change and creating innovative environments.

INTEGRATED DIGITAL MEDIA PROGRAM

Academic Adviser: Carl Skelton

GENERAL INFORMATION

1.1 Mission

What do we mean by “Integrated?”: A synthesis of cutting-edge technology, creative mastery, and critical thinking. For a long time, Brooklyn’s Polytechnic University has been at the forefront of new developments in education and research in the areas of computing, telecommunications, imaging sciences and the Internet. The University maintains close ties to New York’s media-related industries and their leaders. Faculty members bring to their academic and research programs a practical, “real-world” perspective.

Polytechnic University offers Bachelor of Science, Graduate Certificate, and Master of Science programs in Integrated Digital Media. The programs are designed to make the best use of Polytechnic’s extensive resources in the interests of expanding the traditionally separate areas of media creation, criticism and technology development. New media creation depends upon the incorporation of media theory and practice for its viability. Polytechnic’s location offers access to leaders in the field of digital media academics, designers, developers, producers and their various workplaces and equipment, all within a 10-mile radius of the Polytechnic campus. Our programs develop not only a mastery of technique, but also of concepts and context. In order to achieve such a synthesis without compromising quality or depth, we offer (and require) an exceptional level of commitment, leading to an exceptionally desirable credential in industry and culture: a full understanding and experience of all aspects of media invention, production, and distribution, in order to prepare our graduates not just for their first entry-level position or proof-of-concept, but for the longer term future in which they can rise up within existing institutions, genres, and companies, or build new ones with confidence.

1.2 Integrated Digital Media Institute

The Integrated Digital Media Institute (IDMI) is set up to provide a point of contact between top-level investigators in technological, creative, and strategic areas across the academic, civil, and private sectors. Periodic IDMI-sponsored conferences and public events will showcase the best in the field, at one of digital media’s epicenters: New York City. The IDMI also hosts visiting scholars

and artists, and collaborates with partner institutions to develop new interdisciplinary projects and exchange programs.

1.3 Facilities

Polytechnic University’s Integrated Digital Media lab, one of several accessible to students at the Brooklyn campus, is designed with a specific approach in mind: to provide access to state-of-the-art audio, video, web, and multimedia tools for studio and field production. Individual students and small teams are organized to produce professional work under the direct supervision of senior faculty. Where appropriate, leaders in allied professions are brought in to work hands-on with students and faculty. The 344-seat Dibner auditorium is available for special projects and public events, which can be initiated by faculty, students, or guests at will. The acoustics are excellent, and the control room allows for a broad range of technical setups. The Polytechnic Hall of Fame is a 9-screen multimedia venue with 5.1 sound system, which can be used as a development environment or public venue for special projects. The sound studio is an ongoing development project, designed to enable everything from podcasting to mixing and mastering to ambisonic sound installation projects.

Our digital media labs’ core functions:

Digital video and audio production and post-production; 2D and 3D interactive design and programming; web; single and multi-player game development; experimental interfaces. We are also partnering with other institutions and firms to provide access to professional television and radio production environments, multimedia facilities, and specialized communications facilities, as required for specific projects. In keeping with much of the creative side of the industry, our labs are Mac-based; development of the facilities is ongoing. Linux and Windows facilities are also available, where appropriate. Likewise, we use and support open-source tools and practices where they are most effective.

1.4 Faculty

Poly Faculty and technical staff come from a great variety of backgrounds, and offer a complete range of expertise for digital media, from television production to database programming, from the principles of audio filters to the art of interface design. All of our technical work is grounded in first-class science and engineering, and backed up by

Poly’s strong history as a center of technological research and development. The Humanities department offers further resources, including a research center for the history and philosophy of science and technology, and experts in behavioral psychology, environmental studies, music theory, and technical writing. Our permanent faculty will be supplemented by visiting instructors, as well as a program of guest speakers, and students will find opportunities to work with scholars and creators in residence on projects selected for their relevance to the program of study: multimedia documentaries, interactive design, and advocacy. Our location offers access to the very best people, institutions, and enterprises in traditional and new media disciplines.

1.5 Students

The program is designed to bring together students with the right mix of educational and professional backgrounds, and to help them make the most of their own and each other’s expertise and initiative. This is intended to reflect the working reality of the best in digital media: small interdisciplinary teams of people with complementary skills, working very hard together on exciting projects, with tight deadlines. No one person can expect to combine all the elements (or do all the work), so we look for people who have already demonstrated their proficiency in one or more areas, and who are ready to work with others.

1.6 Eligibility

Candidates for the Bachelor of Science program are subject to the university’s general admissions procedures and standards; special consideration will be given to applicants who present a portfolio of work demonstrating relevant ability and commitment. Students wishing to pursue a graduate certificate in Integrated Digital Media should contact the academic advisor.

All candidates for the MS program will be selected for their demonstrated ability and motivation. From the best applicants, we will select a group with a mix of experience and skills, to maximize opportunities for the kind of team work and learning that are characteristic of media professions. A bachelor’s degree or equivalent is required; we do not require GRE scores, but we will admit applicants based on an interview and review of previous work.

1.7 Contact Information

Carl Skelton, *Director*
 Integrated Digital Media Institute
 Polytechnic University
 RH 209, Six Metro Tech Center
 Brooklyn NY 11201
 cskelton@poly.edu
 (718) 260-4018

Further Information:
<http://idmi.poly.edu>
 Apply online:
<http://www.poly.edu/admissions>

2. PROGRAMS

2.1 Bachelor of Science Program

Candidates for a Bachelor of Science in Integrated Digital Media are required to complete DM Core Courses (minimum 61 credits), Polytechnic University’s general education requirements in the Humanities and Sciences (42 credits), and electives (25 credits), for a total of 130 credits over four years. The electives may be taken towards a minor (14 credits or more in a subject outside the major) in any subject at Poly, subject to course prerequisites and the approval of the host department. Students are encouraged to make the most of Polytechnic University’s full range of disciplines in their course of study in order to develop the best combination of knowledge and skills for their chosen career and to help them choose that career with a real experience-based awareness of their own abilities and interests. It is therefore important to choose foundation courses and electives with care to be sure to have the right prerequisites for specific upper-level courses, especially in related areas of science and technology. For detailed current information about available options and requirements, please contact a program advisor, who will consult with faculty in the host departments as necessary. All DM courses except Media Studio are offered as Production Studios. This means that students will be expected to produce finished projects of professional quality under the guidance of active digital media practitioners. While top-quality equipment and facilities are provided, students will be expected to obtain and maintain their own suitable laptop computer (consult the department for current specifications), as well as basic peripherals and consumables. In general, digital media production calls for teamwork and a willingness to go the extra mile to make work that is innovative AND of high quality. “Excellent” and “Acceptable” are the same to us.

2.1a Bachelor of Science Degree Requirements

Digital Media Core Requirements (61 credits)

- DM 1114 Sound Studio 1 (4)
- DM 1124 Moving Image Studio 1 (4)

40 credits other Digital Media Practice Courses, as approved by adviser, of which 24 must be at the 3XXX and 4XXX levels

- DM 2164 Media Studies 1 (4)
- DM 3163 Media Studies 2 (3)
- DM 4163 Media Studies 3 (3)
- DM 4003 Senior Project (3)

Humanities/Social Science Requirements (26 credits)

- EN 1014 or EN 1034 Writing in the Humanities I (4)
- EN 1204 Writing in the Humanities II (4)
- PL 2014 Symbolic Logic (4)
- HI 2104 Modern World History (4)
- 2000-level HuSS elective (4)
- 3000-level HuSS elective (3)
- 3000-level HuSS elective (3)

Math and Science Requirements (16 credits)

- MA 1XX4 Freshman Mathematics (4)
- CS 1214 Intro. to Object-Oriented Programming (Java) (4)
- PH 1214 Physics of Motion and Sound (4)
- PH 1224 Physics of Electricity and Light (4)

Restricted Electives (must be chosen from Humanities/Social Science/Mathematics/Natural Science) (12 credits)
 Free Electives (15 credits)

GRAND TOTAL: 130 credits

2.2 Graduate Certificate

Students may take a five-course sequence for a Graduate Certificate in Integrated Digital Media. The program is available as a minor for students in other graduate programs or for students applying directly for the certificate. Students who complete this certificate may subsequently apply to complete a Master of Science in Integrated Digital Media.

2.2a Graduate Certificate Requirements

Two theory seminars and three studio seminars, for a total of 15 credits at the graduate level.

2.3 Master of Science

The Master of Science Program in Integrated Digital Media is designed to provide the tools, skills, and insight to craft a better future not only for our alumni, but for everyone their work and life will touch after they graduate. In general, the Master of Science degree is designed to provide a balance of specialized knowledge and experience with a

high standard of cultural capital”. Whether it is undertaken as the beginning of a career in academic research, industry, or service, an MS must provide the right mix of mastery of one’s particular discipline with a broad understanding of the long-term patterns and tendencies of society and culture. As the reach and impact of new technologies increases, so must the wisdom of those making decisions about their deployment and use. Our MS in Integrated Digital Media is made to be the best preparation for a rewarding future in the rapidly expanding field of digital media communications, across a wide spectrum of interests: creative experience, an understanding of the broader forces shaping communications technologies and society, and the ability to make the most of what they know, and what they can imagine. Individual students and small teams are organized to produce professional work under the direct supervision of senior faculty. Where appropriate, leaders in allied professions are brought in to work hands-on with students and faculty together, including faculty from other departments at the university, or elsewhere in New York City.

The Master of Science program in Integrated Digital Media is fulltime and intensive: three consecutive semesters, including a major creative/research thesis project. This requires complete commitment, albeit for a manageable span of time, from “literate practitioners” who are prepared to make the most of their personal resources. While the formal course requirement of 30 credit-hours including a 6-credit thesis project may seem very manageable, it must be borne in mind that a considerable commitment of work is expected outside of class hours. The curriculum combines hands-on production work with study of historical, legal, and philosophical aspects of digital media communications. Guest scholars and conferences supplement the regular program, and maximize personal contact with leaders in various sectors of the field: business, advocacy, service, entertainment, and education. On the production side, we emphasize the development of skills applicable to a broad spectrum of media and mandates: small groups working on specific projects, with a focus on content-driven design, planning, and creation. In general, the facilities and strategies are geared to top-of-the line portable gear, rather than capital-intensive studio setups. This makes it practical for our labs to offer up-to-the-minute technology, and also for our students to prepare for freelance work and/or their own start-ups, as well as the corporate and public sectors.

2.3a Master of Science Degree Requirements

To complete the program, students must obtain 30 graduate credits, including DM 6013, DM 6023, DM 6033, DM 6043, DM 7033, and DM 7043. A course may be re-taken for a better grade (which will replace the previous grade); after the second retake, new grades will not erase the previous one. Up to 9 substitute credits may be transferred from other qualified institutions, or taken in other programs, such as Psychology, Philosophy, Computer Science, Electrical Engineering, or Management, subject to the prior approval of the academic advisor and the host department. A Capstone thesis or project may be undertaken with the approval and under the guidance of an academic advisor, for up to 6 of the 30 required credits.

3. COURSES

3.1 UNDERGRADUATE COURSES

DM 1114 Sound Studio 1 3:1:0:4

This course is a technical and theoretical foundation studio. It combines an orientation to sound and listening with the fundamentals of digital audio production: project planning, recording, and mixing. The course will emphasize high-quality field recording and mobile (laptop) post-production. *Note: required for freshman DM majors.*

DM 1124 Moving Image Studio 1 3:1:0:4

This is an introduction to the fundamentals of visual communication design: color, composition, motion, and interaction. The primary creation tool will be [[<http://processing.org/Processing>]], a Java-based graphics development tool for non-programmers. Once the general compositional principles have been worked through with Processing, video will be introduced as a means of capturing color, form, and motion. *Note: required for freshman DM majors.*

DM 2114 Sound Studio 2 3:1:0:4

This course will follow up on the general principles treated in DM 1114 with a series of more advanced projects, organized to reflect the practical realities of professional work: the elements of pre-production, production, and post-production for different genres. Students will be expected to demonstrate not only an understanding of the principles and tools, but also true commitment to quality. Projects may be narrative/dramatic or music, according to the

skills and goals of each student. *Prerequisite: DM 1114 Note: required for DM Majors.*

DM 2124 Moving Image Studio 2 3:1:0:4

In this course, students will complete a coordinated sequence of short projects designed to add up to a finished live-motion video project. There will therefore be considerable emphasis on the relevance of particular tools and techniques to the specific work at hand. Concepts will be introduced through screening of historical examples, from 1895 to the present. The format of the course is modeled on professional standards and workflow for pre-production, production, and post-production. *Prerequisite: DM 1124 Note: required for DM Majors.*

DM 2134 3D Graphics Studio 1 3:1:0:4

Students will learn and apply fundamental principles and technical requirements for 3D model construction and surfacing for a broad range of applications, from animation and game development to rapid prototyping and simulation. *Prerequisite: DM 1124.*

DM 2144 Interaction Design Studio 1 3:1:0:4

In order to design interfaces, we must first understand how humans interpret visual, tactile, and auditory phenomena, and how these perceptions inform their actions in the physical world. This course will familiarize students with the relevant principles of cognition, and address basic interaction design issues through two solo projects and one group project. *Prerequisite: CS 1214 Introduction to Programming and Problem-Solving in Java.*

DM 2154 Game Development Studio 1 3:1:0:4

This class will introduce the principles of 2D and 3D computer game design. Students will learn about the range of game types and understand their conceptual building blocks. Students will complete a structured sequence of assignments towards the completion of a design for a new game. *Prerequisite: CS 1214.*

DM 2164 Media Studies 1 4:0:0:4

This is a historical orientation to media, from oral culture to the Internet. The course is designed as a foundation for both the analysis of historical and contemporary media practices, and to provide vital critical

tools for creative professionals in a dynamic culture (which must have come from somewhere, and be headed somewhere else). *Prerequisites: EN 1014/1034, EN 1204 Note: required for DM majors.*

DM 2184 Digital Photography Studio 1 3:1:0:4

This is a general introduction to digital photography in its two most fundamental aspects: as a technology, and as an art form. DM 2184 is intended to serve as the first half of a two course sequence in digital photography. Taken consecutively, DM 2184 and DM 3183 will provide a good elective sequence for interested students in other degree programs. It will also provide an opportunity for DM majors to further develop their composition and shooting skills in the context of their other work with graphics and/or video.

DM 3113 Sound Studio 3 2:1:0:3

Having completed the prerequisites DM 1114 and DM 2114, students will be expected to have strong production skills coming into this production-oriented studio course. The goal will be to complete a project which reflects experiment and innovation, as well as professional quality. There will be more freedom for each student to define the scope of their project, and emphasis will be placed on self-direction in its execution. *Prerequisites: DM 1114 and 2114.*

DM 3123 Moving Image Studio 3 2:1:0:3

Students in DM 3123 will use the skills they have developed in the prerequisite DM 2124 to explore and make the most of digital video technology. Thematically, the course material will center on documentary and pseudo-documentary forms. Class time will be divided between hands-on technical demonstrations, group work, and case studies of particularly relevant historical work in film and video, to inform the high-quality and cutting-edge results we expect from DM students. The emphasis on experiment and group work is designed to reflect the realities of professional production. A range of approaches to video will be demonstrated and encouraged, as appropriate. *Prerequisites: DM 1124, DM 2124.*

DM 3133 3D Graphics Studio 2 2:1:0:3

Students will apply their 3D modeling skills and understanding of the Studio Tools environment to the fourth dimension: Time. Using Maya, one of the leading industry-

standard animation packages, students will produce a short animation over the duration of one term. The project will be a sequence of three phases to balance the need for structure with the fundamental reality of high-quality animation work: it takes time. Students must be prepared to devote considerable time outside of class hours if they want good results. Through case studies and group discussion, students will be encouraged to develop their creative and critical skills, as well as their proficiency. In other words, this course should be thought of as a combination of “art” and “technical”. *Prerequisite: DM 2134.*

DM 3143 Interaction Design Studio 2 2:1:0:3

Anyone who has used a computer in the past 20 years knows how to navigate WIMP (Windows, Icons, Menus, Pointer). Building upon this well-developed model, the course will focus on usability, user-testing, and user-centered design. It will end up exploring interfaces that move beyond established metaphors to provide new ways of interacting with the computer screen. This course will start with small assignments to illustrate the concepts. The last half of the semester will be spent developing a group project. *Prerequisites: CS 11X4, DM 2144.*

DM 3153 Game Development Studio 2 2:1:0:3

This class continues from DM 2154, delving into advanced technological implementations of 2D games. Taking designs from DM 2154 and working together in teams, students will implement a complete game during the course of the semester. Based on students’ current abilities and individual goals, production areas ranging from sprite creation, mapping and level design, to engine coding, and interaction scripting will be assigned to individual students. It will be their responsibility to complete their assignments, as if they were members of a professional game development team. *Prerequisites: CS 1214, DM 2154.*

DM 3163 Media Studies 2 3:0:0:3

Where DM 2164 was primarily a historical orientation to media communications, this course is its complement: a critical orientation. Drawing on the combination of their strengthening research, discursive, and creative skills, students in DM 3163 will be encouraged and expected to consider contemporary media communications practices as integral parts of an ongoing global cultural

process, with all the variety of potential that implies. *Prerequisite: DM 2164 Note: required for DM majors.*

DM 3173 Visualization and Simulation Studio 2:1:0:3

This course is a design and production studio, geared to the completion of a professional-quality project. Students will be expected to have the necessary design/scripting/programming skills necessary, and to be prepared to make the most of them. Production of a project relevant to research and teaching initiatives underway in other programs at Poly is strongly encouraged, subject to the permission and counsel of faculty in the host departments. *Prerequisites: DM 2134, DM 2144.*

DM 3183 Digital Photography Studio 2 2:1:0:3

This is the second of a general two-course studio sequence in digital photography, considered in both its technical and creative dimensions. Taken together, the courses offer a good introduction to digital photographic practice for non-DM majors, or an opportunity for DM majors to gain more experience in image capture and composition, to apply in their graphics and video work. *Prerequisite: DM 2184.*

DM 3404 Special Topics in Digital Media 4:0:0:4

Focus on a special topic in digital media completed under the guidance of a faculty member. Course may be repeated for credit on a different topic. *Prerequisite: instructor’s permission.*

DM 3504 Independent Study in Digital Media 4:0:0:4

Independent or small group work, under supervision of instructor, by special arrangement. *Prerequisites: for Liberal Studies and Digital Media majors only and instructor’s permission.*

DM 4003 Senior Research Project 0:0:3:3

This is a research/production project to be completed under the guidance of a faculty member in the final term. Topic, approach, and schedule is determined by prior agreement with the instructor and program director. This studio/seminar is designed to be the Capstone for DM students, and is a thesis-quality design and production project con-

ducted under the supervision of a faculty member active in the particular field and area in which the project is undertaken. Where appropriate, the student may receive supplementary guidance from faculty in another department, by special agreement. *Note: required course for DM seniors.*

DM 4023 Digital Media Internship 0:0:0:3

An internship can be undertaken for academic credit by special arrangement between the academic adviser and a partner company or institution. *Prerequisite: permission of adviser.*

DM 4113 Sound Studio 4 2:1:0:3

This is a production course geared to the preparation of students committed to the advancement of the field. Seminars will be led by an active practitioner in the field, and culminate in the production of a presentation to the public. This course is intended to complement the senior project class, by providing an opportunity to work and exchange ideas with an active practitioner in the industry, with a view to establishing professional contacts in advance of graduation, and to inform student work with up-to-date awareness of opportunities and issues in New York’s very broad and dynamic media sector. *Prerequisites: DM 3113.*

DM 4123 Moving Image Studio 4 2:1:0:3

Students will make the most of their experience in the introductory and intermediate studios to produce a short video piece of professional quality. As much as possible, the project is to be self-directed, as project management skills are an important part of proficiency at this level. Where appropriate, group work will be encouraged, bearing in mind that each student must take individual responsibility for specific aspects of the project. The emphasis in class will be on formal structure and post-production (editing and compositing). *Prerequisite: DM 3123.*

DM 4133 3D Graphics Studio 3 2:1:0:3

In this course, students will be required to produce a complete animation sequence of professional quality, showcasing the skills they have developed in the prerequisites. The project may be geared to scientific, engineering, or entertainment applications, according to each student’s skills and professional aspirations. This will be the venue for

students wishing to pursue the development of specific projects in 3D graphics/animation. Such projects may be part of large initiatives or collaborations with other departments. *Prerequisite: DM 3133.*

DM 4143 Interaction Design Studio 3

2:1:0:3

When talking about human computer interaction, we almost always think of sitting in front of a monitor, mouse, and keyboard, and manipulating visual elements on the screen. This is an unnatural asymmetric interaction, with the human communicating using physical input, and the computer communicating visually. This interaction model greatly restricts the possibilities. Over the semester, students will develop a project based on other modes and means of human-computer interaction, either individually or within a small group, and will regularly present to the class for discussion and criticism. *Prerequisites: CS 1214, DM 3143.*

DM 4153 Game Development Studio 3

2:1:0:3

This class continues from DM 3153, delving into advanced technological implementations of 3D games, specifically focusing on the Torque Game Engine, but with concepts applicable to game production in general. Working together in teams, students will implement a complete game during the course of the semester. Based on students' current abilities and individual goals, production areas ranging from modeling, texturing, and level design, to engine coding, and interaction scripting will be assigned to individual students. It will be their responsibility to complete their assignments, as if they were members of a professional game development team. *Prerequisite: DM 3153 and/or DM 4133 and/or DM 4143.*

DM 4163 Media Studies 3

3:0:0:3

This seminar is a synthesis of the historical and critical approaches developed in the prerequisites, DM 2164 and DM 3163. In this seminar, students will participate actively, to consider a set of key aspects of media in depth. This senior seminar is intended for students seriously committed to the subject, and to the development of their own skills as media theorists, within a well-developed critical framework. Students are expected to participate actively through seminar presentations on specific subjects, and through vigorous class discussion and debate. The standards of research, writing, and presentation will be consistent with the expectation

that postgraduate study is a real possibility. *Prerequisite: DM 3163 Note: required for DM Majors.*

CS 1214 Introduction to Programming with Java

4:0:0:4

This is an introductory course in computer programming and problem solving for students in the Digital Media program. The course is taught in the Java programming language due to its interactive multimedia capabilities. Students will learn the main components and features of Java, understand the elements of Object Oriented Programming and how they relate to Java, and write applications and applets which can be incorporated into HTML documents for the World Wide Web. Students will also learn programming methodology, which involves thinking about the best way to plan out the design using object-oriented design and appropriate features of Java, and methodical and efficient development of the implementation using step-wise refinement, incremental testing and debugging. *No prerequisite Note: required for DM majors.*

3.2 GRADUATE COURSES

DM 6013 Production Studio Seminar 1

3:0:0:3

This course will be an intensive orientation to the technical tools and skills required to produce digital media for broadcast, web, and multimedia presentations, with a conceptual emphasis on logistical requirements, and best practices for the planning of different production types. As students work hands-on with state-of-the-art production tools, they will become better able to assess different technology configurations, working styles, workflow arrangements, and the sheer number of person-hours it takes to actually produce top-quality professional media. They will also be encouraged to consider ways in which new tools make it possible to do better or more effective work in the kind of small teams that are typical of the industry, across a broad spectrum, at the highest level. *Prerequisites: admission to program, Co-requisites: DM 6023 Note: required course.*

DM 6023 Interactive Studio Seminar 1

3:0:0:3

Interactive media are proliferating, both in terms of their variety and their abundance. On the understanding that all participants in the program will have experience as creators of interactive media, and that their ex-

perience will vary widely, this studio seminar will call for the production of a variety of small interactive projects, followed up by a broad-ranging critical consideration of the relative demands and potentials of particular technologies and approaches. This course is designed to help participants understand the broader context of their existing skills, and to consider alternative tools, practices, and careers, or simply identify the best way to advance the course they have already set for themselves. It is expected that participants will share their experience and skills in the context of seminars as well as projects, with a view to identifying potential collaborators among the class for future work. *Prerequisite: admission to program, Note: required course.*

DM 6033 Media Organization

3:0:0:3

This course is designed as a general orientation to a broad range of types of media-producing organization types, from pirate radio stations and ad hoc collectives to major corporations. Each of the types of organization has a specific set of advantages and disadvantages, and each has a very specific range of work types it can support effectively. The ultimate purpose of the course is twofold: on one hand, to provide a "big picture" orientation to the different environments in which media get made and distributed; on the other hand, to help students clarify their own goals and needs, so they can make wiser choices about directing their studies and work towards the right career. *Prerequisites: admission to program, Note: required course.*

DM 6043 Graduate Media Studies 1

3:0:0:3

The first of a sequence of two lecture-seminar courses designed to provide students with a mature understanding of the historical, technical, and cultural forces that have shaped today's media landscape, by analyzing the precedents and circumstances driving the development of mass media in the first instance, and the more evolved forms that have grown out of them up to the present. *Note: required course.*

DM 7013 Production Studio Seminar 2

3:0:0:3

This course follows up on its prerequisite preproduction course, DM 6013. The emphasis will be on making the fullest use of a variety of image, audio, and video production tools, to achieve the very best quality by the most efficient means. Students will be ex-

pected to devote some time to experimentation, as well as produce examples of top-quality media for a variety of formats. Individual students will be expected to demonstrate proficiency across a broad range of tools, but encouraged to focus for virtuosity on those tools for which they have the greatest aptitude, or which will be the most useful for their thesis project. *Prerequisite: DM 6013.*

DM 7023 Interactive Studio Seminar 2
3:0:0:3

A studio seminar in interactive media for students intending to specialize in interaction design, both for their program of study and for their subsequent career. This is the second of a three-course sequence combining intensive research-level technical seminars, a major production project, and a series of workshops with leading experts in the field. *Prerequisite: DM 6013.*

DM 7033 Media Law 3:0:0:3

An advanced seminar, exploring in depth the theoretical and practical aspects of the principles and regulations that should be taken into account by working professionals in the field of media communications. A full range of models will be explored, from Open Source public license to Digital Rights Management, as well as working definitions of Fair Use, and the practical limits of sampling/mixing in different idioms and sectors of the economy. *Prerequisites: admission to program, DM 6033, Note: required course.*

DM 7043 Graduate Media Studies 2
3:0:0:3

This lecture/seminar course will follow up on its prerequisite, DM 6043, through study of subsequent developments in the technological and social aspects of media production and distribution, to provide students with a deeper understanding of the forces that have influenced our present practices and circumstances, with a view to anticipating and directing future developments. *Prerequisite: DM 6043, Note: required course.*

DM 8013 Production Studio Seminar 3
3:0:0:3

This course follows up on its prerequisite pre-production course, DM 7013. It is expected that each student will give one seminar *and* complete a major project on a subject that complements, but does not duplicate, their thesis work. The project is to be a substantial audio/visual production, on a subject and in a form to be agreed on beforehand with the instructor. Collaborations, group projects, and work including third parties is acceptable by prior agreement, bearing in mind that the work to be graded is the student's own contribution, rather than the product of the group in general. Therefore, the specifics of each student's contribution to group work must be clearly defined and documented in the final submission. A series of guest lectures by leading producers and critics will start off the session, and set the standard for presentations. *Prerequisite: DM 7013.*

DM 8023 Interactive Studio Seminar 3
3:0:0:3

A studio seminar in interactive media for students intending to specialize in interaction design, both for their program of study and for their subsequent career. This is the third of a three-course sequence combining intensive research-level technical or critical seminars, a major production project, and a series of workshops with leading experts in the field. It is expected that each student will give one seminar *and* complete a major project on a subject that complements, but does not duplicate, their thesis work. The project is to be a substantial interactive production.

Collaborations, group projects, and work including third parties is acceptable by prior agreement, bearing in mind that the work to be graded is the student's own contribution, rather than the product of the group in general. Therefore, the specifics of each student's contribution to group work must be clearly defined and documented in the final submission. A series of guest lectures by leading producers and critics will start off the session, and set the standard for presentations. *Prerequisite: DM 7013.*

DM 910X Digital Media Special Topics

1-3 credits, variable offered by special arrangement with faculty, visiting scholars, and professionals in the field. May be repeated for credit.

DM 990X Thesis/Project 3 or 6 credits

This six-credit course sequence is the capstone of the MS program in Integrated Digital Media. Under the guidance of a thesis adviser, and with the support of other faculty as required by the particular project, each student will complete a major media production project. The form and format of the thesis will be set out by agreement between the student and their adviser, with the approval of the department, with a view to advancing the student's career, but also contributing constructively to the profession as a whole. Students will be encouraged to seek professional outlets for their thesis, where appropriate; the department and the University will do everything possible to help ensure that our graduates' excellent work find its audience, and its market. The thesis may be undertaken in two consecutive 3-credit increments, or all at once, six credits, by agreement with the thesis advisor. *Note: optional.*

Typical Course of Study for the Bachelor of Science in Integrated Digital Media

FRESHMAN YEAR

Fall Semester

Course No.	Course Title	Hours/Week			
		Class	Lab.	Rec.	Cr.
DM 1114	Sound Studio 1	3	1	0	4
MA 1054	Calculus w/Pre-calculus	4	0	0	4
EN 1014	Writing and the Humanities I	4	0	0	4
PH 1214	Physics of Motion and Sound	4	0	0	4
	Freshman Seminar				4
					16

Spring Semester

Course No.	Course Title	Hours/Week			
		Class	Lab.	Rec.	Cr.
DM 1124	Moving Image Studio1	3	1	0	4
PL 2014	Symbolic Logic	4	0	0	4
EN 1204	Writing and the Humanities II	4	0	0	4
PH 1224	Physics of Electricity and Light	4	0	0	4
					16

SOPHOMORE YEAR

Fall Semester

DM 2XX4					4
DM 2XX4					4
HI 2104	Modern World History				4
CS 1214	Intro: to Object Oriented Programming (Java)	4	0	0	4
					16

Spring Semester

DM 2XX4					4
DM 2XX4					4
HU 2XX4					4
DM 2164	Media Studies 1	4	0	0	4
					16

JUNIOR YEAR

Fall Semester

DM 3XX3					3
DM 3XX3					3
HU 3XX3					3
	Restricted Elective (MA/HU/NS/SS)				3
	Free Elective				3
					15

Spring Semester

DM 3XX3					3
DM 3XX3					3
HU 3XX3					3
	RestrictedElective (MA/HU/NS/SS)				3
	FreeElective				3
					15

SENIOR YEAR

Fall Semester

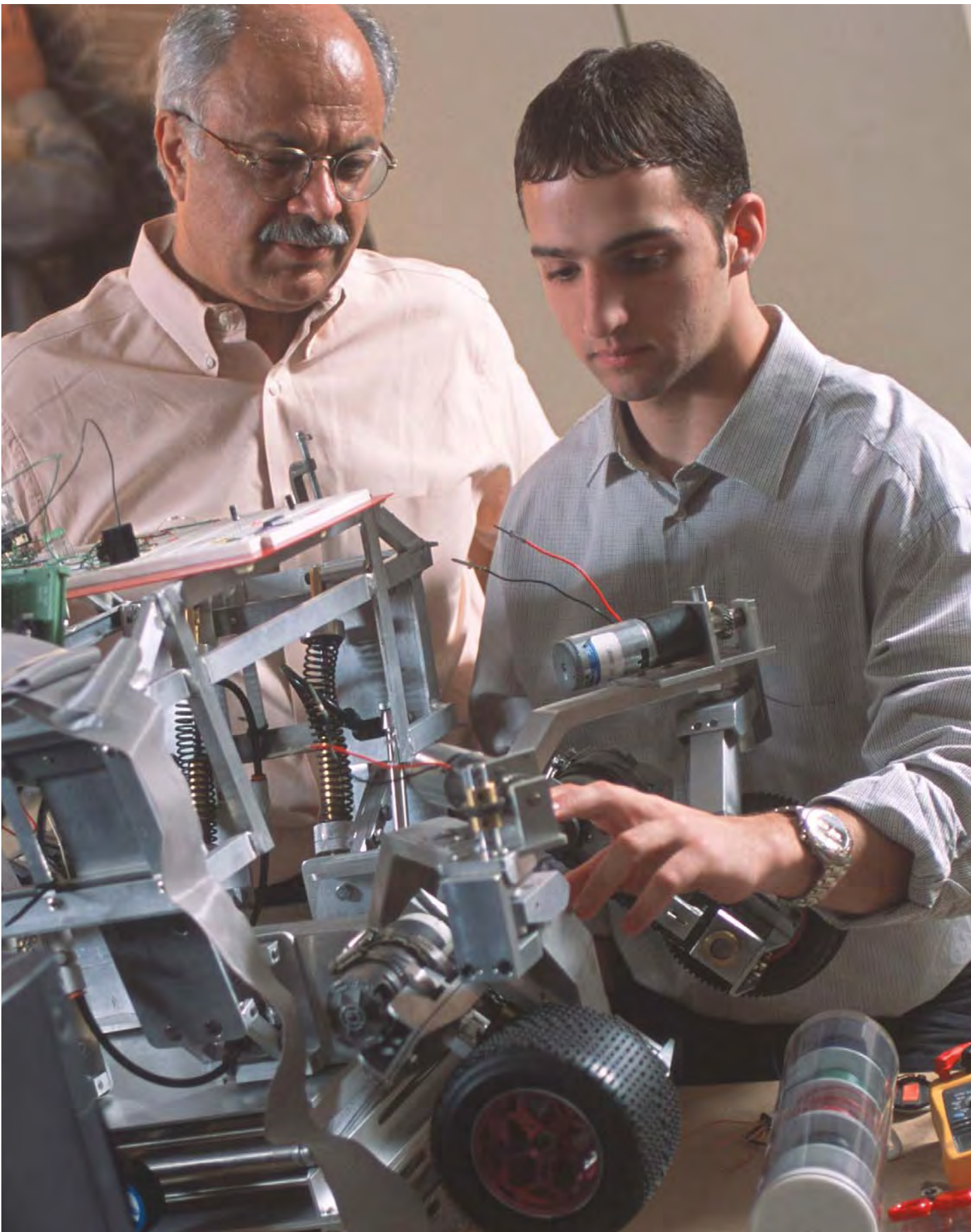
DM 4XX3					3
DM 4XX3					3
DM 4XX3					3
DM 3163	Media Studies 2				3
	RestrictedElective (MA/HU/NS/SS)				3
	FreeElective				3
					18

Spring Semester

DM 4XX3					3
DM 4003	Senior Research Project				3
	FreeElective				3
	RestrictedElective (MA/HU/NS/SS)				3
	FreeElective				3
DM 4163	Media Studies 3	3	0	0	3
					18

Total credits required for graduation:

130



INTERDISCIPLINARY STUDIES IN ENGINEERING PROGRAM: MASTER OF ENGINEERING

GOALS AND OBJECTIVES

The program Interdisciplinary Studies in Engineering leads to the Master of Engineering degree. It is intended for students seeking in depth knowledge in fields requiring courses from multiple disciplines, especially disciplines taught by different academic departments. The degree meets the needs of many companies seeking professionals who must integrate knowledge from different fields and create new knowledge through research at the interface of different fields.

REQUIREMENTS

To obtain the degree, students must satisfactorily complete a total of 30 credits in graduate courses with a Capstone experience and at least one 12-credit graduate advanced certificate in an engineering department or in the Department of Computer and Information Science.

The advanced certificates and courses required already exist at the university; new ones will be created and approved as the program evolves to meet the needs of students and industry. Admission to the program requires a bachelor's degree from an accredited institution, with a superior academic record and completion of all prerequisite courses. Applicants who are otherwise sufficiently prepared for admission may nevertheless be required to take specific undergraduate and introductory-level graduate courses. Such graduate courses may count towards the master's degree, depending on the practice of the department offering the advanced certificate.

To administer this interdisciplinary program, each academic department will assign an adviser (or more than one if needed as the program grows). These advisers will evaluate applicants for admission to the program. Based upon a student's selection of the first certificate, an adviser from the appropriate department will become the student's adviser. Advisers will help students select appropriate courses and determine their progress.

To satisfy the requirements for the Master of Engineering degree, students must complete a total of 30 credits of courses, as described below, and maintain a B average for each certificate.

1. Certificate 1 (required): a 12 credit advanced certificate in any engineering department or in the Department of Computer and Information Science.
2. Additional courses agreed upon by the student and adviser to total 30 credits.

One or more courses in management are generally encouraged. A student may also choose to complete a second certificate as part of the additional courses beyond the first certificate.

The majority of the 30 credits must be from engineering disciplines and the first advanced certificate included in the degree must be from one of the advanced certificates listed below. Prospective students must specify the first advanced certificate as part of the application process. There is no option for a thesis in this degree program. An average GPA of at least 3.0 is required in all graduate courses taken at Polytechnic for graduate credit. No more than 9 of the 30 credits may be transferred as part of this degree, based upon prior work at other acceptable institutions in subject matter relevant to this degree. A maximum of 3 transfer credits may be applied toward each certificate.

The degree shall include a Capstone experience in one of the following ways: (a) a Capstone course within one of the advanced certificates included in the degree; (b) a for-credit internship that builds on the program of study within the degree and is monitored by a faculty adviser; or (c) an advanced design course that builds on the program of study and is explicitly designated by the adviser as the Capstone course for the student's program of study. Where feasible, Polytechnic will designate in the University catalog a capstone course within each of the advanced certificates. It will generally be a laboratory or design project course or include a major design project. Where this is not done (b) or (c) will be the preferred mode of completing the degree.

ENGINEERING ADVANCED CERTIFICATES

Examples of engineering advanced certificates currently available for the first certificate from Polytechnic's departments include the following:

Department of Civil Engineering

- Executive Construction Management (Exec 21)
- Traffic Engineering
- Construction Management

Department of Computer and Information Science

- Software Engineering

Department of Electrical and Computer Engineering

- Wireless Communications
- Image Processing
- Computer Engineering
- Telecommunications Network Management

Interdisciplinary:

- Achieving World Class Quality
- Industrial Engineering
- Manufacturing Engineering and Production Science
- Manufacturing Excellence by Design: Holistic Approach

A second advanced certificate (optional) may be selected from among the first group or may include:

Department of Civil Engineering

- Hazardous Waste Management
- Transportation Planning
- Transportation Management and Economics

Department of Electrical and Computer Engineering

- Telecommunication Network Management

Department of Financial and Risk Engineering

- Financial Engineering

Department of Humanities and Social Sciences

- Environment Behavior Studies
- Technical Communications

Department of Technology Management

- Human Resource Management
- Organizational Behavior
- Technology Management
- Telecommunications Management

In addition, some departments offer specific course sequences that may appropriately be applied toward the Master of Engineering program.

WIRELESS INNOVATION

Below is a selection of courses focused on wireless innovation that fulfill requirements for a Certificate in Wireless Communications and for the degree Master of Engineering in Interdisciplinary Studies in Engineering.

GROUP 1: Required

EL 6303 Probability (Required)

EL 9953 Advanced Project I (Required)

GROUP 2: Restricted Electives:

Choose 3 courses (9 credits) from the following:

EL 5013 Wireless Personal Communication Systems

EL 5023 Wireless Information Systems Lab I

EL 5033 Wireless Information Systems Lab II

EL 6013 Principles of Digital Communications: Modulation & Coding

EL 6023 Wireless Communications: Channel Modeling & Coding

EL 6033 Modern Wireless Communications: Techniques and Systems

EL 6063 Information Theory

EL 6073 Coding Theory

EL 7023 Space-Time Wireless Communications

EL 6753 Radio Propagation for Wireless Systems

GROUP 3: Electives.

Choose 5 courses (15 credits) in electrical engineering, management or computer science. A maximum of three management courses is allowed. Sample Courses are listed below:

EL5363 Principles of Communication Networks

EL6373 Local and Metropolitan Area Networks

EL 6393 Advanced Network Security

MG 8673 Technology Strategy

MG 6073 Marketing

MG 7503 Electronic Business

MG 8653 Innovation Management

CS 6813 Information, Privacy & Security

CS 6823 Network Management & Security

CS 9153 Mobile Computing

GPA requirements: An overall GPA of 3.0 in all graduate courses is required.

LIBERAL STUDIES PROGRAM

Academic Adviser: Elisa Linksy
Program Director: Richard Wener

Liberal Studies is an interdisciplinary liberal arts degree that emphasizes the role of technology in world civilization and provides students interested in science and technology a place to pursue a practical degree program with greater breadth and flexibility than is possible in an engineering degree. Working closely with academic advisers, students develop majors or concentrations that reflect their interests and career goals. The core of the Liberal Studies Program is a series of seminars that look at technology from different perspectives: history, the arts, cultural studies, politics, philosophy, and literature. Students focus on a concentration of their choice and combine traditional liberal arts learning with technologically focused career education.

The Bachelor of Science in Liberal Studies is offered by the Department of Humanities and Social Sciences. All students must complete an interdisciplinary major that includes a core concentration in one of the following focus areas:

- History
- History (with Science & Technology)
- Literature
- Philosophy
- Psychology

All students can choose, with the consultation of an academic adviser, a second major or professional concentration in almost any field represented in the entire Polytechnic curriculum. In addition to the above areas it is possible to concentrate in the following areas of study:

- Behavioral Science
- Interdisciplinary Physics
- International and Global Studies
- Legal and Political Studies

GOALS AND OBJECTIVES

The objectives of the Liberal Studies Program are to:

- Foster literacy regarding science and technology in their social, cultural and historical settings
- Produce broadly educated citizens ready to assume leadership positions in a technologically driven world
- Provide practical education for non-engineering students that will lead to meaningful and rewarding careers

DEGREE REQUIREMENTS

All candidates for a BS in Liberal Studies are required to complete the Liberal Arts core courses, the Interdisciplinary Liberal Arts major (36 credits comprising six focus courses and three seminars) and additional courses to total 128 credits. Second majors and professional concentrations (40 credits) may be developed by students in consultation with the program academic adviser. A description of second majors is available from the program adviser. Liberal Studies students may also earn a minor in any of the subject areas.

Course No.	Course Title	Credits
EN 1014/1034	Writing & the Humanities I	4
EN 1204/1234	Writing & the Humanities II	4
HI 2104	Main Themes in Contemporary World History	4
	Liberal Arts Electives	8
	Advanced Liberal Arts Elective	4
CS 1114	Intro. to Programming & Problem Solving	4
MA 1114	Mathematics for Liberal Studies	4
	Natural Science Sequence (CM, PH, LS or others as approved by adviser)	8
LA 1014	Introduction to the History & Philosophy of Technology	4
LA 1024	Computers, Technology & Values	4
LA 2014	Technology & the Human Condition	4
	Liberal Studies Focus Courses in the area of primary concentration (as approved by adviser)	24
	Liberal Studies Seminars	12
	Professional concentration or free electives	40
TOTAL		128 credits

UNDERGRADUATE COURSES

ANTHROPOLOGY

AN 3134 Introduction to Physical Anthropology 4:0:0:4

Biosocial bases of human conduct seen in evolutionary perspective; elementary genetic, demographic, and ecological models necessary for understanding human behavior; biology as an evolutionary complex extending from Prosimian revolution through the Neolithic revolution. *Prerequisite:* HI 2104.

AH 3144 North American Indians 4:0:0:4

Social evolution from the hunting and gathering band through state society; considera-

tion of variation and developmental trends in several institutions: kinship, economic organization, warfare, politics, religion and technology. *Prerequisites:* HI 2104.

AN 3404 Chinese Art and Civilization 4:0:0:4

A basic discussion of the structure of Chinese civilization with a review of important art forms from Neolithic times to the present, with emphasis on visual documentation. *Prerequisite:* HI 2104.

AN 3504 Special Topics in Anthropology 4:0:0:4

Focus on a special topic in anthropology completed under the guidance of a faculty member. May be repeated for credit on a different topic. *Prerequisite:* instructor's permission.

AN 3604 Independent Study in Anthropology 4:0:0:4

Independent or small group work under supervision of instructor, by special arrangement. *Prerequisites:* for Liberal Studies/Integrated Digital Media majors only and instructor's permission.

N 4504 Senior Project in Anthropology 4:0:0:4

In this Capstone course, students develop a major project that integrates the knowledge and skills they have acquired through the program. Students manage the project from start to finish under the guidance of their project advisor. In addition, students revise selected projects from previous classes to develop a professional portfolio of writing samples. *Prerequisite:* Liberal Studies seniors only and by departmental permission.

ART HISTORY

The Art History electives are divided into two levels: introductory (2000-level) and advanced (3000-level). The fourth credit hour for all Art History courses take the form of an increased communication component: at least four graded writing assignments, regular informal writing and individual or group presentations. All Art History electives have a final exam.

AH 2114 Introduction to Art History 4:0:0:4

An introduction to Western art in different historical periods, with a focus on pre-20th century art. Objectives: to sample important periods and themes in European art history from archaic Greece to the present; and enhance cultural, social and aesthetic understanding through intensive engagement with a variety of visual forms in different historical periods. *Prerequisite: EN 1204/1234.*

AH 2124 Modern Art 4:0:0:4

Western art from the late 19th century to the present. Objectives: to sample important periods and themes in modern art; and enhance cultural, social, and aesthetic understanding through intensive engagement with a variety of visual forms in different historical periods. *Prerequisite: EN 1204/1234.*

AH 3114 Studies in National Traditions in the Visual Arts 4:0:0:4

Study of a particular national tradition or several related national traditions in the visual arts. Objectives: to study the emergence of a national tradition within the visual arts; and enhance cultural, social and aesthetic understanding through intensive engagement with a variety of visual forms in different historical periods. *Prerequisite: one 2000-level AH course.*

AH 3124 Special Topics in Art History 4:0:0:4

Independent or small group work under supervision of instructor, by special arrangement. *Prerequisites: Liberal Studies majors only and instructor's permission.*

AH 3404 Independent Study in Art History 4:0:0:4

Focus on a special topic in the history of art. May be repeated for credit for different topics. Objectives: to study a particular aspect of art history and enhance cultural, social, and aesthetic understanding through intensive engagement with a variety of visual forms in different historical periods. *Prerequisite: one 2000-level AH course.*

ECONOMICS**EC 2504 Basic Economics** 4:0:0:4

An introduction to the field of economics. Covering both micro- and macroeconomics, it includes such concepts and specific areas of

study as supply and demand, income distribution, national output, money and banking, fiscal and monetary policy, and international trade. In general, the course introduces the way economists approach economic questions by focusing on five interrelated economic areas:

- (1) economic theory and methodology;
- (2) the sources and reliability of economic data;
- (3) economic institutions, such as the Federal Reserve or the IMF;
- (4) the role of government in the economy; and
- (5) the historical contexts of contemporary economic questions

Prerequisite: HI 2104.

EC 2514 Microeconomics: An advanced Course in Microeconomics 4:0:0:4

Theory is presented in all its elegance along with a variety of illustrative applications. Designed for students concentrating in economics or management, those intending to go on to graduate programs in economics or business administration, and others interested in the field of economics. *Prerequisite: EC 2504.*

EC 2524 Managerial Microeconomics 4:0:0:4

An advanced course in microeconomics for students with appropriate mathematical background. This course presents microeconomic analysis and its application to business decision making. Fundamentals of the theory of the firm, the theory of the consumer and market structure and competition are presented, including both theoretical models and quantitative analysis techniques. Advanced topics in information asymmetries and externalities are presented. *Prerequisite: required for students in the Business and Technology Management Program; MA 1124; does not satisfy general education requirements in Humanities and Social Sciences.*

EC 2534 Macroeconomics 4:0:0:4

An advanced course in macroeconomics. Presents macroeconomic theory and applies it to the US macro-economy in the post-World War II period. Course focuses on macroeconomic phenomena and macroeconomic problems, including unemployment, inflation, and recessions. It pays special attention to the role of government in this area. Finally, it introduces economic data and their inherent problems. Designed for students concentrating in economics or management, those intending to go on to

graduate programs in economics or business administration, and others interested in the field of economics. *Prerequisite: EC 2504.*

EC 3254 Economic Issues 4:0:0:4

Building on the foundation provided in the introductory course in economics, course examines a number of contemporary economic issues in greater depth. The specific issues studied vary and depend on student interests, professor's interests and the availability of appropriate reading material. Occasionally a text is used, although usually reading material from a variety of sources is assigned. Issues focused on include: government regulation of safety, regulation and testing of pharmaceutical drugs by the FDA; potential use of the market for organ transplants; alternative tax proposals; social security "reforms"; NAFTA; racial and sexual discrimination; alternative medical plans. *Prerequisite: EC 2504.*

EC 3264 American Economy: Boom and Bust 4:0:0:4

An advanced macroeconomic course that examines the nature of the fluctuations in aggregate economic activity, the so-called "business cycle", that have characterized capitalist growth in general and the American economy in particular. The course focuses on recent decades, especially the period since 1993. In doing so, it studies the changing features of the American economy since then and the problems that have accompanied these changes, such as unemployment, inflation, recessions, and the budget and trade deficits. Within this context, much time is spent in careful analysis of government's role in the economy, in particular, the role of the Federal Reserve, but also the impact of the fiscal policy of the federal government on macroeconomic stability. *Prerequisite: EC 2504.*

EC 3404 Special Topics in Economics 4:0:0:4

Focus on a special topic in Economics, completed under the guidance of faculty member. May be repeated for credit on a different topic. *Prerequisite: instructor's permission.*

EC 3504 Independent Study in Economics 4:0:0:4

Independent or small group work under supervision of instructor by special arrangement. *Prerequisites: Liberal Studies majors only and instructor's permission.*

ENGLISH AND LITERATURE

Basic English and Writing Courses:

EN 1080	Reading and Writing in English/ESL
EN 1090	Introductory Composition
EN 1014	Writing and the Humanities I
EN 1034	Writing and the Humanities I/ESL
EN 1204	Writing and the Humanities II
EN 1234	Writing and the Humanities II/ESL

The English/Literature offerings are divided into two levels: introductory (2000-level) and advanced (3000-level). The introductory literature courses are designed to introduce students to intensive reading and research in either a particular literary genre or in survey courses.

In a genre course such as poetry, other forms of cultural expression such as painting or nonfiction prose may be considered when appropriate, or the instructor may choose to include poetry from a range of national literatures.

Advanced studies courses are designed to allow students to explore at a more advanced level specific cultural, aesthetic, and historical questions through (1) reading and writing about literary texts from specific national and cultural traditions, or (2) exploring the interrelations between literary expression and other forms of cultural, social, and political discourse. May be repeated for credit, provided that the topic differs.

The fourth credit hour for all literature courses takes the form of an increased communication component (at least four graded writing assignments, regular informal writing and individual or group presentations) and an intercultural/interdisciplinary component. For example, in a Shakespeare survey course, the intercultural interdisciplinary component might be readings in Renaissance philosophy, history or art history. In an American literature survey course, this component might be readings in American and European political history.

All literature courses include a final exam or final project.

GENRE (2000 level)

Prerequisite: EN 1204 or EN 1234

EN 2114	Poetry
EN 2124	The Short Story
EN 2134	The Novella
EN 2144	The Novel
EN 2154	Drama
EN 2164	Science Fiction

SURVEY (2000 level)

Prerequisite: EN 1204

EN 2214	World Literature
EN 2224	English Literature
EN 2234	American Literature
EN 2244	Shakespeare

ADVANCED LITERATURE

(3000+ level)

Prerequisite: one 2000-level EN course.

EN 3114	Advanced Studies in World Literature
EN 3124	Advanced Studies in English Literature
EN 3134	Advanced Studies in American Literature
EN 3214	Gender and Literature
EN 3224	Media Studies
EN 3234	Science, Technology and Literature
EN 3244	Literature and the Arts
EN 3254	Special Topics in Literature
EN 3404	Independent Study
EN 4504	Senior Project

EN 1014 Writing and the Humanities I

4:0:0:4

An introduction to the humanities and to effective techniques of college level writing. The course examines basic concepts, form and techniques of philosophy, art and literature, with emphasis on fluency, precision, and imaginative use of source materials in writing. *Prerequisite:* SAT essay score (beginning fall 2006) or placement examination administered by the Department of Humanities and Social Sciences, or EN 1090. EN 1080 only with the recommendation of the student's EN 1080 instructor, approved by the director of writing curriculum.

EN 1034 Writing and the Humanities I (English as a Second Language)

4:0:0:4

An introduction to the humanities and to effective techniques of college level writing. Designed for students for whom English is a second language.

The course examines basic concepts, forms and techniques of philosophy, art, and literature, with emphasis on fluency, grammar, syntax, precision, and imaginative use of source materials in writing. *Prerequisite:* SAT essay score (beginning fall 2006) or placement examination, or EN 1080. EN 1090 only with the recommendation of the student's EN 1090 instructor, approved by the director of writing curriculum.

EN 1080 Reading and Writing in English as a Second Language

6:0:0:0

An intensive course for non-native speakers of English, taught at the high intermediate level. Students develop grammatical and syntactical control in writing, improve their comprehension of college-level texts, and learn to organize an essay in the American academic idiom. The course includes some practice in listening and speaking for academic and professional purposes. *Prerequisite:* SAT essay score (beginning fall 2006) or placement examination administered by the Department of Humanities and Social Sciences.

EN 1090 Introductory Composition

4:0:0:0

An intensive course in reading comprehension and composition skills for students who have not been adequately prepared for college composition and reading. Designed for native speakers of English or non-native speakers with a high-level of experience communicating in American English. Emphasis is on improvement of control of standard grammar and syntax in American English and on fluency in writing. Students develop grammatical and syntactical control in writing, improve their comprehension of college level texts, and learn to organize an essay in the American academic idiom. *Prerequisite:* SAT essay score (beginning fall 2006) or placement examination administered by the Department of Humanities and Social Sciences.

EN 1204 Writing and the Humanities II

4:0:0:4

An introduction to the humanities and to advanced techniques of writing. Thematic emphasis on change and continuity in the humanities is presented, as well as an exploration of the interrelationship of the humanistic disciplines through the study of works of art, philosophy, literature and, in some sections, music. Advanced work is given to stylistic options and more complex forms of writing, including the longer critical study, the formal report, and, especially, the research paper. In some cases, this course may be presented as an introduction to literature. *Prerequisite:* EN 1014 or EN 1034. In the interest of maximizing the student's potential for success, advanced placement and transfer credits are only accepted as prerequisites pending the results of a placement test and approval by the director of writing curriculum. Under no circumstances will transfer credit be given for EN 1204 in the absence of approved transfer credits for its prerequisite, EN 1014 (or EN 1034).

EN 1234 Writing and the Humanities II (ESL)

4:0:0:4

The student population of this course is limited to students whose first language is not English. These students receive extra support in the grammatical and syntactic structures of English, support not provided in sections of the alternative course, EN 1204. EN 1234 and EN 1204 are fully equal as prerequisites, and both bear 4 credits. Like EN 1204, EN 1234 provides an introduction to the humanities and to advanced techniques in writing. Thematic emphasis on change and continuity in the humanities is presented, as well as an exploration of the interrelationship of the humanistic disciplines through study of great works of art, philosophy, literature

and, in some sections, music. Advanced work is given to stylistic options and more complex forms of writing, including the longer critical study, formal report, and research paper. In some cases, this course may be presented as an introduction to literature. *Prerequisite: EN 1034. EN 1014 only with the recommendation of the English Final Examination Grading Committee, approved by the Director of ESL Writing Curriculum. Note: In the interest of maximizing the student's potential for success, advanced placement and transfer credits are only accepted as prerequisites pending the results of a placement test and approval by the Director of ESL Writing Curriculum. Under no circumstances will transfer credit be given for EN 1234 in the absence of approved transfer credits for its prerequisite, EN 1034.*

EN 2114 Poetry 4:0:0:4

An introduction to a range of poetic forms and an exploration of the relation between poetry and other forms of cultural expression. Objectives: to promote research and critical reading and thinking skills; to promote written and oral communication skills; and to enhance cultural, social and aesthetic understanding through intensive reading of and writing about a range of poetic forms. *Prerequisite: EN 1204.*

EN 2124 The Short Story 4:0:0:4

An introduction to the themes, structures, and techniques of the short story. Objectives: to introduce the short story as a literary form; to promote research and critical reading and thinking skills; to promote written and oral communication skills; and to enhance cultural, social, and aesthetic understanding through intensive reading of and writing about short fictional texts. *Prerequisite: EN 1204.*

EN 2134 The Novella 4:0:0:4

An introduction to the themes, structures, and techniques of the short story. Objectives: to introduce the novella as a literary form; to promote research and critical reading and thinking skills; to promote written and oral communication skills; and enhance cultural, social, and aesthetic understanding through intensive reading of and writing about literary texts. *Prerequisite: EN 1204.*

EN 2144 The Novel 4:0:0:4

An introduction to the history, themes, structures, and techniques of the novel. Objectives: to introduce the novel as a literary

form; to promote research and critical reading and thinking skills; to promote written and oral communication skills; and to enhance cultural, social and aesthetic understanding through intensive reading of and writing about literary texts. *Prerequisite: EN 1204.*

EN 2154 Drama 4:0:0:4

An introduction to the themes, structures and techniques of dramatic writing. Objectives: to explore the purpose of theater and investigate techniques of modern drama, its language and its subject matter, and to generate a critical discourse around selected dramatic masterpieces; to promote research and critical reading and thinking skills; to promote written and oral communication skills; and to enhance cultural, social, and aesthetic understanding through intensive reading of and writing about literary texts. *Prerequisite: EN 1204.*

EN 2164 Science Fiction 4:0:0:4

A survey of science fiction. Definitions and development of the genre, scientific and historical contexts, contemporary and future visions. Promote understanding of the relationship between science and literature and of the conventions and special concerns of this genre. Objectives: to promote research and critical reading and thinking skills; to promote written and oral communication skills; and to enhance cultural, social, and aesthetic understanding through intensive reading and writing about literary texts. *Prerequisite: EN 1204.*

EN 2214 World Literature 4:0:0:4

A survey of forms, ideas, and changes in world literature, emphasizing a comparative approach. Objectives: to read literary works from Europe and other continents and explore the meaning of literary traditions through works written in English and in other languages and translated into English; to study the structural differences and parallels of great works of diverse cultures; to promote research and critical reading and thinking skills; to promote written and oral communication skills; and to enhance cultural, social and aesthetic understanding through intensive reading of and writing about literary texts. *Prerequisite: EN 1204.*

EN 2224 English Literature 4:0:0:4

A survey of British literature from the medieval period to the present. Objectives: to introduce the themes, forms, and historical

contexts of British literature; to promote research, critical reading, and thinking skills; to promote written and oral communication skills; and to enhance cultural, social, and aesthetic understanding through intensive reading of and writing about literary texts. *Prerequisite: EN 1204.*

EN 2234 American Literature 4:0:0:4

A survey of American literature from the Puritans to the present. Objectives: to introduce the themes, forms, and historical contexts of American literature; to promote research, critical reading, and thinking skills; to promote written and oral communication skills; and to enhance cultural, social, and aesthetic understanding through intensive reading of and writing about literary texts. *Prerequisite: EN 1204.*

EN 2244 Shakespeare 4:0:0:4

Representative tragedies, comedies, histories. Cultural and literary influences. Textual problems, recent criticism, Elizabethan theater. Objectives: to introduce the works of William Shakespeare and to explore their aesthetic, cultural, and historical contexts; to promote research, critical reading, and thinking skills; to promote written and oral communication skills; and to enhance cultural, social, and aesthetic understanding through intensive reading of and writing about literary texts. *Prerequisite: EN 1204.*

EN 3114 Advanced Studies in World Literature 4:0:0:4

Focus on a special topic in world literature; may include comparative and intercultural studies. May be repeated for credit for different topics. Objectives: to promote research, critical reading, and thinking skills; to enhance cultural, social, and aesthetic understanding through intensive reading of and writing about literature from a nonwestern and/or non English speaking culture. *Prerequisite: 2000-level EN course.*

EN 3124 Advanced Studies in English Literature 4:0:0:4

Focus on special topic in literature of Great Britain. May be repeated for credit for different topics. Objectives: to promote research, critical reading, and thinking skills; and to enhance cultural, social, and aesthetic understanding through study of texts from Great Britain. *Prerequisite: 2000-level EN course.*

EN 3134 Advanced Studies in American Literature 4:0:0:4

Focus on special topic in literature of the United States. May be repeated for credit for different topics. Objectives: to promote research, critical reading, and thinking skills; and to enhance cultural, social, and aesthetic understanding through study of particular issues in American Literature. *Prerequisite: 2000-level EN course.*

EN 3214 Gender and Literature 4:0:0:4

Explores literary, philosophical, social, and cultural questions related to gender and sexuality. May be repeated for credit for different topics. Objectives: to promote research, critical reading, and thinking skills; and to enhance cultural, social, and aesthetic understanding through intensive reading of and writing about texts concerned with gender issues. *Prerequisite: 2000-level EN course.*

EN 3234 Science, Technology and Literature 4:0:0:4

Study of literary texts and other forms of cultural expression in relation to issues in science and technology. May be repeated for credit for different topics. Objectives: to promote research, critical reading, and thinking skills; and to enhance cultural, social, and aesthetic understanding through intensive reading of and writing about cultural expression in relation to issues in science and technology. *Prerequisite: 2000-level EN course.*

EN 3244 Literature and the Arts 4:0:0:4

Study of the interrelation of literary texts and other forms of cultural expression, particularly music and/or visual arts. May be repeated for credit for different topics. Objectives: to promote research, critical reading, and thinking skills; and to enhance cultural, social, and aesthetic understanding through study of the possible connections among a variety of representative and aesthetic forms. *Prerequisite: 2000-level EN course.*

EN 3254 Special Topics in Literature 4:0:0:4

Study of a special topic in literature. May be repeated for credit for different topics. Objectives: to promote research, critical reading, and thinking skills; and to enhance cultural, social, and aesthetic understanding through study of a special topic in literature. *Prerequisite: 2000-level EN course.*

EN 3404 Independent Study in Literature 4:0:0:4

Independent or small group work, under supervision of instructor, by special arrangement. *Prerequisites: Liberal Studies majors only and instructor's permission.*

EN 4504 Senior Project in Literature 4:0:0:4

In this Capstone course, students develop a major project that integrates the knowledge and skills they have acquired through the program. Students manage the project from start to finish under the guidance of their project advisor. In addition, students revise selected projects from previous classes to develop a professional portfolio of writing samples. *Prerequisites: Liberal Studies seniors only and departmental permission.*

HISTORY**HI 2104 Modern World History** 4:0:0:4

Required course for all students. An introduction to provide students with a degree of cultural literacy in modern and contemporary history. The course should also provide an understanding of the ways in which historians use sources and shape narratives, and the necessity and pitfalls of using historical analogies to understand the present. *Prerequisites: EN 1204/1234 or LA 1014 or permission of the department*

HI 2214 Introduction to the History of Science 4:0:0:4

General introduction to issues in science and society through the perspective of history. The course's approach is to look at a scientific world view in its varying social contexts as it developed over several hundred years. The mechanical world view emerged during the scientific revolution and led to an understanding of planetary motion, the ability to go to the moon, and the power to harness nuclear energy. Topics include social context of the scientific revolution, Copernicus, Galileo, science and the Church, Newton, Bohr and atomic structure and nuclear energy, and the decision to drop the atomic bomb. *Prerequisite: HI 2104.*

HI 2224 Science and Industry in the Modern World 4:0:0:4

Examines science and industry in the 19th and 20th centuries, a time when science and technology became very closely bound. Course covers areas where significant ad-

vances occurred that brought large societal changes.

For example: (1) the development of new forms of communication like the telegraph, radio and telephone and (2) the development of a theoretical basis for mechanical computing and the computer revolution. Course pays close attention to the political and business contexts of these developments. *Prerequisite: HI 2104 and one of the following: HI 2214, HI 2314, PL 2104, PL 2094, PL 2064, EN 2164 or instructor's permission.*

HI 2314 United States History from Colony to Empire 4:0:0:4

Surveys the history of the United States, focusing on the history of British North America, the American Revolution, the development of capitalism in the early republic, the conflict over slavery caused by the schism between capitalist and liberal values and the resulting cataclysm of southern secession and civil war. How and why did the United States become the world's leading military and industrial power in the 20th century. Topics include the re-unification of the United States as nation-state after the Civil War, the social, technological and economic effects of the "second industrial revolution," the closing of the frontier and the subsequent push for U.S. territorial expansion in the Pacific Ocean and the Caribbean Sea, immigration and nativism, the era of Progressive reform, and the catastrophic wars and depressions of 1914-1945.

The course reaches into the post-1945 world to explore the Cold War and examine American participation in the wars in Indochina, 1941-1975, and the attempt to create a "new world order" under US leadership. *Prerequisite: none.*

HI 2514 History of the City of New York 4:0:0:4

Advanced level undergraduate course covers the history and development of the city of New York from its exploration by Giovanni de Verrazano in 1524 to the present. Major themes include the evolution of the city's political economy, political and economic influences on the use of land and space, and ethnic and class conflict in the urban environment, the consolidation of Greater New York. *Prerequisite: HI 2104.*

HI 2624 American Civil Liberties 4:0:0:4

Examines the development of civil rights beginning with their roots in early modern England, through the latest Supreme Court decisions in the field. Builds on students'

basic legal research skills by teaching them how to read, discuss, and write about complicated constitutional cases, and how to transcend the narrow boundaries of legal discourse by placing cases in historical context. *Prerequisite: HI 2104 or instructor's permission.*

HI 2714 Modern Asia 4:0:0:4

Explores the major civilizations in Asia from the mid-17th century to the present with attention to their interaction with the West. Primary emphasis on Chinese, Indian, and Japanese history. Topics include colonialism and imperialism, the Opium Wars, the 20th-century revolutions in China, India under the British, Gandhi, the modernization of Japan, the rape of Nanking, Mao Zedong, Deng Xiaping, the Asia-Pacific Economic Zone, French Indo-China, Ho Chi Minh, and Islamic revolutions in Iran and Afghanistan. *Prerequisite: HI 2104.*

HI 3032 Urban Infrastructure in Antiquity and Today 4:0:0:4

The course will compare urban infrastructure engineering in the ancient city to that in the current city. Topics include health, security, water supply, streets and building. *Prerequisite: HI 2104.*

HI 3034 History of the Urban Infrastructure 4:0:0:4

This course examines the history of New York City's infrastructure, concentrating on water, sanitation and public health, transportation, electrical and communications systems, the development of housing and real estate, the security infrastructure and plans for its future. The broad question the course addresses is how the political economy of the city has shaped its physical environment, and more particularly the technological innovations that have made the city modern and postmodern. *Prerequisite: HI 2104.*

HI 3064 Global Housing 4:0:0:4

Housing is one of the basic needs of all human beings. Not surprisingly, therefore, a great deal of public and private debates have centered on the form, financing, and allocation of shelter. Housing is about more than four walls and a roof; it is about the idea of "home," about gendered division of labor, and about identity. It has also been fundamentally connected with the health of the construction industry and national banks, the accumulation of domestic savings, and thus with the success or failure of national

development. In this class, there are three key questions. First, what are some of the critical issues when designing housing vis-à-vis the city or countryside? How can design affect use (and vice versa)? How can housing engineer social harmony, stability, and community? Secondly, who has traditionally paid for what kind of housing? Who deserves to be subsidized by whom? Third, what types of housing exist, and who benefits (or is hurt by) each type? How can identity inform architecture? These three themes will structure our debates and discussions about international housing. *Prerequisite: HI 2104 and instructor's permission.*

HI 3214 Early Modern Science 4:0:0:4

Covers the development of modern science from the Renaissance through the Enlightenment. Sets the stage for the scientific revolution. Looks at the contribution of the Arab world, the Renaissance in the West, and the importance of voyages of discovery to the New World. Takes a comprehensive look at the scientific revolution by considering its revolutionary nature, the social and professional contexts within which it took place, and the experimental practices and theoretical ideas that brought it to fruition. Course concludes with the work in electricity and magnetism, chemistry, and encyclopedic understanding of the Enlightenment. *Prerequisites: HI 2104 and one of the following: HI 2214, HI 2224, PL 2104 or instructor's permission.*

HI 3224 Science and Ethics in the Twentieth Century 4:0:0:4

Science is often depicted as an intellectual pursuit totally detached from society. The isolated genius working away in the ivory tower has become the romantic emblem of the scientist in his/her noble pursuit of objective, disinterested knowledge. However, a more critical, and historically informed, view reveals the shortcomings of this caricature. Over the past century, scientists have debated the ethical ramifications of their work. And legislation has struggled to keep pace with scientific discoveries and their applications as biomedical research has raised serious ethical challenges. This course will investigate how science generates ethical debates, and conversely how moral controversies often shape the conduct and context of the scientific enterprise. Students will engage in lively and enlightened debates and improve their writing skills. No previous knowledge of science is required. *Prerequisite: HI 2104 and instructor's permission.*

HI 3234 Biology and Society 4:0:0:4

This lecture course, intended primarily for juniors and seniors, explores the relationship between the biological sciences and society from Enlightenment France to the Human Genome Project and biotechnology in the United States. Although a university-level course in the biological sciences would be most helpful, it is not a prerequisite for the course. *Prerequisite: Junior/Senior status or permission of the instructor.*

HI 3252 History of the Mass Media from Printing to the Internet 4:0:0:2

This course will explore the history of mass media broadsides, newspapers, cinema, radio, TV, and the internet from the advent of cheap print in the early modern period to the turn of the twenty-first century. Themes will include the history of mass media technology, the mass dissemination of news and its effects on popular culture, and gender relations, sensationalism, the role of the media in the development of advertising, and consumer culture. *Prerequisite: HI 2104 or LA 1014*

HI 3404 Special Topics in History 4:0:0:4

Independent or small group work under supervision of instructor, by special arrangement. *Prerequisites: HI 2104 or instructor's permission.*

HI 360X Independent Study in History 4:0:0:X

1-6 variable credit independent or small group work under supervision of instructor, by special arrangement. *Prerequisite: Instructor's permission.*

HI 3714 Seminar in American Foreign Relations and International History 4:0:0:4

Examines selected topics in the history of international and transnational relations between Americans and the rest of the world from the early modern period to the present. Students will discuss a variety of methods and interpretations of American foreign policy and public and private interactions abroad, and of the United States place in the world. *Prerequisites: HI 2104 or permission of the department.*

HI 4724 Seminar in International History since 1945 4:0:0:4

An advanced interdisciplinary course in international history since 1945 designed as a Capstone course in global studies. The course will explore selected topics in international history since 1945 with the goal of a deep understanding of the narratives of the field of cold war studies, the limitations of the cold war paradigm for understanding the post-1945 period and the alternative paradigms. It assumes that students are generally familiar with the historical events under discussion and will require students to complete and report on substantial research projects on topics approved by the instructor on the historiography and history of international and transnational relations since 1945. *Prerequisites: HI 3714 and another 3000-level history course or instructor's permission.*

LAW AND TECHNOLOGY

The Law and Technology Sequence is an 8-credit sequence designed to fit with the requirements of engineering and computer science majors. It is intended to give undergraduates some exposure to law, legal methods, and intellectual property so that they can:

1. Better understand the legal implication of their work as computer scientists and engineers
2. Evaluate their potential for law school admission and their possible interest in a legal career

The sequence consists of LW3104 Introduction to Legal Writing and Research and LW 4104 The Law of the Internet.

LW 3104 Introduction to Legal Writing and Research 4:0:0:4

This course acquaints students with a basic knowledge of how laws and regulations are passed and how competing interests are adjudicated by the three branches of government. Emphasis on the administrative and judicial processes. Students learn how to read judicial and administrative decisions and the basics of legal writing. *Prerequisite: none.*

LW 4104 The Law of the Internet 4:0:0:4

This course is a general survey of legal regulation of the Internet, including an outline of intellectual property law relevant to the Internet, the law of commercial transactions on the Internet, and computer crime. *Prerequisite: LW 3104.*

LW 4533 Construction Law 3:0:0:3

This course introduces students to the areas of the law that they are most likely to encounter in construction. Following an introduction to the legal system and of legal analysis, areas to be addressed include contracts, procurement, scope definition, delays and acceleration, site conditions, warranties, termination, tort claims, dispute resolution, and ethics. *Prerequisite: students must be enrolled in the Construction Management Program, junior standing.*

LIBERAL STUDIES

All liberal studies courses are required for students in the Liberal Studies Program. LA courses can NOT be applied toward a humanities or social sciences course requirement.

LA 1014 Introduction to the History and Philosophy of Technology 4:0:0:4

Introduces students to important issues, historical and contemporary, related to technology from a variety of social, political, and philosophical viewpoints. Course serves as a foundation for the interdisciplinary approach of the Liberal Studies Program. *Prerequisite: none.*

LA 1024 Computers, Technology and Values 4:0:0:4

Introductory examination of the social, cultural, and political impact of networked computers in the contemporary world. *Prerequisite: none.*

LA 2014 Technology and the Human Condition 4:0:0:4

This course provides an understanding of the human species and human technological output from the interdisciplinary perspectives of biology, psychology, anthropology, and ethics. Through readings, lectures, discussions, and field trips, the interrelationship between human growth, development, evolution and technology, and the impact and implications of technology for both the human species and the ecosystem are analyzed. *Prerequisite: LA 1014.*

LA 3014 Directed Study 4:0:0:4

Directed study under supervision of a faculty advisor in Humanities & Social Sciences. Students are exposed to foundational research techniques under the guidance of a faculty advisor.

Library research, written and oral reports required. *Prerequisites: Permission of HUSS faculty advisor and LA 1014, LA 1024, LA 2014.*

LA 3024 The Design of Cities 4:0:0:4

The course is intended to help students discover different ways of looking at and understanding what cities are and how they work to affect people and institutions, largely from the perspective of environmental social sciences. Course topics address methodological approaches to observing and studying city spaces, the historical context of urban life, including the role of preservation in maintaining a sense of community. Course addresses sustainable approaches to creating urban spaces, including "smart growth" strategies; the special role of the arts in urban life and development; the relationship between urban settings and natural environments; and the role of design in crime and crime prevention. Students work as teams to conduct a case study of a local urban setting, assessing its context, design and impact as an urban development. *Prerequisite: LA 1014.*

LA 4014 Internship/Study Abroad 4:0:0:4

Students may decide to engage in a service learning internship project in the local area, or they may choose to participate in a study abroad program. Internship Option: Supervised semester-long project carried out in community or industry setting. Evaluated on basis of written and oral reports presented to faculty and external project cosponsors. Students must maintain a course load equivalent of 16 credits (including the 4 for LA 4014) during this semester.

Study Abroad Option: Semester-long course of study at a foreign institution. Students must maintain a course load equivalent of 16 credits (including the 4 for LA 4014) during this semester. *Prerequisites for both options: Junior/Senior status and permission of HUSS faculty advisor.*

LA 4024 Capstone Project 4:0:0:4

Research project under supervision of faculty advisor in Humanities & Social Sciences. Library research, written and oral reports required. *Prerequisites: Permission of HUSS faculty advisor, senior status, LA 1014, LA 1024, LA 2014, LA 3014, LA 4014, STS 3014.*

LA 4053 BIOSOMA -Environmental Design of the City of the Future 3:0:0:3

The goal of this course is to improve the engineering design of a city and its components. The course focuses on the city as an entity; which concentrates living organisms, societal organizations and activities; and machines, interacting with the environment both outside and inside the city. Throughout the class, a number of essential questions about the future of cities will be examined such as:

- 1) What does urbanization mean for the future of humankind in terms of resources, capabilities, ideologies, and culture?
- 2) How can the design of cities affect their future?
- 3) What should be the role of the engineer?
- 4) How can the engineer of the future be prepared for that role?
- 5) What critical engineering interventions are needed to influence the future of today's cities?

Each student will select a project dealing with some aspect of the course, and present its results to the class. Cross-listed as CE 4053. *Prerequisite: instructor's permission.*

MUSIC

The Music electives are divided into two levels: introductory (2000-level) and advanced (3000-level). The fourth credit hour for all music courses takes the form of an increased communication component: At least four graded writing assignments, regular informal writing, and individual or group presentations. *Prerequisite: EN 1204.*

MU 2114 Understanding Music 4:0:0:4

A survey of Western classical music from the early Middle Ages through 19th-century Romanticism. Objectives: to introduce students to ways of listening to classical music; to promote written and oral communication skills; and to enhance cultural, social, and aesthetic understanding through intensive engagement with musical expression. *Prerequisite: EN 1204.*

MU 2124 Modern Music 4:0:0:4

A survey of modern music, from the Late Romantics to contemporary composers. Objectives: to introduce students to ways of listening to modern music; to promote written and oral communication skills; and to enhance cultural, social, and aesthetic understanding through intensive engagement with musical expression. *Prerequisite: EN 1204.*

MU 2134 Introduction to Opera 4:0:0:4

A survey of the opera form. Objectives: to introduce students to ways of listening to opera; to promote written and oral communication skills; and to enhance cultural, social and aesthetic understanding through intensive engagement with musical expression. *Prerequisite: EN 1204.*

MU 3114 Studies in National Traditions in Music 4:0:0:4

Focus on a particular national tradition in music. Objectives: to promote written and oral communication skills; and to enhance cultural, social, and aesthetic understanding through intensive engagement with traditions in national music. *Prerequisite: one 2000-level MU course.*

MU 3124 Special Topics in Music 4:0:0:4

May be repeated for credit for different topics. Objectives: to promote written and oral communication skills, and to enhance cultural, social, and aesthetic understanding through intensive engagement with a special topic in music. *Prerequisite: one 2000-level MU course.*

PHILOSOPHY

The Philosophy electives are divided into: Introductory (2000-level) and Advanced (3000-4000 levels). The B.S. in Liberal Studies allows students to focus in philosophy. The following are requirements for such a focus:

1. PL2014
2. One PL course from each of the following categories totaling 4 courses:

(a) History of Philosophy

Courses that Satisfy Category:
PL2024, PL2034, PL2044, PL2054,
PL2074, PL2094, PL2104, PL2164,
PL3044, PL3104

(b) Philosophy and Society

Courses that Satisfy Category:
PL2024, PL2034, PL2044, PL2054,
PL2064, PL2074, PL2084, PL2164,
PL3034, PL3044, PL3054

(c) Metaphysics & Epistemology

Courses that Satisfy Category:
PL2024, PL2074, PL2094, PL2104,
PL2114, PL2124, PL2164, PL3034,
PL3074, PL3094, PL3104

(d) Science & Technology

Courses that Satisfy Category:
PL2064, PL2084, PL2094, PL2104,
PL2114, PL2124, PL3014, PL3064,
PL3074, PL3094

3. One additional PL course.

Total credit hours: 24.

PL 2014 Symbolic Logic 4:0:0:4

An introduction to the methods and applications of 1st-order symbolic logic, including both sentential logic and predicate logic (up to and including relational predicate logic with identity). The course covers methods of testing arguments for deductive validity and deductive invalidity, as well as methods for identifying tautologies, contradictions and logical equivalences. *Prerequisite: none.*

PL 2024 Ancient Philosophy 4:0:0:4

An introduction to ancient philosophy in the Western tradition. Works covered include the Pre-Socratic Philosophers, Plato, Aristotle, Seneca, Marcus Aurelius, and the Roman Stoics. The goal of the course is to bring these philosophers into dialogue with each other, highlighting their similarities and differences in an attempt to show their importance in the history of philosophy and their relevance to society today. *Prerequisite: none.*

PL 2034 Philosophy of Religion 4:0:0:4

An investigation of the concepts, belief systems, and practices of religions. By analyzing central concepts of religion, such as God, faith, revelation, salvation, and the relationships between religion and science and morality and art, both the believer and non-believer may achieve a more sophisticated understanding and appreciation of religions. The class addresses such topics as religious experience, faith and reason, arguments for God's existence, the problem of evil, religious language, life and the after-life, and the conflicting claims of different religions. *Prerequisite: none.*

PL 2044 Social Philosophy 4:0:0:4

The social sciences deal specifically with human subjects and institutions rather than the natural world and phenomenon. As opposed to the natural sciences, which are explanatory, the social sciences are interpretive. This interpretive turn raises a number of questions: What exactly is an interpretation? What makes an interpretation correct or better than another interpretation? Are interpretations universal or relative to culture? The class examines the relationship between individuals and societies in order to form a better understanding of who we are, how we should live together, how we investigate societies and social phenomena, what constitutes a personal identity, what constitutes a political identity, what is race, what is gender? *Prerequisite: none.*

PL 2054 Ethical Theories 4:0:0:4

Ethics, or moral philosophy, endeavors to establish rational principles of right conduct that can serve as decision-making guides for individuals and groups. It also prescribes the characteristics and personality traits that enable individuals to live well in communities with others. This class attempts to achieve a systematic understanding of the nature of ethics and what it requires of us. Discussion includes several historical sources (Plato, Aristotle, Hobbes, Mill, Kant), ethical theories (moral relativism, egoism, utilitarianism, justice and rights, virtue ethics, and feminist transformations of moral theory), and contemporary moral problems (abortion, euthanasia, economic justice, animal rights, the death penalty and affirmative action). *Prerequisite: none.*

PL 2064 Ethics and Technology 4:0:0:4

Considers how technology shapes and patterns - and, in turn, how it is shaped and patterned by - human activities from a moral point of view. The focus of this course will be upon the ways in which our technologically textured world changes human life, individually, socially, and culturally - for better or worse. We will consider several views of technology and several ethical theories for evaluating technology. The aim of this course will be to understand the structures of change and transformation, and to develop critical forms of thought so as to be able to understand, evaluate, appreciate, and criticize technological development. *Prerequisite: none.*

PL 2072 Bioethics 4:0:0:2

Bioethics is a critical, reflective examination of the impact, effects, and transformations of biotechnology upon human activities. The use of biotechnology is becoming an increasingly important feature of society. Biotechnologies are more than mere things that do nothing in themselves; instead they affect the very ways people act, perceive, and understand. The class examines the relationship between biotechnology and ethics and politics, questioning the limits of what are its just and appropriate uses. *Prerequisite: none.*

PL 2074 Asian Philosophy 4:0:0:4

Addresses the fundamental questions of philosophy (What is real? What is good? How do we know?) by considering the answers given by philosophers from India, China and Japan. Philosophy in Asia has not been viewed as an abstract academic subject with

little or no relevance to daily life. Rather, it has been seen as one of life's most basic and most important enterprises. It is seen as essential to overcoming suffering and improving the quality of human life. There are no rigid distinctions between philosophy and religion in Asian thought. The class examines the Asian philosophical tradition in an attempt to understand both its historical importance and its relevance to society today. *Prerequisite: none.*

PL 2084 Science and Society 4:0:0:4

Investigates the relation between science and society. Offered in either of the following forms:

(1) Thinking About the Environment: A survey of contemporary environmental issues with emphasis on the development of the reasoning skills needed to make informed judgments. Topics include the history of environmentalism in the U.S., atmospheric ozone, global warming, acid rain, air pollution, global population growth, pesticides, radon, nuclear power, biodiversity and species extinction, and genetically modified crops.

(2) Science and Pseudoscience: A survey of popular "pseudoscientific" claims with emphasis on such issues in the philosophy of science as demarcation, evidential warrant, scientific progress, science and public policy, and fallacies of reasoning. Topics include UFO sightings and alien abductions, the Nemesis theory of dinosaur extinctions, astrology, creationism, psychic phenomena, theories of intelligence, alternative medicines, global warming, and cold fusion. Student input in determining topics to cover is heavily emphasized. Students are required to make a 20-minute presentation on a topic of their choice and submit a follow-up written report. *Prerequisite: none.*

PL 2094 Space and Spacetime 4:0:0:4

What is the nature of space? Is it an independently existing substance, or does it merely consist in the relations between physical objects? Can motion be described simply in terms of the relational properties of objects, or must we always define motion with respect to an absolute motionless substratum? Does the existence of left-handed gloves entail the existence of absolute space? This course considers these and other questions about the nature of space and time as they appear in the writings of the following philosophers and scientists: Plato, Aristotle, Descartes, Newton, Leibniz, Berkeley, Kant, Poincare and Einstein. *Prerequisite: none.*

PL 2104 Magic, Medicine and Science 4:0:0:4

An introduction to basic issues in metaphysics (What does reality consist of?) and epistemology (What is knowledge and how is it obtained?). The course takes the form of a philosophically oriented survey of the history of western science from the Greeks to the Newtonian synthesis. It looks at the metaphysical and epistemological origins of three grand systems of thought -- organic, magical and mechanical -- and indicates the extent to which modern science can be seen as arising out of their synthesis. The course views the key figures in this history as they saw themselves, first and foremost as natural philosophers. Topics covered include Pre-Socratic cosmology, Plato, Aristotle, Plotinus, the Hermetic Corpus, Ficino's naturalistic magic, Pico's supernatural magic, Paracelsus and the ontic theory of disease, Copernicus, Galileo, Kepler, Descartes, Hobbes, the Cambridge Platonists, and Newton. *Prerequisite: none.*

PL 2114 Philosophy of Relativity 4:0:0:4

The first part of this course develops the physics underlying special relativity and considers such conceptual questions as: Does Special Relativity prohibit faster-than-light travel? Does it allow a traveling astronaut to age less and return home in the distant future? What is the significance of Einstein's famous equation "E = mc²"? The second part of the course develops the physics underlying general relativity and considers conceptual issues surrounding such current applications as time machines, wormholes, and "warp-drive" spacetimes. *Prerequisite: none.*

PL 2124 Philosophy of Quantum Mechanics 4:0:0:4

Quantum mechanics is the best-confirmed theory of particle dynamics in existence today. Not only is it the basis for all digital technologies, it also serves as the theoretical foundation for our best-confirmed theories of matter (quantum field theories). On the other hand, since its inception, it has been beset with conceptual problems. In particular, there is no current consensus on just how to interpret it: What would the world be like, if it were true? This course first develops the theory from a historical perspective, and then canvasses a number of proposals that have been offered as to how it should be interpreted. Other topics include conceptual issues surrounding such current applications as quantum teleportation, quantum computing, and quantum cryptography. *Prerequisite: none.*

PL 2164 Modern Philosophy 4:0:0:4

This course examines the central figures and issues of the Modern era -- 17th and 18th Century European Enlightenment. The course focuses on issues that were important not only in this modern period, but remain important today, including the state of nature and society, epistemology, metaphysics, and the role of God in philosophical thinking. Topics covered include the Renaissance and science, Descartes and rationalism, Hume and empiricism, and Kant's Copernican revolution. *Prerequisite: none.*

PL 3014 Metalogic 4:0:0:4

This course demonstrates the soundness and completeness of first-order logic, the Gödel incompleteness theorem for formal arithmetic, and reviews Turing machines and the notions of computability and undecidability. *Prerequisite: PL 2104 or a strong mathematical background (third-/fourth-year mathematics major).*

PL 3034 Critical Theory 4:0:0:4

Critical theory covers the interactions between the explanatory, the normative, and the ideological dimensions of social and political thought. It bridges the usual divides between explanation and justification, philosophical and substantive concerns, and theory and practice. The course examines a range of contemporary issues in critical theory, among them the fate and meaning of the ideal of a universal humanity, the standpoint of critique, the fragmentation of culture and politics, the rise in identity politics, the challenge to nationalism, feminist philosophies, race theory and other issues of historic, and contemporary theoretical and practical importance. *Prerequisite: One 2000-level PL course.*

PL 3044 Political Philosophy 4:0:0:4

Political philosophy is concerned with evaluating the ways people should live together in communities and with finding the appropriate, legitimate, governing institutions that promote the ideals of freedom, justice, equality, and happiness. The question is why these institutions have a legitimate authority over their members, and what is their role in determining how the benefits and burdens of a society are distributed among citizens. The class starts from two essential historical sources, Locke and Kant, before considering contemporary social-political philosophy, including contractarianism, libertarianism, utilitarianism, communitarianism, and dem-

ocratic socialism. Discussion includes the connections among such issues as democracy, freedom, justice, rights, private property, economic equality, global justice, and community. *Prerequisite: One 2000-level PL course.*

PL 3054 Philosophy of Art 4:0:0:4

Philosophy of Art is concerned with the perception, interpretation, expression, and creation of works of art and beauty. It asks, What does it mean to describe anything as aesthetic? What is a work of art? What do artists do? How can we understand a work of art? Does art have more to do with emotion than reason? We will examine the nature of aesthetic experience as well as works of art, including painting, photography, film, architecture, sculpture, music, literature, theater, dance, and popular arts like television and video. *Prerequisite: One 2000-level PL course.*

PL 3064 Philosophy of Technology 4:0:0:4

Philosophy of technology is a critical, reflective examination of the impact, effects, and outcomes of technologies upon human activities. Above all, it is the study of the nature of our technologically textured ecosystem, or technosystem. The course focuses on the ways in which technologies change human life, individually, socially and culturally. It also considers the effects of human-technology relations on science, culture, democracy, and human values. Its aim is to understand the structures of change and transformation, and to help students to develop critical forms of thought so as to be able to understand, evaluate, appreciate and criticize technological development. *Prerequisite: One 2000-level PL course.*

PL 3074 Philosophy of Mathematics 4:0:0:4

Are the objects of mathematics real? What does it mean to say that a mathematical claim is true? What is the nature of mathematical knowledge? What is the relation between mathematics and the physical world? This course looks at how contemporary philosophers have attempted to answer these and related questions. *Prerequisite: One 2000-level PL course, or permission of the instructor.*

PL 3094 Philosophy of Science 4:0:0:4

An advanced introduction to topics in the philosophy of science. The course covers the

notions of natural laws, scientific explanation and confirmation, the nature of scientific theories, the realism/antirealism debate, logical positivism and its successors (logical empiricism, historicism, social constructivism, etc.) as well as surveys work in one or more of the following (time permitting): philosophy of physics, philosophy of biology, philosophy of psychology, philosophy of social sciences, philosophy of medicine. The objectives are to be introduced to the major fields of study in contemporary philosophy of science and, above all, to gain a firm understanding of the relation between philosophy and science and the important reciprocally enhancing role each has for the other. *Prerequisite: One 2000-level PL course.*

PL 3104 Metaphysics and Epistemology 4:0:0:4

Metaphysics seeks to answer general questions concerning the nature of reality: What does reality consist of? What are the presuppositions that underlie inquiry into nature? Epistemology seeks to answer general questions concerning the nature of knowledge: What is knowledge? How is it obtained? This course surveys answers to these and related questions in the works of five important philosophers in the western tradition: Aristotle, St. Aquinas, Leibniz, Kant and Whitehead. *Prerequisite: One 2000-level PL course.*

PL 3114 Special Topics 4:0:0:X

Topic to be determined by instructor. Variable credit. *Prerequisite: one 2000-level PL course and instructor's permission.*

PL 3404 Independent Study in Philosophy 4:0:0:4

Focus on a special topic in Philosophy completed under the guidance of faculty member. May be repeated for credit on a different topic. *Prerequisite: instructor's permission.*

PL 4052 Business Ethics 4:0:0:2

This course considers issues of corporate responsibility and the ethical challenges of economic systems. It presents the principles and criteria for making ethical decisions in relation to law, corporate relations, social responsibility, privacy, and other contexts. It investigates the influence of technology on the ethics of corporate decision-making. A case study approach is used. *Prerequisite: none.*

PL 4062 Computer Ethics 4:0:0:2

The study of the ethical questions that arise as a consequence of the development and use of computers and computer technologies. It involves two activities: (1) identifying and bringing into focus the issues and problems that fall within its scope, raising awareness of the ethical dimensions of a situation; and (2) providing an approach to these issues or a means of advancing understanding and suggesting a way of reaching reasonable solutions to these problems. This class considers such issues as information acquisition, access and stewardship, computer crime, abuse, hacking, intellectual property, privacy, liability, professional responsibility, and the social implications of computer technology. *Prerequisite: none.*

POLITICAL SCIENCE**PO 1404 Introduction to Urban Policy** 4:0:0:4

The purpose of this course is to introduce students to the process and some of the major substantive issues in urban policy and politics both in the United States in the world. These include some of the basic issues of any political system: how cities function as part of a global urban network; the structure of decision making; the allocation of resources; and delivery of services. *Prerequisite: HI 2104.*

PO 2614 Introduction to Political Science 4:0:0:4

The course introduces the basic topics of political science. The main focus of the course is to give an overview of human polity and its impact and affect as a civil society. It covers different political systems, concepts, political ideology, political process, origins and functions of different types of rights, justice, and equal treatment, duties and responsibilities of states and citizens, libertarianism, policymaking as a process, and international systems. *Prerequisite: none.*

PO 3614 Comparative Politics 4:0:0:4

The course focuses on nations and national states and their political relations to each other. The main feature includes the interrelations and confrontations among the bloc nations, such as first, second, third and fourth worlds. In doing so, major emphasis will be given to advanced as well as underdeveloped nations such as France and Great Britain, the mid-developed nations such as Germany and Japan, late-developed nations, such as Soviet Union and Russia, experimen-

tal developed nations such as India and South Africa, and underdeveloped nations such as Afghanistan and Bangladesh. *Prerequisite: PO 2614.*

PO 3704 Special Topics in Politics 4:0:0:4

Focus on a special topic in anthropology completed under the guidance of faculty member. May be repeated for credit on a different topic. *Prerequisite: instructor's permission.*

PO 3804 Independent Study in Politics 4:0:0:4

Independent or small group work, under supervision of instructor, by special arrangement. *Prerequisites: Liberal Studies and Digital Media majors only; instructor's permission.*

PSYCHOLOGY

The fourth credit hour for psychology courses is used for experimental investigations, laboratory work, fieldwork or trips to museums and/or zoos to provide an opportunity to make descriptive observations of subjects. The psychology electives are divided into introductory (2000-level) and advanced (3000-4000 levels). PS 2104 is a prerequisite for all advanced PS electives for a two or more course sequence.

Prerequisite Psychology Course

PS 2104 Introduction to Psychology

Advanced Electives

PS 3114	Physiological Psychology
PS 3124	Comparative Psychology
PS 3214	Learning and Cognition
PS 3314	Social Psychology
PS 3324	Environmental Psychology
PS 3414	Developmental Psychology
PS 3424	Abnormal Psychology
PS 3434	Personality Psychology
PS 344X	Special Topics
PS 3704	Humans and Their Environment
PS 3714	Its About Time
MA2212	Data Analysis I*
MA2222	Data Analysis II*
LA 2014	Technology and the Human Condition

*Two math courses in statistics (MA 2212 and MA 2222) are required.

PS 2104 Introduction to Psychology 4:0:0:4

The scientific study of behavior and the mind. Topics include experimental design and basic statistics, learning and memory and biopsychology. Also included: the nature of sensation and perception, cognitive, abnormal, developmental, social and environmental psychology. Course consists of lectures, class discussion, films and videos,

and a number of projects, both in class and on computers. *Prerequisite: HI 2104.*

PS 3114 Physiological Psychology 4:0:0:4

The study of the relationship between the body, especially the brain, and behavior and the mind. Topics include the physiological and biochemical bases for learning, memory, sensation and perception, motor control, hunger, sex, sleep, and mental disorders. Lateralization in the brain and its implications, as well as techniques and technologies in neuroscience. Course consists of lectures, class discussion, films and videos and a number of projects, both in class and on computers. *Prerequisite: PS 2104.*

PS 3124 Comparative Psychology 4:0:0:4

Examines behavior and neuroanatomical mechanisms across species providing an investigation of comparative developmental stages, causal mechanisms, evolutionary history and function of animals' behavior. Topics include learning and cognition, neuroanatomical and neurochemical controls of behavior, thought and language, sensory and perceptual capacities and the biological bases of social behavior. In addition to course text readings and lectures, students participate in labs (interactive computer programs), in-class demonstrations, fieldtrips and videos that provide hands on experience and supplementary exposure to examples of concepts and ideas within the area of comparative psychology. *Prerequisite: PS 2104 (PS 3214 is optional).*

PS 3214 Learning and Cognition 4:0:0:4

This course concerns the experimental analysis of cognition and behavior in animals. Most of the discussions focus on laboratory findings with animals, but as viewed from an evolutionary framework concerned with the natural histories of the species. In addition to discussions of established results about cognition and intelligence in animals, an important emphasis is also placed on critiquing the methods of these studies, specifically the logic, evidence and technology used to test and interpret conclusions. *Prerequisite: PS 2104.*

PS 3314 Social Psychology 3:1:0:4

Explores issues of human behavior as it is affected by social interaction and situations. Addresses the nature of social psychological inquiry, with particular emphasis on research methods. Course topics include aggression,

altruism, attitudes, attraction, conformity, group dynamics, perception of self and others, prejudice, social roles, the biological basis of social behavior and interpersonal bargaining. Cultural differences in interpreting social behavior and context are also considered.

Students are asked to collect data on social psychological phenomenon for each major topic covered, as the major part of the laboratory requirement. A final term paper is required that contains a review and critical analysis of the research on a topic in social psychology. *Prerequisite: PS 2104.*

PS 3324 Environmental Psychology
3:1:0:4

Course deals with the interactions people have with built and natural environments: how settings affect behavior; how people change environments to fit their needs; how people can become an active part of the environmental design process. It is concerned with the way people use space and the way environmental design meets (or fails to meet) human needs. These concerns are valid for very small scale design problems (as in human factors engineering); mid-size spaces (architecture and interior design); and for large scale spaces (communities, urban areas). The goals of the course are to introduce the student to this subject matter, provide familiarity with research methods associated to studying people and behavior in real world settings and issues in environment and human relations. *Prerequisite: PS 2104.*

PS 3344 Urban Impact Assessment
4:0:0:4

This course is designed to introduce you to theory, methods and practice involved in approaches predicting and evaluating the environmental consequences of a proposed action or undertaking in an urban context. Urban Impact Assessment or Environmental Impact Assessment can be defined as: "The process of identifying, predicting, evaluating and mitigating the biophysical, social, and other relevant effects of development proposals prior to major decisions being taken and commitments made." (IAIA 1999 - <http://www.iaia.org/modx/>). Impact assessment is critical in decision making and identifying possible mitigations for negative consequences of projects. *Prerequisite: PS 2104.*

PS 3414 Developmental Psychology
4:0:0:4

The development of humans across the life-span. The main focus is on the effects of aging on the social and cognitive development of the person. Issues in parenting, child's care, education, elder care, death and dying are also discussed. Lab and field examples are used to illustrate main themes in this course. *Prerequisite: PS 2104.*

PS 3424 Abnormal Psychology 4:0:0:4

Covers a variety of different psychological disorders. Common examples are depression, anxiety, schizophrenia, and personality disorders. Major theories such as psychoanalytical, behavioral, cognitive, and biological are discussed in terms of why people develop such disorders and how to treat them. *Prerequisite: PS 2104.*

PS 3434 Personality Development
4:0:0:4

The study of psychological theories related to personality theory. Its goal is to ask the question why we think and act the way we do. Exploration of topic through many of the major theories of psychodynamic, behavioral, cognitive, humanistic, traits and biological perspectives. *Prerequisite: PS 2104.*

PS 344X Special Topics

Focus on a special topic in psychology completed under the guidance of faculty member. May be repeated for credit on a different topic. *Agreement of instructor required before registration.*

PS 3704 Humans and their Environment
4:0:0:4

This course addresses ecological understanding of interactions of human with nonhuman environments through relevant topics: ecosystems, human interaction with ecosystems, human societies as self-regulating systems, attitudes toward nature, case studies in ecological history, present environmental crises and attempts at resolutions. *Prerequisite: PS 2104.*

PS 3714 It's About Time 4:0:0:4

This course is concerned with all aspects of time, including its measurement, time scales in nature, psychological issues, and the nature of time itself. Topics include origin and evolution of calendars and clocks, psychological and physiological basis of time and timing, time in the arts and, finally, the nature of time itself in philosophy and modern physics, from Einstein's relativity to modern cosmology. *Prerequisite: PS 2104.*

PS 3724 Psychology of Sustainability
4:0:0:4

The purpose of this course is to review the psychological bases of environmental problems, investigate theories of behavior change as they relate to environmental issues, and introduce practical strategies that foster behavior change. It will focus on identifying the general conditions that encourage or constrain environmental behavior, describing psychological approaches to the study of environmental problems, analyzing a particular target behavior, developing a plan to investigate barriers to this behavior and implement a workaround to overcome these barriers, and integrating some of the necessary foundations of environmental behavior change into their own lives and bring them to others through their communication and teaching. *Prerequisite: PS 2104.*

PS 4114 Senior Research Thesis

One-or two-semester research project to be completed under the guidance of a faculty member. *Prerequisite: Agreement of instructor required before registration.*

PS 4124 Guided Readings

Selected problems in psychology. Individual or group studies/projects under faculty supervision involving guided reading and/or research, topics to be arranged. For mature students wishing to undertake specialized in dependent study under tutorial guidance. *Prerequisite: junior standing or departmental permission. Agreement of instructor required before registration.*

SOCIOLOGY

SO 2014 Technology and Social Change 4:0:0:4

Given that (at least on a mythic level) technology is the most important force shaping society and culture today, we will concentrate on the dialectical, interactive shaping of societies and technologies. Many approaches, from technological determinism to neo-marxism and postmodernism, are used in examining various social issues having to do with social change. The objective of this course is to provide a survey of the development of sociological theories of societal development and change. In addition, this course surveys the current information and research on the specific impact of modern technology on contemporary society. Issues of social identity, communication, work, inequality, deviance, power, and social control are examined in the context of society, technology, and social change. *Prerequisite: HI 2104.*

SO 2024 Sociology of Organizations 4:0:0:4

Modern societies are organizational societies. Indeed, nearly all modern work and much play occurs in organizations. As a result, organizations and organizational management have important personal and social effects: organizational experiences can bring pain or pleasure to their members, and managerial decisions can send an organizations profits soaring or plummeting. The course examines the nature and place of organizations and managerial systems in modern societies. The central questions of the course include:

Do organizations pursue goals or do managers use organizations to pursue narrow interests? How do managers control workers and how much control is necessary and optimal? To what extent are managers rational decision makers? Is there a “best way” to structure and manage an organization? *Prerequisite: HI 2104.*

SO 3014 Environmental Sociology 4:0:0:4

Environmental sociology is the study of the reciprocal interactions between the physical environment, social organization, and social behavior. Within this approach, environment encompasses all physical and material bases of life in a scale ranging from the most micro level to the biosphere. Two major themes form the focus of this course:

- (1) Sociology is often described as the study of human communities. Ecology is often described as the study of natural communities. Environmental Sociology is the study of both together. People, other animals, land, water, air are all closely interconnected. Together they form a solidarity that has been called ecology. As in any community, there are also conflicts in the midst of interconnections. Environmental sociology studies the largest of communities with an eye to understanding the origins of, and proposing solutions to, these social and bio-physical conflicts.
- (2) Environmental problems are problems that threaten our existing patterns of social organization and of society problems that challenge people to change those patterns of social organization. One of sociology's most basic contributions to the study of environmental problems is to point out the pivotal role of social inequality. Social inequality cannot be understood apart from the communities in which it takes place. Inequality shapes social experience and social experiences shape all experiences. *Prerequisite: instructor's permission*

ORGANIZATIONAL BEHAVIOR

This program is offered at Brooklyn's MetroTech campus only and is limited to 15 incoming students per semester. Students who meet all of the course and GPA requirements are formally admitted to the MS in Organizational Behavior in the Department of Technology Management at the end of their junior year.

Requirements for the MS in Organizational Behavior

Core Courses:	9 credits
Area of Concentration:	18 credits
Free Electives:	6 credits
Research Project:	3 credits
Total:	36 credits

SCIENCE AND TECHNOLOGY

STS 3014 Seminar in Science and Technology Studies 4:0:0:4

Science and Technology Studies is an interdisciplinary field in which methods from a wide range of disciplines in the humanities and social sciences are used to analyze the relations between science, technology, and society.

This course considers the current state of the field, helping students to understand the range and methods of STS as well as determine their own place within the field. It is designed specifically to bring students with different academic backgrounds into contact with each other in a classroom setting. *Prerequisites: One 2000-level STS elective, or any one of LA 1014, LA 1024, or LA 2014.*

STS 325X Special Topic in Science and Technology Studies 4:0:0:X

Study of a special topic in Science and Technology Studies. May be repeated for credit for different topics. Course serves to research new topics of STS; to develop critical reading, writing, and thinking skills; and to enhance the understanding of the field through study of a special topic in STS. The course may be designed to qualify for 1 to 4 credits. It may be repeated for credit with different topics. *Prerequisite: STS 3014.*

STS 440X Independent Study in Science and Technology Studies 4:0:0:X

Focus on a special topic in Science and Technology Studies; arranged for advanced students capable of undertaking specialized independent study with tutorial guidance. May be repeated for credit on a different topic. This course may be designed to qualify for 1 to 4 credits. *Prerequisite: Junior/Senior standing or permission of the instructor.*



MS IN MANAGEMENT PROGRAM

Interim Academic Director: Mel Horwitch
Administrative Director: Bohdan Hoshovsky

The Department of Technology Management at Polytechnic University is the New York City/Tri-state region's academic hub for technology and innovation management. Because most of the department's students are working professionals, class schedules are geared to their needs and are typically offered after regular office hours. Classes are structured to enable participants to receive individual attention and to work closely with faculty. The course of study is designed for those who work in technology-intensive industries and in companies that depend on technology for products and services.

The Master of Science in Management degree (MSM) is recognized, along with the Master of Business Administration (MBA), by the Graduate Management Admission Council as a graduate professional management degree. Polytechnic's modern MSM curriculum is designed to prepare working professionals for increasing responsibility in management positions in technology-intensive settings. This updated program is aimed at developing competencies in modern decisionmaking and in the selection, allocation and direction of human, financial, physical, technological, and organizational resources in a period of rapid technology-led change.

These management skills can be applied in a broad range of professional settings in both the private and public sectors, in production and service-oriented activities and in traditional as well as high-technology environments.

Polytechnic's graduate program in management takes a pragmatic, modern results-oriented approach that emphasizes integrating technology and people for the creation of value in the marketplace and in modern organizations. Even subjects such as accounting, finance, and marketing are taught not as special areas of expertise, but as basic tools for managerial decisionmaking in a technology-intensive and knowledge-based environment. Courses are increasingly supported by a modern technological, web-based infrastructure. The program continually introduces state-of-the-art material in paper and digital format.

After completing the core courses, degree candidates build further managerial skills in their choice of seven Concentrations, which are all designed for success in the global economy.

- Entrepreneurship

- Electronic Business
- Project Management
- Technology Management
- Information and Telecommunications Management
- Human Resource Management
- Construction Management

The program concludes with a Capstone project course, MG 970 Project in Strategy and Innovation, which takes a high-level perspective in learning how to set goals, establish policies and implement strategies for ongoing competitive success, especially in environments where technology and innovation are critical.

Students may elect, with their adviser's approval, to conclude their studies with a Thesis instead of this project course.

Some fundamental knowledge of probability and statistics is required for this program. Students without such a background are required to take a managerial probability and statistics course such as MA 2054, or its equivalent. Students with this knowledge may apply for a waiver of this requirement.

Visit the program's website at www.msm.poly.edu for the most current information.

GOALS AND OBJECTIVES

The goal of the Master of Science in Management is to provide the highest quality and most effectively designed learning experience that centers broadly on the modern managerial arenas encompassing innovation, technology and information management, e-Business, and entrepreneurship in the New York City Tri-State Region and beyond.

ADMISSION AND DEGREE REQUIREMENTS

Criteria for admission include a bachelor's degree with at least a B average from an accredited college or university and demonstrated evidence of motivation, maturity, the ability to benefit from and contribute to professional graduate studies and a strong desire to make a difference that in some fashion is associated with innovation, technology, and modern change. An applicant who does not meet all the criteria may be admitted as a non-degree student with the opportunity subsequently to become a degree candidate. Satisfactory scores on the Graduate Management Admission Test (GMAT) or an acceptable equivalent test such as the Graduate Record Examination (GRE) may be requested as support for admission.

The MSM requires completion of 12 courses, or 36 credits with a B average or better. A maximum of 9 credits of transfer credits may be granted for graduate courses taken elsewhere, as evaluated by an adviser.

UNDERGRADUATES IN GRADUATE MSM CLASSES

With three exceptions, undergraduates may not enroll in graduate MSM classes. The three exceptions are: (1) undergraduate students enrolled in a joint BS-MS program associated with the Management Department may, with the approval of the Management Department adviser, register for Graduate Management courses; (2) undergraduate seniors with a 3.0 GPA or better may, with the signature of the MSM program director, register for MSM core courses: MG 6013, MG 6073, MG 6083, MG 6093, MG 6503, and MG 8673; and (3) undergraduate seniors majoring in BTM with a 3.0 GPA or better may, with the signature of the MSM program director, register for any MSM course.

ADVANCED CERTIFICATE PROGRAMS

The Department of Technology Management offers several advanced certificate programs designed for professionals with work experience. Applicants for certificate programs must hold bachelor's degrees. A certificate program requires five courses, which are selected according to individual needs. On completion of a sequence with an average grade of B or better, students are issued certificates. Those who choose to work toward the master's degree are able, upon admission, to apply all courses taken toward a certificate toward fulfillment of a degree program. Additional information may be obtained from the department.

Management Certificates are offered in the following fields:

- Electronic Business
- Entrepreneurship
- Construction Management
- Human Resource Management
- Information Management
- Project Management
- Technology Management
- Telecommunications Management

THE MS MANAGEMENT CURRICULUM

Core Courses. The core courses provide a foundation upon which students can pursue cutting-edge specializations within the degree program. These courses provide intensive exposure to the disciplines required of a professional manager. Students who have taken these courses elsewhere or previously at Polytechnic, or who have had equivalent experience, may apply to substitute elective courses for such core courses; however, all students are required to complete 36 credits (12 courses).

MG 6013	Organizational Behavior
MG 6073	Marketing
MG 6083	Economics
MG 6093	Accounting and Finance
MG 6503	Management of Information Technology and Information Systems
MG 8673	Technology Strategy

Core courses should be taken as early in the program as possible.

Areas of Concentration. Students must choose an area of concentration. This may be one of those listed below or, with the adviser's approval, a set of courses designed to meet students' special needs. A minimum of four courses must be selected in any one area of concentration. Courses in all the available concentrations are shown below.

Project in Strategy and Innovation Management (MG 9703). This required integrating course is recommended for students' final semester. In special cases, MG 9973 Thesis for Degree of Master of Science may be substituted for students who wish to produce a major dissertation in a specialty.

CONCENTRATION COURSE REQUIREMENTS

Each concentration sequence consists of a minimum of five courses. Substitutions may be made with adviser's approval in any concentration area.

ELECTRONIC BUSINESS

The Electronic Business Concentration focuses on the arena of electronic business and the Internet. The key aspects for managing a firm that operates increasingly in digital space and the process of digital-intensive market creation are studied. The relevant methods and concepts for effective electronic-business decision making are explored and applied.

Required:

MG 7173	Enterprise Data Systems
MG 7503	Management of Electronic Business

Select three courses of interest with an "MG" or "FE" prefix

ENTREPRENEURSHIP

The Entrepreneurship Concentration is offered for the manager, professional or specialist who is interested in entrepreneurial management, either as an entrepreneur starting a new business, as an "intrapreneur" in a large, established firm or as a professional (e.g., venture capitalist) interested in playing a role in new enterprises. This concentration develops a valuable entrepreneurial state of mind no matter what the business setting. Modern entrepreneurial concepts and cases are learned and applied.

Required:

MG 7703	Entrepreneurship
MG 8653	Managing Technological Change & Innovation

Select Two:

MG 7733	Managing Intellectual Property and Intellectual capital
MG 8713	Entrepreneurial Finance
MG 8723	Corporate Entrepreneurship
MG 8743	Entrepreneurial Marketing and Sales

Select one course of interest with an "MG" or "FE" prefix

CONSTRUCTION MANAGEMENT

The Concentration in Construction Management provides engineers and other professionals in the construction industry with the knowledge necessary to understand relevant managerial and physical infrastructural technological developments and to be able to integrate construction and management to be effective and innovative.

Required:

MG 6303	Operations Management
MG 8203	Project Management

Select Three:

CE/MG 8253	Construction Administration
CE/MG 8263	Construction Cost Estimating
CE/MG 8273	Contracts and Specifications
CE 8243	Construction Modeling Techniques
CE 8283	Risk Analysis
CE 8303	Information Systems in Project Management

Selected courses in the Exec21 Program offered by the Department of Civil Engineering can be counted as concentration electives in construction management with the approval of the Department of Technology Management and the Exec21 Program.

HUMAN RESOURCE MANAGEMENT

The Concentration in Human Resource Management prepares professionals for today's technology-intensive environment. It provides the knowledge and techniques to deal with human resource issues and to achieve high quality innovation and productivity in often turbulent organizational settings. The changing nature of work and shifting professional expectations are explored.

Required:

MG 6123	Human Resource Management
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Choose One:

MG 6173	Performance Measurement and Reward Systems
MG 6223	Staffing Organizations

Select Three:

Select three courses of interest with an "MG" or "FE" prefix

INFORMATION MANAGEMENT AND TELECOMMUNICATIONS MANAGEMENT

The Concentration in Information Management and Telecommunications Management provides Information Technology (IT), telecom and networking professionals, programmers, systems experts, and others with IT-related career goals and experience with the knowledge to understand how IT and networking enhances the effectiveness of modern firms and with the ability to manage creative and professional people.

Required:

MG 6553	Telecommunications Management I
MG 7173	Enterprise Data Systems

Select Three:

(9 credits) of interest with an "MG" or "FE" prefix

Project Management

The Concentration in Project Management is designed for managers involved in managing, financing or facilitating in another major way projects in modern enterprises. This Concentration is designed to provide managers with the latest managerial knowledge and methods available for effectively managing a diverse array of projects.

Required:

MG 6303 Operations Management
MG 8203 Project Management

Select Three:

Select three full courses (9 credits) of interest with an “MG” or “FE” prefix

TECHNOLOGY MANAGEMENT

The Technology Management Concentration is designed for managers, engineers, and other professionals in technology-intensive environments or involved with technology-intensive products, processes or services. It provides the modern methods and concepts necessary for making strategic technology investment decisions; for understanding technology and innovation strategy, product life cycles, and competitive factors; and for developing the special skills necessary for managing creative people and professionals.

Required:

MG 8203 Project Management
MG 8653 Managing Technological Change and Innovation

Select Three:

Select three full courses (9 credits) of interest with an “MG” or “FE” prefix

MSM GRADUATE COURSES

MG 5050 Probability and Managerial Statistics 2½:0:0:(3.00 NO CREDIT)

Starts with the basic concepts of random phenomena and goes on to advanced applications of statistics relevant to managers. Topics include: probability theory, discrete and continuous probability variables, sampling, measures of central value and dispersion, hypothesis testing, statistical inference, quality control, analysis of variance, regression, correlation, and nonparametrics. Emphasis is placed on application of concepts. No credit will be allowed towards any graduate degree program administered by the Department of Technology Management.

MG 6013* Organizational Behavior

2½:0:0:3

Introduction to theory, research, and practice to better understand human behavior in organizations. Topics include motivation and job satisfaction; decision-making; group dynamics; work teams; leadership; communication; power, politics and conflict; organization culture, structure and design; impact of technology; management of work stress; organizational change and development; and career management. Analysis of organizational behavior problems by self as-

sessments, case studies and simulations. *Online version available.

MG 6073 Marketing 2½:0:0:3

Marketing concepts, processes and institutions: positioning, segmentation and product life cycles. Integration of marketing with new product planning, design and development. Strategies for technology-based products, services and processes. Market research, consumer behavior, advertising, promotion and sales. The special character of governmental and international markets.

MG 6083 Economics 2½:0:0:3

The fundamentals of microeconomics needed by managers. Demand theory (theory of the consumer) including models of demand, demand elasticities, and demand forecasting. Supply theory (theory of the firm) including diminishing returns, profit maximizing production levels, labor/capital tradeoffs, and long-run vs. short-run issues. Market structures and how they affect optimal production and profit levels. Positive and negative externalities and government intervention including regulation, tariffs, and subsidies. Selected applied topics. All topics are presented with examples and with emphasis on managerial application.

MG 6093 Accounting and Finance 2½:0:0:3

Elements of accounting and finance of importance to managers. Analysis of principles and practices of the finance function. Financing methods for internal and external ventures and innovations; capital budgeting; R&D portfolio analysis. Contrast of strategic perspectives emphasizing innovation and development with those emphasizing short-term return and investment.

MG 6103 Management Science 2½:0:0:3

Introduces major concepts and methods associated with Management Science, which deals with the application of quantitative modeling and analysis to management problems. Students learn to employ important analytical tools, to determine assumptions used, and to recognize limitations of such methods. The methods discussed include linear and nonlinear programming, queuing, decision analysis, simulations and game theory. The course also introduces modeling with spreadsheets.

MG 6113 Career Management 2½:0:0:3

Provides an integration of theory, research, and practice pertaining to careers in organizations, particularly as they change through the life span. Examination of careers from the perspectives of both the individual and the organization, including topics such as career stage models, organizational entry, early career development, mid-career transition, career change, and career issues for women. Facilitates the development of greater understanding and insight into one's own career growth and development through the use of career assessment techniques and standardized instruments for self evaluation.

MG 6123* Human Resource Management 2½:0:0:3

Introduction to the broad range of human resource functions and their organizational role. Addresses issues in managing people that impact not only HR professionals but also line managers. The course is divided into four modules: an overview of HRM from a strategic perspective; the management of human resources, including recruitment and selection, performance management, compensation and benefits, training and career support; human resource challenges, including diversity, procedural justice and ethics, collective bargaining, and managing change and innovation; and professional roles in HRM. *Online version available.

MG 6133* Labor Relations 2½:0:0:3

Introduction to labor relations from various perspectives in both union and non-union organizations. Topics include the current state of the labor movement in the US; labor movement history; labor statistics; US labor laws and practices; union organizing; negotiating; economics and labor unions; contract administration; achieving cooperation; grievances; labor and employment arbitration; employee discipline; public sector unions; global aspects; and the future for unions. *Online version available.

MG 6143* Conflict Management 2½:0:0:3

Investigation of the nature and meaning of conflict in professional and technical organizations as well as in society. Analysis of the design of conflict avoidance and mitigation programs. Alternative dispute resolution modalities are presented and demonstrated. Addresses strategies to build successful relationships on an ongoing basis. Skill building around collaborative conflict resolution. *Online version available.

MG 6153* Leadership and Team Development

Focuses on the essential role of multifaceted leadership in diverse organizational settings. Explores the nature of leadership and its relationship to team development and organizational effectiveness. Includes a broad survey of theory and research on leadership and teams in organizations. Includes a hands-on approach involving experiential learning and case analyses, which will be conducted in teams, requiring students to be active participants. **Online version available.*

MG 6163* Job and Workplace Design
3:0:0:3

Examination of theory, research and applications of job and workplace design. JOB design is presented from an interdisciplinary perspective focusing on how job design influences attitudes and work behavior within organizations. Exposure to diagnostic tools for measuring and evaluating jobs and the psycho-social aspects of the workplace environment, as well as the principles of work redesign. Topics include the influences on work design by innovations in information technology, modern manufacturing, virtual work arrangements and open office systems; design and support of effective work teams; reengineering and total quality management; and privacy and communication in the workplace. **Online version available.*

MG 6173 Performance Measurement and Reward Systems
3:0:0:3

Introduction to creating performance appraisal systems that includes theoretical and applied issues. Topics include coaching and feedback; team settings; multi-source feedback and self-ratings; executive performance; and improving evaluations. The role of compensation, benefits and other rewards in attracting, retaining and motivating employees is addressed. **Online version available.*

MG 6223* Staffing Organizations 3:0:0:3

Examination of the design and management of successful staffing practices used to build, deploy and retain a quality workforce in order to achieve organizational effectiveness and individual job satisfaction. Topics include staffing strategy; human resource planning and workforce diversity; job analysis; recruitment; hiring methods; the reliability and validity of employee assessment methods; and retention management. Psychological theories of personnel assessment are reviewed. Legal issues pertaining to staffing practices are integrated. **Online version available.*

MG 6233* Training in Organizations
2½:0:0:3

An overview of the many forms of training and related learning activities found in the modern workplace, including management development, technical training, career planning, and mentoring. The course will focus on training as both an asset to the organization and a necessity for delivering goods or services that will be valued by the customer. Topics addressed include needs analysis, preparation of employees for jobs, training program design, traditional training methods, computer-based methods, development, implementation and evaluation of training, targeting various groups with special training needs, and management development. **Online version available.*

MG 6243* Organization Development
2½:0:0:3

Survey of theory, research, and applications related to the process of managing planned change in organizations. Organization development (OD) encompasses a variety of interventions and techniques, including strategic management sessions, team building, organizational climate studies, career development, and job enrichment. Addresses the practical application of group, intergroup, and individual changes; planned structural revisions in formal organizations; and the dynamics of organizational change processes. Experiential techniques emphasized. **Online version available.*

MG 6253 Seminar in Organization and Career Change
2½:0:0:3

Examination of organizational restructuring, including downsizing, reengineering, delaying, mergers and acquisitions, focusing on the impact of such change on professional and managerial careers. Emphasis on current organizational and individual management practices in coping with rapid structural and cultural change in the work environment. Experts from the private and public sectors as well as consulting firms address these management practices.

MG 6263* Human Resource Information Systems
2½:0:0:3

Introduction to the design, selection, implementation, enhancement and operation of human resource information systems (HRIS), a computer-based tool that allows the efficient entry and updating of employee-related information. Focus is on the design and use of HRIS to facilitate the ob-

jectives of HR functions as well as the organization. Provides a “hands-on” experience with the design of prototype simulations and database programming systems used to solve common HR problems and efficiently manage employee information. **Online version available.*

MG 6283* Web-Based Human Resource Management
3:0:0:3

Survey of the effective use and application of Internet and Intranet technologies for HR functions. Topics include employee self-service and online recruiting as well as software that handle peer reviews, applicant tracking, performance management, succession planning and benefits administration. Issues addressed include Best practices in utilizing web technology for HRM; creating websites to achieve organizational goals; determining HR information to include on an organization website; impact of web technology on organization design; evaluating privacy and security issues; and developing a vision and a plan for utilizing web technology in HRM. **Online version available.*

MG 6303 Operations Management
2½:0:0:3

Analytical techniques for designing and operating production and service systems, including facility layouts and locations, capacity planning, job sequencing, inventory control, and quality control. Introductory linear programming and other formal methods. Cases and PC usage.

MG 6313* Organization Theory and Design
3:0:0:3

Introduction to theories of organizations including structure, design and culture. Provides an understanding of how organizations work and their interrelationship with the external environment. Examines the process by which managers select and manage aspects of structure and culture to achieve organizational goals. Topics include characteristics of bureaucracy, adhocracy, sub-optimization, human dynamics and informal systems; influence and control systems; management of technology; and planned change. Examination of organizations through research and case studies. **Online version available.*

MG 6333* Research Methods 3:0:0:3

Introduction to theories and techniques related to research methods applied to organizations. Provides an understanding of why

and how organizational research is carried out. Focus on analyzing organizational problems and the use of research as a problem-solving tool. Topics include problem definition, theoretical framework, hypotheses development, research design, experimental designs, measurement, data collection methods, sampling strategies and preparing research proposals. Development of a research proposal applied to a problem of interest. **Online version available.*

MG 6353 Quality 2½:0:0:3

Focusing on quality and overall customer satisfaction as a primary objective of manufacturing and service operations is a proven competitive weapon. This course examines the concepts and methods for building quality into the management process. Total quality management (TQM) and similar approaches are covered through readings, cases and examples.

MG 6463 Supply Chain Management 2½:0:0:3

Introduction to supply chain management. Both qualitative and quantitative aspects of supply chain management will be covered by this course. The underlying objective is to: (1) introduce students to the standard business concepts (and associated terminology) involved in the retailing and supply chain management arena; (2) develop student skills in understanding and analyzing retailing, marketing, logistics, operations, channel management and allied issues, and the interactions between them; and (3) examine and discuss the important role played by technology and integration at various points in the supply chain.

MG 6503 Management of Information Technology and Information Systems 2½:0:0:3

This course is designed for managers who need to understand the role and potential contribution of information technologies in organizations. The focus of the course is on different information technologies and their applications in managing business critical data, information and knowledge. The course concentrates on the current state of IT in organizations, challenges and strategic use of IT, IT infrastructure and architecture, building, implementing, and managing IT applications, and emerging issues such as intelligent systems, business process reengineering, knowledge management, and group support systems.

MG 6523 Telecommunications Policy 2½:0:0:3

The relationships between the development of the telecommunications industry, national growth and the development of telecommunications policy issues and policy making organizations. Analysis of the major issues that have impact on the telecommunications industry and commerce and society generally. The options and opportunities afforded by recent regulatory and policy issues are also examined.

MG 6543 Economics for Information Sectors 2½:0:0:3

This course in applied competitive strategy draws upon recent experiences associated with the impact of information technology upon diverse industries. Students completing this course will have mastered a basic understanding of the economic and competitive implications of information technology. This competence in analysis is arrived at through understanding how availability of information (through technology or otherwise) affects the basic strategic options available and how firms and industries are likely to be affected. In addition, students will be introduced to the often poorly structured process of evaluating the economics of potential systems innovations. They will then be able to participate in strategic systems planning from a managerial point of view.

MG 6553 Telecommunications Management I 2½:0:0:3

Introduction of the fundamentals of modern telecommunications and networking for current and future managers. Covers basic concepts such as components of data-communication, data transmission, Open System Interconnection (OSI), TCP/IP and other models, data link and network layers, and local area networks (LANs). The emphasis is to expand technical knowledge and discuss related managerial issues.

MG 6563 Telecommunications Management II 2½:0:0:3

Explores advanced issues and trends in modern enterprise networking. Examines the implications of such developments in the business environment and the infrastructural needs of organizations and clusters of organizations. Reviews ramifications of the TCP/IP revolution leading to commercialization of the Internet/World Wide Web. Discusses the network infrastructure re-

quired to implement Intranets/Extranets, electronic commerce and interorganizational business communication and collaboration generally. Evaluates emerging technologies (such as electronic payment systems, corporate digital libraries, push technology, multicasting, firewalls, and digital signatures). Deals with the implications of Internetworking, such as digital cities, smart buildings, distance learning, telecommuting, and teleconferencing. *Prerequisite: MG6553*

MG 6603 Management of New and Emerging Technologies 2½:0:0:3

A survey and exploration of the business implications of selected new and emerging technologies that have the potential to change business practices and create new industries. Technologies discussed include new Internet architectures, Wikis, Open Source, security issues, new web services, social networking, and Web 2.0. This course is for the manager who is interested in staying current with and learning about new technologies for use in business. No specific engineering background is required. A variety of reference texts, journals, cases, and websites will be used throughout the course.

MG 6643 Management and the Legal System 2½:0:0:3

Impact of the legal system on corporate strategy, managerial decisions, and planning processes. Issues covered include protection of intellectual and technological properties; consumer, contract, and commercial laws; employer liability; negligence and risk-management from legal and corporate viewpoints; and constitutional and regulatory aspects of conducting business.

MG 7173 Enterprise Data Systems 2½:0:0:3

Addresses modern issues of large-scale information and knowledge management through design, development, and implementation of different kinds of database technologies. Introduces and elaborates on data modeling through relational models, SQL applications, database architecture, different types of database management systems, data integrity and administration, etc. Also introduces emerging database technologies, such as distributed Internet-based databases, distributed client/server databases, multidimensional databases, groupware, data warehousing, and data mining for decision support, etc.

MG 7503 Electronic Business Management 2½:0:0:3

Investigates the management implications of electronic business. Topics include: (1) accelerated new product development; (2) impact of technology on the value chain: the changing role of intermediaries; (3) electronic commerce: business models and strategies for survival general lifestyle; (4) implications of “being wired”; and (5) business applications involving collaborative communication, computation, and teamwork. Course material is designed to be dynamic and Internet-based, reflecting the nature of change in electronic commerce and the IT industry, and the potential implications of electronic business for managers. Students work on a project that requires: following developments in the business and IT press, interviewing managers and product developers and simultaneously testing and discussing current developments in the e-commerce marketplace. Classes are conducted using the case method, and a high level of class participation is expected.

MG 7693 Managerial Analytics 2½:0:0:3

This course focuses on the use of “analytics”—a fast-growing element in modern management—for achieving both more effective operations and heightened competitive advantage. This course provides a managerial overview of current deployment of a diverse range of analytics—internally-oriented and externally-oriented. The course also identifies the impact of analytics on a firm’s performance; and explores the strengths and weaknesses of analytics. The course also presents best practices of analytics from a range of industries, including retailing, hospitality, financial services, consulting, healthcare, and logistics. *Prel Co-Requisites: MG 6083 Economics AND MG 6093 Accounting and Finance.*

MG 7703 Entrepreneurship 2½:0:0:3

Focuses on entrepreneurship and venture creation as key engines for wealth creation and successful business strategy in the modern innovation-intensive, high-tech economy. Deals with such key issues as: (1) assessing attractiveness of opportunities; (2) launching a new venture; (3) nurturing, growing and entrepreneurial venture; (4) obtaining the necessary financial, human and technology resources; (5) managing the transition from a small entrepreneurial firm to a large, sustainable professionally managed but still entrepreneurial corporation; and (6) being an entrepreneur and promoting entrepreneurship in a large corporation.

MG 7733 Services Innovation 2½:0:0:3

This course deals with services innovation. Services have eclipsed manufacturing, and are now the dominant part of a modern, advanced economy. According to some estimates, services account for close to 80 percent of US employment. This course examines how value creation occurs in a range of fast-growing services sectors, including retailing, hospitality, financial services, professional services, travel, logistics, and healthcare. The course emphasizes that services are diverse, and explicitly distinguishes traditional and high-value services. This course focuses especially on the latter type of services. A key objective of this course is introducing to course participants best practices for nurturing modern services innovation.

MG7871 Introduction to Managing Intellectual Property 2½:0:0:3

This course introduces the topic of Managing Intellectual Property, which constitutes a major strategic and financial asset of a modern business. IP can be employed to protect existing products, services, and business methods and to accelerate development of new products, services, and business methods. IP can also be leveraged to enhance the competitiveness, value, and profitability of a firm. This is true in the physical world and in the online world of the Internet and e-business (where traditional principles of Intellectual Property Rights are often stretched and may need reinterpretation and even modification). Intellectual Property is complex and becoming more so as emerging digital technologies advances. This course is intended to be only an introduction to managing IP.

MG 7873 Managing Intellectual Property and Intellectual Capital 2½:0:0:3

Intellectual Property and Intellectual Capital constitute major strategic and financial assets of a modern business. They can be employed to protect existing products, services and business methods and to accelerate development of new products, services, and business methods. They can also be leveraged to enhance the competitiveness, value, and profitability of a firm. This is true in the physical world and in the online world of the Internet and e-business (where traditional principles of Intellectual Property Rights are often stretched and may need reinterpretation and even modification). Intellectual Property is complex and becoming more so as emerging digital technologies advances.

This course is intended to be a broad and full survey of main areas and issues of concern associated with Managing Intellectual Property and Intellectual Capital. The course concludes with an examination of how firms can best manage their intellectual capital.

MG 8203 Project Management 2½:0:0:3

Management of technology-based projects ranging from individual research and development to large-scale and complex technological systems. Feasibility and risk analyses. Project selection and portfolio optimization. Functional and administrative structures, coordination and scheduling of activities, personnel planning, negotiations and contracts, cost estimation, capital budgeting, cost controls, effective matrix management. Also listed under CE8203.

MG 8603 Financial Planning and Control 2½:0:0:3

Examines the latest and most relevant approaches for modern financial planning and control. Specific examples of best practices are studied. Topics covered include an overview of financial planning and control, operational-level financial planning and control, management reporting, forecasting, the application of technology and analytics, the relationship between strategic planning and operational-level financial planning and control, the challenges of implementation, and emerging trends in the financial planning and control area. Particular emphasis is placed on trade-offs and balance with regard to the need for financial planning and control and the desire to also have empowerment in modern firms. *Prerequisite: MG6093.*

MG 8633 Market Research 2½:0:0:3

This course deals with the role of market research in modern firms and with the ways market research can help in making business decisions. The specific focus is on how market data and information is gathered, analyzed, and used. Topics include experimental and questionnaire design, use of various analytical tools, interpretation of findings and development and execution of plans based on market research results. The strengths and drawbacks of various techniques are also examined. *Prerequisite: MG6073.*

MG 8643 New Product Development 2½:0:0:3

The dynamics of technology and the pressures of competition are driving enterprises to make their product development and pro-

duction processes strategically more effective, and economically more efficient in time and cost. Course deals with the state-of-the-art in new product activities for services and manufacturing firms, examining in-depth the marketing, technology, and manufacturing technology linkages.

MG 8653 Managing Technological Change and Innovation 2½:0:0:3

Focuses on the effective management of technological change and innovation, which is accomplished by employing a dual perspective. One perspective is based on individual, group and organizational theory, research and practice. This body of literature, viewpoints, and experience provides essential guides for successfully managing the introduction of new technologies. Realizing the full potential of new technologies requires effectively managing change to assure the commitment of all stakeholders. The second perspective is based on innovation theory, research, and practice. This body of literature, viewpoints, and experience provides key insights for effectively managing the process of innovation and the impact of innovation on all parts of an enterprise. Specifically, there is explicit consideration of the need within a firm to manage and inspire people so that they can effectively communicate and innovate.

MG 8663 Technology Policy 2½:0:0:3

This course focuses on the macro-environment influencing and relevant to technology decision making, strategy and innovation in firms, government agencies, non-profit institutions and other organizations. Primary concerns include introducing effective approaches for analyzing and evaluating societal-wide factors that influence innovation; assessing various attempts and policies for stimulating innovation in a city, region, nation or on a global basis; exploring the role of technology and innovation in diverse managerial, economic and social contexts (e.g., advanced economies, rapidly emerging economies, and Third World economies); the relationship between business-government and NGOs in promoting and sustaining innovation; the impact of global rivalry and global cooperation in the technology and innovation arena; and the place of technology and innovation in the post-Cold War era and in the early 21st century. Also listed under ST8663.

MG 8673 Technology Strategy 2½:0:0:3

Examines in depth the strategic technological decisions that a general manager faces. From entrepreneurial start-ups to established

companies, in dynamic as well as mature environments, there must be a conscious process of formulating and implementing a technology strategy to serve the business interests of the firm. Such a strategy would guide investments in research and development, selection among and timing of alternate technologies, organization and communications, formation of alliances and funding of ventures.

MG 8721 Introduction to Managing Growing Enterprises 1½:0:0:1½

This introductory course deals with a critical challenge all successful entrepreneurial small or medium-size firms potentially confront: how to sustain and accelerate major growth. At some point in the life of all growing enterprises, a firm usually must change. This course introduces some of the ways a growing firm can transform itself from a small to a larger enterprise. The course begins to explore how such companies can maintain the benefits of an entrepreneurial commitment and spirit while still obtaining needed skills associated with professionally managed larger firms. Offered at the request of other Depts. Not open to MSM, MSOB and MBA students.

MG 8723 Managing Growing Enterprises

This course deals with a critical challenge all successful entrepreneurial small or medium-size firms potentially confront: how to sustain and accelerate major growth. At some point in the life of all growing enterprises, a firm usually must change. It can no longer be run in a small-scale and possibly ad hoc and overly responsive fashion. To successfully exploit past success in the marketplace and future attractiveness of innovative products and services such a firm needs to adapt. This course examines the ways a growing firm can transform itself from a smaller to a larger enterprise. In particular, the course focuses on how such companies can maintain the benefits of an entrepreneurial commitment and spirit while still obtaining needed skills associated with professionally managed larger firms. In this way, fast-growing firms can take advantage of innovation-based opportunities while scaling up.

MG 8711 Introduction to Entrepreneurial Finance 1½:0:0:1½

This course provides a brief introduction to the financial requirements of entrepreneurial ventures and to different sources of finance available to entrepreneurs. The course presents the fundamentals on how to assess var-

ious entrepreneurial financial strategies. Will consider offering this course only when requested by other departments. This course is not open to MSM and MBA students.

MG 8713 Entrepreneurial Finance 2½:0:0:3

This course focuses on the financial requirements of entrepreneurial ventures and on different sources of finance available to entrepreneurs. The course helps develop an understanding on how to assess various entrepreneurial financial strategies. The course also examines the unique roles occupied by such factors as retail banks, investment banks, VCs, angels, internal sources of capital, and incubators in the entrepreneurial finance arena.

MG8721 Introduction to Managing Growing Enterprises 1½:0:0:1½

This introductory course deals with a critical challenge all successful entrepreneurial small or medium-size firms potentially confront: how to sustain and accelerate major growth. At some point in the life of all growing enterprises, a firm usually must change. This course introduces some of the ways a growing firm can transform itself from a small to a larger enterprise. The course begins to explore how such companies can maintain the benefits of an entrepreneurial commitment and spirit while still obtaining needed skills associated with professionally managed larger firms. Will consider offering this course only when requested by other departments. This course is not open to MSM and MBA students.

MG 8723 Managing Growing Enterprises 2½:0:0:3

This course deals with a critical challenge all successful entrepreneurial small or medium-size firms potentially confront: how to sustain and accelerate major growth. At some point in the life of all growing enterprises, a firm usually must change. It can no longer be run in a small-scale and possibly ad hoc and overly responsive fashion. To successfully exploit past success in the marketplace and future attractiveness of innovative products and services such a firm needs to adapt. This course examines the ways a growing firm can transform itself from a smaller to a larger enterprise. In particular, the course focuses on how such companies can maintain the benefits of an entrepreneurial commitment and spirit while still obtaining needed skills associated with professionally managed larger firms. In this way, fast-growing firms can

take advantage of innovation-based opportunities while scaling up.

MG 8731 Introduction to Corporate Entrepreneurship 1½:0:0:1½

Although large firms require professional management, to innovate, large corporations also often must practice entrepreneurship. This course serves as a brief introduction on how large corporations nurture and sustain entrepreneurship. Not open to MSM, MSOB and MBA students. Will consider offering this course only when requested by other departments.

MG 8733 Corporate Entrepreneurship 2½:0:0:3

Although large firms require professional management, to innovate, large corporations also often must practice entrepreneurship. This course focuses on how large corporations nurture and sustain entrepreneurship and on how entrepreneurship is an integral part of a successful large firm's strategy and structure today. Among the topics discussed in this course are forms of internal entrepreneurship, corporate venture capital, and the obtaining of entrepreneurial capabilities via acquisition.

MG 8741 Introduction to Entrepreneurial Marketing and Sales 1½:0:0:1½

This course provides an introduction to entrepreneurial marketing and sales. Various topics associated with entrepreneurial marketing and sales are discussed. Will consider offering this course only when requested by other departments. This course is not open to MSM and MBA students.

MG 8743 Entrepreneurial Marketing and Sales 2½:0:0:3

This course focuses on critical marketing and sales challenges facing entrepreneurial firms. An underlying theme of this course is that successful innovative enterprises must possess deep familiarity of relevant markets and must be effective in cultivating and reaching such markets. Topics discussed in this course include market identification, segmentation, sales, overall market planning, niche and viral marketing, and customers as sources of innovative ideas.

MG 9343 Research Project in Organizational Behavior 3:0:0:3

Integration and application of advanced re-

search techniques utilized in studies of organizations. Students develop and carry out individual applied research projects. Prerequisite: MG 6333 or instructor's permission.

MG 8763 Knowledge Management 2½:0:0:3

Knowledge workers, who are primarily in professional and technical occupations, increasingly become an important segment of the labor force in the US. The success of innovative organizations today is often a result of the knowledge and skills applied by their professional and technical employees. Effective management of such a work force has become one of the most critical problems faced by organizations in both the private and public sectors. Reflecting this, the course addresses issues relating to the creation, sharing and application of knowledge in organizations. In the course, we examine knowledge management from various perspectives, focusing primarily on the organizational, managerial, and technological perspectives

MG 9703 Project in Strategy and Innovation 2½:0:0:3

An integrative course that brings together concepts and theories from a number of individual courses. Usually considers issues from a holistic and top management perspective. Employs case studies and projects in focusing on key interrelationships between strategy, technology, innovation, corporate culture, organization structure, and human factors. Covers domestic and global corporations, large, medium-size, and small firms; and established and new enterprises. Prerequisite: advanced standing.

MG 9753 Selected Topics in Management 2½:0:0:3

Current topics in various fields are analyzed and discussed. Prerequisites: advanced standing and Department's Chair's permission.

MG 9763 Readings in Management 2½:0:0:3

Directed individual study of supervised readings in advanced areas of management. Prerequisite: Department Chair's permission.

MG 9771 Readings in Management 1½:0:0:1½

Directed individual study of supervised readings in advanced areas of management. Prerequisite: Department Chair's permission.

MG 9781 Selected Topics in Management 1½:0:0:1½

Current topics in various fields are analyzed and discussed. Prerequisites: advanced standing and Department's Chair's permission.

MG 9853 Selected Topics in Organizational Behavior 3:0:0:3

Each 3 credits

Discussion and analysis of current topics in organizational behavior. Prerequisites: Advanced standing and instructor's permission.

MG 9873 Readings in Organizational Behavior 3:0:0:3

Each 3 credits

Directed individual study or supervised readings in advanced areas of organizational behavior. Prerequisite: Program Director's permission.

MG 9973 Thesis for Degree of Master of Science 2½:0:0:3

Original investigation in a topic chosen by the student. Conferences with advisor and progress reports are required while conducting thesis and drafting of the thesis. A final written report is required at completion. Oral examination may be requested by the department. Prerequisites: Degree status and approval of supervising professor, adviser and Department Chair.

MANAGEMENT OF TECHNOLOGY PROGRAM

Academic Program Co-Directors:
Mel Horwitch and Nina D. Ziv

For forward-thinking managers, the Management of Technology (MOT) Program is the path to leadership in today's knowledge economy.

One of the first accredited universities to offer an advanced degree in MOT, Polytechnic University is a recognized leader in the field. Rather than grafting a few courses onto a traditional MBA program, Polytechnic's MOT Program possesses a thoroughly innovative integrated curriculum.

Key characteristics of the MOT Program:

- Provides knowledge needed to manage technology-intensive corporations
- Focuses on strategic implications of technology and innovation
- Encompasses innovation management in all modern technology arenas such as media/entertainment, bio-medical/pharma/chemical, new materials, telecoms, financial and professional services
- Deals with the impact of technology and innovation throughout an enterprise
- Addresses physical, digital (including Internet-based) and mobile innovation
- Enables key transition from technologists to high-level, effective technology managers
- Assumes a global perspective
- Explores and develops new business models based upon technology-enabled innovation

In the MOT curriculum, even traditional subjects such as finance, operations management, and marketing are taught with technology-enabled-innovation issues in mind. Subjects, concepts and issues directly related to technology management and accessing innovative capability that form the MOT Program core include:

- Customers, suppliers, and other partners as sources and co-creators of innovation
- New product and services development
- The global search for innovation and technology and choosing among increasingly global technology sources and markets, including Europe, the Pacific Rim, Israel, India and others
- Entrepreneurship
- Integrating technology and management
- Venture capital and venture creation
- The Internet and the Web-innovation as new platforms for innovation
- Innovation-friendly cultures and organizations
- The IT-innovation connection
- Revitalized R&D
- High-technology products and services

- Strategic technology planning and innovation-intensive new product business models
- Knowledge management
- Technology choice and acquisition
- Multiple and diverse levers for technology-enabled innovation

The program is well-suited for engineers and scientists with increasing managerial responsibility, as well as professionals, functional and business managers in finance, banking, telecommunications, design, retailing, media/entertainment, and other increasingly technological environments.

MOT is an executive program. As such, it has the following general features:

- Close interaction and teamwork
- A professional, modern, and informal learning environment
- Participants viewed as real partners in the learning process (in class and in the joint generation of intellectual capital as presentations, reports or cases—in paper and digital formats)
- A curriculum that is continually updated
- Close collaboration with respected partners in industry and the relevant scholarly community
- Full courses and half-semester courses to make the most of the limited time available
- Carefully selected elective courses to maintain flexibility in meeting diverse professional needs
- A blend of live class experience with the use of modern, Web-based technology
- Effective remote-collaboration learning and teamwork that are also enabled by technology
- Learning materials that are often in digital Web-based format to take advantage of Internet-based technologies and methods
- The incorporation of technology with ease of use and access as key watchwords

There are also more focused tracks in MOT: Bio-Pharma, Management of Technology and Innovation in Financial Services (MOTIFS), Management of Technology and Innovation Media and Entertainment (MOTIME) Management of Technology and Innovation in Retailing (MOTIR) and an e-Business track.

MOT classes are held every other week on Thursday evening and all day Saturday at 55 Broad Street, in the heart of lower Manhattan. An all-inclusive fee covers tuition and fees, textbooks and other educational material, special tutorials and lectures, and meals on class days. Visit the program's Web site at www.mot-tim.poly.edu for the most current information.

ADMISSIONS REQUIREMENTS

The Executive Master's Degree Program uses an admission process called the Self-Managed Application (SMA). Applicants must gather the materials required by the program and forward them in a single envelope to:

Administrative Director
MOT-TIM Executive Master's Degree Programs
Polytechnic University
55 Broad Street, Suite 13B
New York, NY 10004

HOW TO APPLY

1. Complete the application and attach a copy of your professional resume and the application fee.
2. Please ask the registrar at all colleges and universities you attended to send official transcripts directly to you. In order for them to remain official, they must be sealed in the original envelope. Opened transcripts are not considered official.
3. Please arrange for two (2) letters of recommendation to be sent directly to you. These letters are generally from a supervisor or high-level colleague who is familiar with your professional work. As with transcripts, to be considered official, recommendations must be sent directly from the recommender to the applicant unopened. Use the enclosed forms for this purpose. Write your name at the top, sign the waiver if you wish and give one form and one of the enclosed envelopes to each person writing in support of your application.
4. After we have received all necessary materials:
 - Application form
 - Application fee
 - Professional resume
 - Transcripts from all schools
 - Two letters of recommendation
5. The final step for admission is a personal interview with one of the Academic Co-Directors to discuss career objectives and to make sure the Program fits your goals.

For more information, contact the MOT program Administrative Director:
Tel: 718-260-4014
Fax: 212-547-7029
E-mail: mot-tim@poly.edu
Web: www.mot-tim.poly.edu

DEGREE REQUIREMENTS AND CURRICULUM

The 30 credit program consists of the following (the order in which courses are given may vary):

First Semester

- MG 6033 Organizational Behavior & Management Processes in Innovative Corporations
- MG 6093 Managerial Accounting & Finance
- MG 8653 Managing Innovation

Second Semester

- MG 6083 Managerial Economics and the Economic Environment
- MG 6703 Operations Management for Knowledge-Based Enterprises
- MG 6933 Information Technologies, Systems & Management in Organizations

Third Semester

- MG 6073 Marketing
- MG 7743 Advanced Topics in Technology Management and Innovation
- MG 9503 MOT Capstone Project**
- MG 8763 Knowledge Management**

Fourth Semester

- MG 7953 Global Innovation
- MG 8203 Project Management & Assessment for Technology Managers
- MG 9503 MOT Capstone Project**
- MG XX Elective** (select one from the list below)

Elective Course Portfolio

- MG 7813 Selected Topics in Networking & Information Technologies**
- MG 7843 Negotiation in Technology-Intensive Sectors**
- MG 7853 Leadership**
- MG 7863 High-Technology Entrepreneurship**
- MG 7873 Intellectual Property for Technology & Information Managers**
- MG 7883 Modern Supply Chain Management: Integration Through Technology**
- MG 7893 Special Elective Topics for MOT & TIM**
- MG 7973 Financing for Value Creation**

** half-semester courses

SPECIAL MOT TRACK:

Bio-Pharma Track

The Bio-Pharma MOT Track deals with the effective management of technology and innovation in the bio-pharma sectors. Jointly sponsored by the Department of Technology Management and Othmer Department of Chemical and Biological Sciences and Engineering, this track covers the diverse array of firms that comprise the modern bio-pharma arena. The track also provides a broad and business-oriented overview of emerging technologies that are changing the nature of competition in bio-pharma. Finally, the Bio-Pharma Track introduces participants to the key managerial and competitive implications of developments that are significantly affecting the structure and future of bio-pharma value creation.

The Bio-Pharma curriculum is as follows:

First Semester

- MG 8653 Managing Innovation
- MG 6093 Managerial Accounting & Finance
- MG 6033 Organizational Behavior & Management in Innovative Corporations

Second Semester

- MG 9633 Information Technologies, Systems & Management in Organizations
- MG 6083 Managerial Economics and the Economic Environment
- MG 7713 Bio-Pharma Sector: Structure, Organization & Management

Third Semester

- MG 6073 Marketing
- MG 7723 Managing Technological Innovation & Emerging Technologies in the Bio-Pharma Sectors
- MG 9503 MOT Capstone Project**
- MG 8763 Knowledge Management**

Fourth Semester

- MG 7953 Global Innovation
- MG 7733 Emerging Trends in Innovation & Technology in the Bio-Pharma Sectors
- MG 9503 MOT Project Capstone**
- MGXX Elective** (select one from the list below)

Elective Course Portfolio

- MG 7813 Selected Topics in Networking & Information Technologies**
- MG 7843 Negotiation in Technology-Intensive Sectors**
- MG 7853 Leadership**
- MG 7863 High Technology Entrepreneurship**
- MG 7873 Intellectual Property for Technology & Information Managers**
- MG 7883 Modern Supply Chain Management: Integration Through Technology**
- MG 7893 Special Elective Topics for MOT and TIM**
- MG 7973 Financing for Value Creation**

** half-semester courses

SPECIAL MOT TRACK:

The e-Business Track

e-Business constitutes for many professionals in the MOT environment an important arena for value creation. It can enhance market performance and can make organizations more efficient and effective. Those MOT participants wishing to be formally recognized as knowledgeable in e-Business may choose to enter the MOT e-Business Track. Choosing this track requires the completion of a final project dealing specifically with an important topic in the e-Business world as part of the Capstone Course in the final semester. The e-Business track is open to all MOT participants.

SPECIAL MOT TRACK:

Management of Technology and Innovation in Financial Services [MOTIFS]

Management of Technology and Innovation in Financial Services [MOTIFS] is a special Track within the overall MOT Program. The

degree that is awarded is the same degree awarded for the overall MOT Program. MOTIFS is designed for professionals in the financial services industry who aim for and require greater understanding of innovation, technology, and information management in financial services. The MOTIFS curriculum emphasizes technological and competitive challenges facing securities, insurance, banking, and other financial services segments.

The MOTIFS curriculum is as follows:

First Semester

- MG 6033 Organizational Behavior & Management Processes in Innovative Corporations
- MG 6093 Managerial Accounting & Finance
- MG 8653 Managing Innovation

Second Semester

- MG 6083 Managerial Economics
- MG 6933 Information, Technology, Systems & Management in Organizations
- MG 7963 Modern Financial Institutions

Third Semester

- MG 6073 Marketing
- MG 6043 Innovation Management in Money, Banking & Financial Markets
- MG 9503 MOT Capstone Project**
- MG 8763 Knowledge Management**

Fourth Semester

- MG 7953 Global Innovation
 - MG 7983 Managing Technological Innovation and Emerging Technologies in Financial Services
- Or
- MG 7993 Modern Financial Products
 - MG 9503 MOT Capstone Project**
 - MG XX Elective** (select one from the list below)

Elective Course Portfolio

- MG 7813 Selected Topics in Networking & Information Technologies**
- MG 7843 Negotiation in Technology-Intensive Sectors**
- MG 7853 Leadership**
- MG 7863 High Technology Entrepreneurship**
- MG 7873 Intellectual Property for Technology & Information Managers**
- MG 7883 Modern Supply Chain Management: Integration Through Technology**
- MG 7893 Special Elective Topics for MOT and TIM**
- MG 7973 Financing for Value Creation**

** half-semester courses

SPECIAL MOT TRACK:

Management of Technology and Innovation in Media and Entertainment [MOTIME]

Management of Technology and Innovation in Media and Entertainment [MOTIME] is a special track within the overall MOT program. The degree that is awarded is the same degree awarded for the overall MOT program.

MOTIME is designed for professionals in the media and entertainment sector who require a greater understanding of the impact of technological innovations on the

media industry landscape. The MOTIME track focuses on understanding the managerial challenges associated with these innovations and emphasizes how managers in such industries as book publishing, motion pictures, newspaper publishing, and music create business value from technological innovations.

The MOTIME curriculum is as follows:

First Semester

- MG 6033 Organizational Behavior & Management Processes in Innovative Corporations
- MG 6093 Managerial Accounting & Finance
- MG 8653 Managing Innovation

Second Semester

- MG 6083 Managerial Economics
- MG 6933 Information, Technology, Systems & Management in Organizations
- MG 6753 The Media and Entertainment Sector: Structure, Organization and Management

Third Semester

- MG 6073 Marketing
- MG 6763 Managing Emerging Technologies in the Media and Entertainment Sector
- MG 9503 MOT Capstone Project**
- MG 8763 Knowledge Management**

Fourth Semester

- MG 7953 Global Innovation
- MG 6773 Advanced Trends in Innovation and Technology in the Media and Entertainment Sector
- MG 9503 MOT Capstone Project**
- MG XX Elective** (select one from the list below)

Elective Course Portfolio

- MG 7813 Selected Topics in Networking & Information Technologies**
- MG 7843 Negotiation in Technology-Intensive Sectors**
- MG 7853 High-Technology Leadership**
- MG 7863 High Technology Entrepreneurship*
- MG 7873 Intellectual Property for Technology & Information Managers**
- MG 7883 Modern Supply Chain Management: Integration Through Technology**
- MG 7893 Special Elective Topics for MOT and TIM**
- MG 7973 Financing for Value Creation**

** half-semester courses

SPECIAL MOT TRACK:

Management of Technology in Innovation and Retailing [MOTIR]

Management of Technology and Innovation in Retailing [MOTIR] is a special track within the overall MOT program. The degree that is awarded is the same degree awarded for the overall MOT program.

The MOTIR Track in the MOT Program integrates the proven curriculum for modern technology management education with selected courses specifically tailored to the key technology and managerial challenges faced by today's retailing industry. This track serves all executives involved in

some part of the overall retailing value chain, from supplier, distributor, to the ultimate consumer.

The MOTIR curriculum is as follows:

First Semester

- MG 6033 Organizational Behavior & Management Processes in Innovative Corporations
- MG 6093 Managerial Accounting & Finance
- MG 8653 Managing Innovation

Second Semester

- MG 6083 Managerial Economics
- MG 6933 Information, Technology, Systems & Management in Organizations
- MG 7653 The Retailing Industry: Structure, Organization & Management

Third Semester

- MG 6073 Marketing
- MG 7663 Managing Technological Innovation & Emerging Technologies in the Retailing Industry
- MG 9503 MOT Capstone Project**
- MG 8763 Knowledge Management**

Fourth Semester

- MG 7953 Global Innovation
- MG 9503 MOT Capstone Project**
- MG 7673 Global Retailing & Supply Chain Management*
- MG 7883 Modern Supply Chain Management: Integration Through Technology**
- MG XX Elective** (select one from the list below)

Elective Course Portfolio

- MG 7813 Selected Topics in Networking & Information Technologies**
- MG 7843 Negotiation in Technology-Intensive Sectors**
- MG 7853 High-Technology Leadership**
- MG 7863 High Technology Entrepreneurship*
- MG 7873 Intellectual Property for Technology & Information Managers**
- MG 7893 Special Elective Topics for MOT and TIM**
- MG 7973 Financing for Value Creation**

* variable credit (1.25/2.5) course

** half-semester courses

COURSES

The following MOT courses are unique to the Executive Master's Management Program. For other course descriptions, refer to the Management Program section of this catalog.

MG 6033 Organizational Behavior and Management Processes in Innovative Corporations 2½:0:0:3

This course increases the student's ability to understand and effectively lead people and groups in organizations. The course draws on concepts from the social sciences (psychology, social psychology, sociology) and explores their implications for managerial practice and leadership. It emphasizes interpersonal relations and team processes, but

also includes the discussion of issues such as organizational culture and change. The course emphasizes team work and thus provides you with the opportunity to use your team experience as a laboratory for personal learning. Course objectives include introducing current concepts and principles from social science to leadership issues in organizations and applying these concepts to personal and work situations; providing opportunities to participate and learn about team work; and allowing students to examine their own behavior and beliefs about leadership and managerial behavior.

MG 6073 Marketing 2½:0:0:3

Introduces marketing concepts, processes and institutions; positioning, segmentation and product life cycles. Focuses on the integration of marketing with new product planning, design, and development. Strategies for technology-based products, services and processes are discussed. Other topics include market research, consumer behavior, advertising, promotion, and sales, global marketing and marketing on the Internet.

MG 6083 Managerial Economics 2½:0:0:3

Course focuses on microeconomic analysis and the macroeconomic environment for managers. The economic basis for managerial decisions in production, investment and technology strategy are discussed. Topics include the economics of the firm; business cycles; economic growth; international trade; financial institutions; currency systems; economics of innovation and entrepreneurial activity; the role of technology in economic growth and in international competition.

MG 6093 Managerial Accounting and Finance 2½:0:0:3

Principles and practices of the modern finance function including accounting and corporate finance and their relevance for all information business managers. Topics discussed include strategic perspectives—balancing long-term development and short-term returns; financing of ventures and innovative activities; project selection, capital budgeting, and risk analysis. A special emphasis is placed on financial decisionmaking in the information business sectors and the financial assessment of increasingly important knowledge-intensive assets.

MG 6103 Quantitative Analysis for Managerial Decisions 2½:0:0:3

Focuses on applications to the management of technology of quantitative and analytical techniques, such as probability, statistical inference, correlation and regression, decision theory, forecasting, linear programming and queuing models; production/operations management techniques. Cases and problems are selected from real-world technology-management experience, including computer-supported decision making and simulation.

MG 6703 Operations Management for Knowledge-Based Enterprises 3:0:0:3

This course focuses on developing a deeper understanding of the role that operations management plays in determining business strategy and in developing competitive advantage. The primary emphasis of this course will be on how to develop and effectively manage operations in knowledge intensive enterprises. Discusses the operational design and managerial implications when the emphasis of the operations group is more on knowledge management than on production and facilities management; managing the effective integration of technology, people, and operating systems; understanding the complexities and challenges of operations management; the challenges of developing and managing supply chain networks; and the critical role of technology in developing operational capabilities in an organization.

MG 6753 The Media and Entertainment Sector: Structure, Organization and Management 2½:0:0:3

This course provides an introduction to the various industries that comprise the media sector and outlines the major issues confronting these industries as they grapple with incorporating digital-based and mobile innovations into their businesses. The structure of industries within the sector will be discussed as well as how managers are recalibrating their business models and redesigning their organizations in order to be competitive in the current media and entertainment sector landscape. Issues to be addressed include the new media industry as a catalyst for change; the transformation of traditional content-intensive industries such as the motion picture business; the book publishing business; the newspaper business and the music industry and the newly defined role of users and customers. Participants will read case studies and articles and access other relevant materials in electronic and print for-

mat. The emphasis will be on interactive discussions in class and on projects developed by individual participants as well as teams of participants.

MG 6763 Managing Emerging Technologies in the Media and Entertainment Sector 2½:0:0:3

This course focuses on selected emerging technologies that are changing the nature of competition in the media sector. The dynamic relationships involving changing technology, business processes, and management response will be seen in light of new digital platforms and applications, standards development, as well as legal and legislative initiatives. Topics to be addressed include intellectual property rights and digital rights management; content-on-demand; and the management, archiving, and preservation of digital content.

MG 6773 Advanced Trends in Innovation and Technology in the Media and Entertainment Sector 2½:0:0:3

This course explores important trends and issues which are having a significant impact on the management of technological innovation in the media sector. The course covers a range of topics which may vary from year to year and will serve as a culmination of the ideas and issues that have been discussed through the MOTIME track. Participants will develop projects that reflect their interests in particular aspects of the sector. Examples are redefinition of the notion of convergence; the intersection of design, content, and technology; and the globalization of the media industry.

MG 6933 Information Technologies, Systems and Management in Organizations 2½:0:0:3

Designed for managers who need to understand the role and potential contribution of information technology (IT) within organizations. The focus is on information technology and its business applications. Course concentrates on the current state of IT in organizations, challenges and strategic use of IT, IT infrastructure and architecture, the technical foundation of IT, building and implementing organization information systems, emerging issues in IT such as intelligent systems, business process re-engineering, knowledge management and group support systems. Course format is interactive with concept presentation followed by open discussion on real-world applications of IT and business cases.

MG 7653 The Retailing Industry: Structure, Organization, and Management 2½:0:0:3

Provides an introduction to the emerging structure of the modern retailing industry and to effective retailing management. Investigates how key firms in the modern retailing sector are managed and how pace-setting firms are organized and structured at both the strategic and operational levels. Covers both physical and internet-based retailing.

MG 7663 Managing Technological Innovation and Emerging Technologies in the Retailing Industry 2½:0:0:3

Course provides an introduction to technological innovation and emerging technologies retailing. The focal point of this course is the effective management of technological innovation in modern retailing. The role of technology platforms and applications, technology development and use, and the relationships between technologies and business processes are also discussed.

MG 7673 Global Retailing and Supply Chain Management (variable 1¼ / 2½)

Course focuses on current theory and practice in global retailing and supply chain management and the link between globalization and supply chain management. The course also examines the flow and transformation of goods from the raw material stage through to the end user. The globalization of retailing has triggered a range of innovations in the supply chain which will also be the focal point of this course.

MG 7713 The Bio-Pharma Sectors: Structure, Organization and Management 2½:0:0:3

Introduction to effective management in the modern bio-pharma sectors. Investigates how key bio-pharma firms are organized and managed at both the strategic and operational levels. Particular attention is paid to various forms of technology and innovation management occurring in the bio-pharma arena. Also listed under CBE 7713.

MG 7723 Managing Technological Innovation and Emerging Technologies in the Bio-Pharma Sectors 2½:0:0:3

Course provides an introduction to technological innovation and emerging technologies that are changing the nature of

competition in the bio-pharma sectors. Focuses on modern approaches for research and discovery of new molecules and on development of processes to manufacture them in large quantities. Explores the two major routes for this discovery activity and manufacturing processes: the “chemical” route and the “biological” route. Provides a blend of conceptual overviews, essential technical and scientific basics, competitive, regulatory, and management implications of the developments studied and specific cases studied and industry examples. Also listed under CBE 7683.

MG 7733 Emerging Trends in Innovation and Technology in the Bio-Pharma Sectors *2½:0:0:3*

Deals with selected important trends and issues that are having a major influence on the management of innovation and technology in the bio-pharma sectors. Covers a range of topics and includes written papers, team presentations, readings and invited speakers. Intended to be integrative, and demands application of the knowledge gained in the Management of Technology Program as a whole. Actual topics explored may vary from year to year. Also listed under CBE 7693.

MG 7743 Advanced Trends in Technology Management and Innovation *(variable 2½ / 1¼)*

This course explores several trends that have emerged in the technology management and innovation arena in the past decade. These include the advent of digital-based innovation in the late 1990s which has had a profound affect on how many firms conduct business; the effect of the crash of the NASDAQ in March 2000 and the September 11 event which had a major effect on corporations which now had to operate within major economic and creative constraints; the development of the concept of networks as it relates to the organization and strategy of the firm; the development of the wireless technology platform and its effect on technology innovation; and the development of a new innovation paradigm which suggests a relationship between information technology, creativity, and business practices. The course emphasizes classroom discussions as well as team based and individual projects.

MG 7813 Selected Topics in Networking and Information Technologies *(half-semester course) 1¼:0:0:1½*

Focuses on an in-depth exploration of selected modern networking and information

technologies. The specific topics studied vary from year to year. Examples are mobile communications, IP telephony, enterprise data systems. The course builds on previous TIM courses. Course provides a solid technology grounding in a learning context which also emphasizes how these selected technologies affect markets, industries, providers, integrators and users. Course’s technical content is supplemented with actual case examples and guest speakers.

MG 7843 Negotiation in Technology-Intensive Sectors *(half-semester course) 1¼:0:0:1½*

Negotiation is the art and science of creating good agreements. This course covers the science of negotiation by discussing and applying theories of negotiation. The art of negotiation is learned through practice; students in this class develop the art of negotiation by negotiating with each other in realistic cases. A wide variety of negotiation applications is covered in this class, including one-time and repeated negotiation, single and multi-issue negotiations, and two-party and multi-party bargaining. Special emphasis is placed on negotiations in technology-intensive environments. This class is taught using the case method. Many of the examples used in this course will be cases that the students actually negotiate with each other. Students’ grades will be based on their performance in these negotiations and on their class participation.

MG 7853 Leadership *(half-semester course) 1¼:0:0:1½*

Leaders set a vision, communicate it well, influence and inspire others to achieve their vision. However, there are many ways to achieve these things and many challenges and ineffective ways. The purpose of this course is to develop the student’s leadership style by analyzing individual styles, understanding their impact, and then enabling each student to create the right leadership style. This course addresses fundamental leadership issues and frameworks, drawing on current organizational research, but most of all it provides students with ways of getting insights on their own leadership style. The course emphasizes hands-on experience and focuses on experiential learning. Course objectives include assessment of leadership styles; developing leadership skills; and understanding the role of leadership coaching in the management of teams.

MG 7863 High-Technology Entrepreneurship *(variable 2½ / 1¼)*

Focuses on entrepreneurship as a critical engine for wealth creation in the high-technology, innovation-intensive economy. Deals with such key issues as: (1) assessing attractiveness of opportunities; (2) launching a new venture; (3) obtaining the necessary financial, human and technology resources; (4) managing the transition from a small entrepreneurial firm to a large, sustainable professionally managed but still entrepreneurial corporation; and (5) being an entrepreneur and promoting entrepreneurship in a large corporation.

MG 7873 Intellectual Property for Technology and Information Managers *(half-semester course) 1¼:0:0:1½*

Focuses on the role of intellectual property (e.g., patents, trade secrets, copyrights, trademarks, etc.) as a major element in modern technology and information strategy. Relevant concepts and case studies are used, with examples representing both classical and digital innovations.

MG 7883 Modern Supply Chain Management: Integration Through Technology *(half-semester course) 1¼:0:0:1½*

Introduction to the role of information technology in supply chain management. Both qualitative and quantitative aspects of supply chain management are covered. Articles pertaining to leading-edge research and management thought are discussed and analyzed by students. The underlying objective is to prepare participants to develop skills that are useful in analyzing technology, marketing, logistics, operations and broader channel-management issues. Classes are conducted using the case method, and a high level of class interaction is expected.

MG 7893 Special Elective Topics for MOT and TIM *(half-semester course) 1¼:0:0:1½*

Covers selected key emerging trends and issues in the MOT and TIM domains. Discussion with industry leaders and specialists from business, government, and academia. Topical treatment of technologies, markets, business practices, government regulations and the relationships among them.

MG 7953 Global Innovation
(variable 2½ / 1¼)

Focuses on global technology-enabled innovation. Topics covered include: accessing global sources of innovation, coordination and organization of activities around the world, new product development on a global basis, the role of revitalized global R&D, growing prominence of IT and e-Business in global innovation, and the role of alliances and linkages with customers, suppliers and other third parties. Introduces the latest and most relevant thinking, research and practices.

MG 7963 Modern Financial Institutions and Their Competitive Environment
2¼:0:0:3

Course focuses on the management of modern financial enterprises, innovation and technology management in these organizations, and the risk-return tradeoff from a financial-institution perspective. Deals with both the theory and practice of financial institutions by analyzing the regulatory, technological and competitive factors that define the dynamics of this rapidly changing industry. Knowledge in this course is developed primarily through a mixture of textbook reading assignments and discussions of concepts in real business contexts through case studies. Course objective is to provide technology managers with a firm knowledge of the normative consequences on financial management decision-making to create shareholder value.

MG 7973 Financing for Value Creation (half-semester course)
1¼:0:0:1½

Organized around the key-creating strategies and financial skills required by managers of entrepreneurial and innovative firms at various stages of evolution: from new, stand-alone entrepreneurial ventures to innovative, technology-driven projects of established corporations.

MG 7983 Managing Technological Innovation and Emerging Technologies in Financial Services
2¼:0:0:3

Introduces emerging information technologies and their applications in financial services industries to current and future managers. Covers three major financial services industries: banking, investment, and insurance. Students develop deeper understanding of concepts and analyze real-business context through case studies. Course provides adequate technical knowledge and discusses in

depth related managerial issues.
MG 7993 Modern Financial Products
2¼:0:0:3

Examines critical management issues of the technology domain that characterizes modern financial products used for investment, hedging or trading purposes. The description and use of these instruments were introduced in MG 796 and MG 693, which provide the necessary background discussion of information technologies and systems. Course's principal focus is on managing the technological challenges in the valuation and risk management of these data-intensive modern financial products.

MG 8203 Project Management and Assessment for Technology Managers
2¼:0:0:3

Managing technology-based projects ranging from individual research and development to large-scale and complex technological systems. Feasibility and risk analysis. Project selection and portfolio optimization. Alternative financing methods. Functional and administrative structures, coordination and scheduling of activities, personnel planning, negotiations, contracts and computer-based techniques. Cost estimation, capital budgeting, cost controls and effective matrix management. Actual case studies are used as are relevant project management software applications.

MG 8653 Managing Innovation
2¼:0:0:3

Examines key managerial features of modern innovation. Identifies diverse ways firms can access innovative capabilities. The managerial interplay between technology and management leading to innovation in the marketplace is a major focus of discussion and work. Important substantive themes include: (1) the variety of innovation processes existing in the modern economy, such as radical vs. incremental, product vs. process vs. service vs. system and physical vs. digital; (2) the diversity of corporate settings in which modern innovation takes place, e.g., large corporation vs. small firm or start-up vs. networked organizations; and (3) the sources of modern innovation, e.g., developers, users, suppliers, universities and other third parties.

MG 9503 MOT Capstone Project Course
2¼:0:0:3

Provides a Capstone, integrative and state-of-the-art intellectual experience for participants at the conclusion of the program. The class focuses on a selected major theme that is of broad and compelling managerial concern and that is related in important ways to the innovation, technology-intensive and/or information business arenas. Students are initially divided into small groups to tackle various aspects of the overall theme; individual participants are expected to submit their own analysis of a specific issue or firm associated with the general theme. Participants are encouraged to employ concepts and insights they have acquired during the course of the entire program.

MANUFACTURING ENGINEERING PROGRAM

Program Director: Michael Greenstein

The Department of Manufacturing and Industrial Engineering offers a graduate program leading to a Master of Science in Manufacturing Engineering. In recent years, much has been written about how to improve the productivity, profitability, and competitiveness of U.S. manufacturers with many new approaches having been introduced. The first wave of these centered on improving competitiveness through improving quality and reducing inventory and cycle time by focusing on design, the introduction of product realization processes, and the introduction of specific new methods such as Total Quality Management, Just-In-Time/Total Quality Control, new production control systems, lean manufacturing, and activity based costing.

The program at Polytechnic emphasizes these methods and supports them through courses in robust design and the design of experiment techniques. As for production, there are courses in Computer Integrated Manufacturing and modern methods of production control such as Goldratt's synchronous manufacturing. Success in the application of these new methods depends upon getting acceptance for their use, so the program addresses specifically how to overcome cultural barriers through courses in managing the human side of technological change and developing high-performance teams. Currently in U.S. industry, attention is being focused on reducing variability in production, thereby improving asset utilization and hence profitability and customer satisfaction. Polytechnic offers new courses in production science that specifically address these issues.

The department's comprehensive program in manufacturing engineering concerns this array of new methods, which are generally applicable and thus portable.

The program is interdisciplinary and designed for working professionals who have responsibilities in manufacturing and for those who plan to enter manufacturing after completing the master's program and full-time students. Because hands-on experience is so important, the program often makes arrangements for full-time students and those part-time students who do not work full-time to do internships with companies where their course work can be applied. Students enrolled full time can complete the MS program, including the internship, in one year.

GOALS AND OBJECTIVES

The objectives of the MS program in Manufacturing Engineering are for its students to acquire the following skills necessary to:

- Develop expertise in methods used in a wide variety of industries to increase profitability and competitiveness by improving quality, cycle time, design and production in factories, and supply chains
- Develop expertise in computer-based programs used throughout industry to analyze problems and improve performance, including simulation, linear programming, project management, facility planning, and production planning and control
- Cultivate a broad knowledge base through the choice of concentration of courses in manufacturing engineering and related fields to suit career needs
- Obtain hands-on experience through internships in local industry

GRADUATE PROGRAM

The Master of Science in Manufacturing Engineering can be taken full time or part time. Students are drawn from a wide variety of manufacturing firms, large and small. This program is designed to:

- Empower the graduate to identify, evaluate, and implement production improvement by applying new methods
- Provide experience in design and production through internships and projects
- Provide hands-on experience in the use of software for design and simulation
- Students graduating from this program will be equipped with working knowledge of advanced methods and techniques in manufacturing that are in use throughout the world. They will have sufficient knowledge and hands-on experience to enable them to contribute significantly to productivity improvement and to provide the leadership that such programs require. They will be well positioned to advance their own careers.

DESIRABLE BACKGROUNDS FOR GRADUATE STUDENTS

Admission to this graduate program is open to those holding an accredited engineering degree (BS or BE), to graduates in physics, chemistry, materials science and the biological sciences, and to those holding an MBA. International students with equivalent backgrounds are eligible to participate in the program.

REQUIREMENTS FOR THE MASTER OF SCIENCE

The degree program requires 30 credits, 9 of which may be granted for up to three relevant graduate level courses completed elsewhere with a grade of B or better. Issues relating to the transfer of courses are at the discretion of the Program Director.

MANUFACTURING ENGINEERING PROGRAM

Prerequisite Courses (or equivalent knowledge)

- Be computer literate
- Knowledge of engineering economy
- Understand probability and statistics

Students lacking the relevant knowledge, will be required to complete additional courses to satisfy these pre-requisites.

Required Core Courses	12 credits
MN 7893 Production Science	
MN 6113 Quality Control & Improvement	
MN 7923 Design For Manufacturability	
MN 7993 Supply Chain Engineering	
Other Courses	18 credits
Total	30 credits

Students are encouraged to organize their electives into "concentrations." Concentrations are designed to suit the student's career needs and, for those who are working, the needs of the firm.

MASTER'S REPORT

MN 9963 MS Report is normally 3 credits and may be expanded to 6 credits by use of MN 9973 as an elective. The master's report is done in an industrial lab setting whenever possible. Local industries with plants accessible to both campuses offer internships in many types of manufacturing.

Part-time students may draw upon their work to provide appropriate master's reports. Full-time students may also work on theoretical or experimental research projects at Polytechnic. In all cases, a faculty adviser is assigned. Written project proposals are required at the start of the work. A written summary and report are required upon completion of the project.

CERTIFICATE PROGRAMS

The department offers certificate programs designed for the professional with work experience. A certificate program requires four specific courses. Applicants for a certificate program must hold a bachelor's degree. On

completion of the sequence with a B average or better, the student is issued a certificate. Students who are later admitted to study for a master's degree are able to apply all certificate course credits toward the master's degree.

If students have taken the equivalent of any required courses as an undergraduate, they must work with their adviser to select substitute courses. Additional information is available from the department. The certificate programs are shown below:

CERTIFICATE IN SUPPLY CHAIN OPERATIONS

Overview

Supply Chain Operations is the hottest technique in today's industrial operations. Supply Chain Operations courses prepare professionals to

- Understand how most industries manage their business today
- Know Supply Chain concepts, principles and approaches
- Apply appropriate solutions and best practices in a work environment

Technical professionals with problem solving skills and a quantitative aptitude, and who are seeking to expand their knowledge of the field should take these courses.

MN 7953	Introduction to Supply Chain Operations (3-credits)
MN 7963	Supply Chain in Operations (3-credits)
MN 7973	Supply Chain Services and Administration (3-credits)
MN 7983	Supply Chain Infrastructure (3-credits)

CERTIFICATE IN TARGET COSTING

Overview

In today's markets, engineers must design and manufacture products at a cost which meets specified functionality, performance, and quality levels while generating the desired profitability at the anticipated selling price over a particular period of time.

Target costing provides the product-realization-process with a disciplined, quantitative method to optimize the trade-offs among marketing requirements, product features, company profitability, customer preferences and manufacturing capabilities. Target Costing compliments engineering technical skills by providing training in a practical application of engineering, design, and manufacturing disciplines to a product-realization process that meets customer expectations at a price that provides adequate profitability to the producer.

Target costing as a design methodology has been implemented in companies with great success. Training engineers and

managers in Target Costing will enhance the performance of professionals as the organizations they work for.

MN 7503	Introduction to Target Costing - Customer Driven Product Design (3-credits)
MG 6093	Managerial Accounting and Finance
MN 7523	Quantitative and statistical techniques in Market Driven Design
MN 7533	Advanced case studies in Market Driven Design (3-credits)

GRADUATE COURSES

The courses with MN designations below are followed by a set of courses from other programs that are commonly taken by manufacturing engineering students.

MN 6113 Quality Control and Improvement 3:0:0:3

The goal of this course is to provide the student with a solid foundation in the cost of quality, quality assurance, and quality management. Emphasis is placed on the basic tools of quality control such as control charts and their use, the concept of "out of control," acceptance sampling, variables and attributes charts, and producer's and consumer's risk. A unique aspect of this course is the demonstration of the power of teams of people with different expertise to improve quality. A course project is required. *Also listed as IE 6113. Prerequisite: MA 6513 Applied Statistics I (Data Analysis) or equivalent.*

MN 6123 Quality Engineering Using Robust Design 3:0:0:3

The goal of this course is to provide a broad review of the procedures involved in improving the quality of manufacturing.

By employing both Taguchi techniques, such as the use of signal-to-noise ratio representations and other techniques less sensitive to parameter interactions, a full spectrum of robust design methods are presented. Applications of these procedures are reviewed, including online troubleshooting methods to assure quality in manufacturing. *Also listed as IE 6123. Prerequisite: MN 6113.*

MN 6183 Managing the Human Side of Technological Change 3:0:0:3

The introduction of new technology brings with it the need to sensitize and educate engineers and managers to the impact these changes have on the technical as well as the general work force. This course concentrates on the manner in which new technologies and the associated new work structures can be introduced to a technology-sensitive or-

ganization. Issues of learning, communication, motivation, the appropriate management of change and the leadership responsibility in "making it happen" are extensively discussed.

MN 6323 Building High Performance Teams 3:0:0:3

Successful manufacturing programs require the teaming of a number of professionals having a variety of types of expertise, such as product design, manufacturing process design, production engineering, quality control, testing, and packaging. In the past, these individual experts were involved only in a serial fashion in the overall product realization process, with not very effective results. Considerable evidence suggests that uniting these experts in a consistent team produces substantial benefits. This course provides students with the skills and knowledge to build work unit effectiveness. Topics include diagnosing team functioning, understanding group dynamics, and creating a productive team culture, surfacing and resolving critical issues, and implementing strategies for organizational support.

MN 6513 Design Strategies 3:0:0:3

Product design is a major determinate of product cost, quality, and customer satisfaction. The design process is explored including establishing customer requirements, developing product specifications, conceptual design, detailed design, design for manufacturability, competitive analysis, and design for the environment.

Computer-aided applications and case studies are reviewed.

MN 7713 Product Realization Process 3:0:0:3

Getting new products developed and to market is a major factor in determining global competitiveness. Case studies will be used to illustrate the product realization process and the successful application of R&D, concurrent engineering, cross-functional teams, continuous improvement, computer applications, target costing, and new product development management.

MN 7763 Manufacturing Resources Planning 3:0:0:3

Computerized systems to effectively run a manufacturing business are discussed as well as the process of software specification, evaluation, selection, and implementation. Topics include manufacturing resources planning logic, enterprise resource planning, manufacturing execution systems, inventory management, and bill of materials. Several different software systems and their features are highlighted. Also listed as IE 776.

MN 7853 Computer Integrated Manufacturing Systems (CIMS) 3:0:0:3

The basic concepts of manufacturing products with complex processes which rely heavily on computer and data processing technologies are introduced.

All aspects relative to products and processes—planning, design, manufacturing, shipping are addressed from a variety of perspectives. Techniques for managing and optimizing manufacturing productivity are explored. Also listed as IE 7853.

MN 7883 Manufacturing Systems Engineering 3:0:0:3

Topics concentrate on contemporary techniques for product design and manufacture, including financials of the manufacturing firm, quality, reliability, Taguchi methods of product and process design, scale-up and partitioning, production flows, modern manufacturing methods such as Just-In-Time/Total-Quality-Control, pull and synchronized manufacturing. Cultural factors are also discussed. Also listed as IE 788.

MN 7893 Production Science 3:0:0:3

Just-in-time and synchronous manufacturing methods are reviewed. The basic dynamics of factories are analyzed to understand the importance of congestion and bottleneck rates on cycle time and inventories. Analytical models are developed to study variability and randomness introduced by breakdown, setups, and batching. Simulation studies are used to provide data on performance of transfer lines.

MN 7923 Design for Manufacturability 3:0:0:3

Concepts and techniques for economical, functionally sound, and high-quality product design for manufacture are introduced. Emphasis is placed on designing for easy assembly, both robotics and manual, and on the effective use of plastics for manufacturing cost reduction. Managerial and organizational approaches and case studies of successful designs are reviewed. Also listed as IE 792.

MN 7953: Basics Of Supply Chain Operations Management 3:0:0:3

Supply Chain Operations seeks to integrate and accelerate the flow of materials, information and cash, throughout the process in the supply of goods or services. Supply Chain Operations optimizes the efforts of Suppliers, Manufacturers, Warehouses, Distributors, Retailers, and Customers to create an efficient and robust process. On the Service side the same concepts prevail with the Suppliers, Institutions, Providers, Administrators, and Customers. All businesses are part of a Supply Chain, and understanding and realizing this relationship leads to economies of time, material, money, and improved customer service

MN 7963: Supply Chain Operations Management 3:0:0:3

Most businesses today have incorporated some version of Supply Chain Management to improve their operations and increase their competitiveness. This approach is a product of the 1990's and is growing exponentially.

Supply Chain Management seeks to integrate and accelerate the flow of materials, information and cash, from end to end, in the supply of goods or services. Supply Chain Management optimizes the efforts of Suppliers, Manufacturers, Warehouses, Distributors, Retailers, and Customers to create an efficient and robust process. On the Service side, the same concepts prevail with the Suppliers, Institutions, Providers, Administrators, and Customers. All businesses are part of a Supply Chain, and understanding and realizing this relationship leads to economies of time, material, money, and improved customer service

MN 7963 Electronics Systems Manufacturing 3:0:0:3

The physical design and manufacturability of modern electronics systems is a result of tradeoffs involving partitioning, electrical performance, cooling, and mechanical stresses. Design parameters are derived to study the tradeoffs, along with specific examples from reverse engineering studies. The current status and future directions of low-cost, high-volume manufacturing technologies are examined.

MN 7983 Supply Chain Infrastructure 3:0:0:3

To operate a Supply Chain effectively there must be well-designed, quality products and the echelons of the supply chain must operate as a team. These elements, also termed the infrastructure, are presumed to exist. The learning objective of this course will be to provide detailed information on the infrastructure elements required to operate a competitive Supply Chain. This infrastructure will cover Product Design and Development, Quality, Employee Involvement and Communication, Supplier and Customer relationships, Logistics, Warehousing, Information technology, and e-Business. Among the topics covered in detail will be product realization process and product design; house of quality; quality improvement process; six sigma; kaizan; employee motivation; communication and team dynamics; logistics including networks, third and fourth party organizations; Warehousing including optimum location, innovative information technology, and e-Business models.

MN 7993 Supply Chain Engineering
3:0:0:3

An understanding of how companies plan, source, make and deliver their products with a global competitive advantage. Course stresses the engineering components in developing an integrated supply chain that covers the entire manufacturing enterprise. It looks at the supply chain infrastructure and the velocities of different models. Focuses on understanding and detecting the constraints of the infrastructure and the lowest common denominator of the information system used. An understanding of logistical networks and the optimizing of the various traffic and location alternatives. Synchronization of supply and demand is examined in detail, looking at variability in both processes with the objective of maximizing throughput and capacity, emphasizing partnering, e-commerce, and the bullwhip effect. Finally, course established global performance measurements that compare various companies in different industries.

MN 9113/9123 Selected Topics in Manufacturing Engineering I/II 3:0:0:3

Areas not covered in other courses. Specific topics vary according to the instructor, who may be a visiting professor. Topics and prerequisites will be announced during the term prior to the offering.

MN 9303/9313 Readings in Manufacturing Engineering I/II each 3 credits

Individual reading of selected papers and current literature in specialized area of study, guided by faculty member. The topic must be beyond the scope of regularly offered courses. The topic must be agreed upon by the student and adviser prior to registration. A written report on the topic is required. Prerequisites: approval of adviser, instructor, and department head.

MN 9963 MS Report I 3 credits

Independent project demonstrating professional maturity and graduate-level knowledge completed under guidance of experimental work, software development, and extensive analyses are expected. Report must include results in one or more of these areas, critical analysis and interpretation of pertinent literature and should represent worthwhile contribution to the written report (unbound). *Prerequisite: adviser's approval.*

MN 9973 MS Report II 3 credits

With the approval of the graduate adviser, some students may undertake a 6 unit MS report. This should be planned in advance, during the registration for MN 9963. In such cases, MN 9973 is used for the second half of the registration. A grade of S or U is awarded in MN 9963 in these cases, and the letter grade given in MN 9973 applies to all 6 units. *Prerequisite: adviser's approval.*

THE FOLLOWING GRADUATE COURSES ARE OFFERED IRREGULARLY IN RESPONSE TO INDUSTRY DEMAND

- MN 7943 Physical Design of Products
- MN 8023 Thermal Design of Electronics System for Performance & Reliability
- MN 8043 Thermal Issues in Manufacturing Processes

MASTER OF BUSINESS ADMINISTRATION (MBA) INNOVATION & TECHNOLOGY MANAGEMENT

Interim Academic Director: Mel Horwitch

OVERARCHING PURPOSE OF THE POLY MBA INNOVATION & TECHNOLOGY MANAGEMENT

The Poly MBA constitutes a unique, high-quality Management learning experience. It is designed especially for candidates engaged in or aspiring toward careers in which managing technology, nurturing innovation and/or entrepreneurship are paramount concerns. It aims to educate innovation-savvy professionals and effective entrepreneurs. The Poly MBA also prepares candidates to achieve leadership positions; to conduct innovation decision making on both a local and global scale; and to serve one's community in an important fashion.

The Poly MBA leverages Polytechnic University's robust technological and innovation heritage and builds on the University's other strengths, including its strong technology foundation and reputation; its proven focused MS, BS, and PhD Technology Management programs; its small size; its easy inter-departmental collaboration; its NYC location; its close ties with premier firms in NYC and elsewhere; its large alumni base comprised of technological entrepreneurs and professionals; and its respected faculty in Management, Applied Sciences, and Engineering.

Poly MBA candidates also learn using the most effective and modern methods, e.g. exposure to individualized and team-based coaching, to intellectual thought leadership, to using an advanced learning platform; to numerous illustrative examples, and to experiential project-based education.

STRUCTURE OF THE POLY MBA CURRICULUM

The Poly MBA is a 54-credit program. The Poly MBA curriculum--anchored in technology and innovation management and entrepreneurship--possesses six key components:

I. Foundational MBA Core Courses (24 Credits)

Foundational MBA Core course comprise those courses that are essential for running any modern MBA enterprise. Foundational MBA Core courses include:

1. MG 6013 Organization Behavior
2. MG 6073 Marketing
3. MG 6083 Economics

4. MG 6093 Accounting and Corporate Finance
5. MG 6103 Management Science
6. MG 6303 Operations Management
7. MG 7183 Strategy for the Modern Enterprise
8. MG 7193 Ethical Dimensions of Modern Management

II. Distinctive Techno-Innovation Management Core Courses (18 Credits)

The Distinctive Techno-Innovation Management Core comprises courses that pay explicit attention to underlying aspects of innovation and technology management. These courses reflect, in essence, the Polytechnic faculty's special commitment and professional expertise, especially related to technology and innovation management. Distinctive Techno-Innovation Management Core courses include:

1. MG 6153 Leadership and Team Development
2. MG 6503 Management of Information Technology and Information Systems
3. MG 7203 Intercultural Dimensions of Global Management
4. MG 8203 Project Management
5. MG 8653 Managing Technological Change and Innovation
6. MG 8763 Knowledge Management

III. MG 8280 Special Immersion Module on Leadership, Global Decision Making and Innovation; (No Credit) 3:0:0:0

The purpose of this Module is to expose Poly MBA students to the most relevant and state-of-the art best practices in modern management, particularly as they relate to technology and innovation management, entrepreneurship, leadership and global decision making. During this Module the Poly MBA student has direct and continuous contact with leading and forward-thinking practitioners and organizations. The Special Immersion Module on Leadership, Global Decision Making and Innovation of the Poly MBA comprises four main Parts: Part I-Overview of Module and Whole-Class Discussion; Part II-General Distinguished Speaker Series and General Field Visits Series; Part III-Individual and/or Small Group Immersion Activities (in NYC and/or overseas); and Part IV-Conclusion: Small Group/Individual Final Presentations, Reports and Module Wrap-Up. A member of the faculty directs this non-credit Module.

IV. Flexible MBA Tracks;(6 Credits)

Flexible MBA Tracks consist of two courses for a total of six credits. Flexible Tracks are learning modules that focus on a specialized or targeted aspect of modern management. Tracks are designed by interested faculty and may include existing, new and/or "Special Topics" courses. They can be co-created by students and faculty. Some possible Tracks are more experimental. Tracks can comprise two 3-credit courses listed in the Polytechnic University Catalogue.

Illustrative Tracks include: Entrepreneurship; Technology Management; Human Resources; Services Innovation; and Managerial Analytics and Advanced Managerial Tools.

ILLUSTRATIVE FLEXIBLE MBA TRACKS

ENTREPRENEURSHIP TRACK

Mandatory Course:

MG 7703 Entrepreneurship

Select One Course From Below:

- MG 7873 Managing Intellectual Property and Intellectual Capital
MG 8723 Managing Growing Enterprises
MG 8713 Entrepreneurial Finance
MG 8733 Corporate Entrepreneurship
MG 8743 Entrepreneurial Marketing and Sales

TECHNOLOGY MANAGEMENT TRACK

Select Two Courses From Below:

- MG 8643 New Product Development
MG 7503 Electronic Business Management
MG 7703 Entrepreneurship
MG 8723 Managing Growing Enterprises
MG 8673 Technology Strategy

HUMAN RESOURCES TRACK

Mandatory Course:

MG 6123 Human Resource Management

Select One Course From Below:

- MG 6223 Staffing Organizations
- MG 6263 Human Resource Information Systems
- MG 6283 Web-Based Human Resource Management

MANAGERIAL ANALYTICS AND ADVANCED MANAGERIAL TOOLS TRACK

Mandatory Course:

- MG 7693 Managerial Analytics

Select One Course From Below:

- MG 6463 Supply Chain Management
- MG 7503 Electronic Business Management
- MG 8603 Financial Planning and Control
- MG 7733 Services Innovation

SERVICES INNOVATION TRACK:

Mandatory Course:

- MG 7733 Services Innovation

Select One Course From Below:

- MG 6463 Supply Chain Management
- MG 7503 Electronic Business Management
- MG 6543 Economics for Information Sectors
- MG 7693 Managerial Analytics

V. Elective (3 Credits):

The Poly MBA student can choose one free elective course for a total of three credits. For electives, Poly MBA students can register for any course listed in the Polytechnic University Catalog provided the student meets all course requirements.

VI. The Polytechnic MBA Capstone Experience (3 Credits)

MG 7283 MBA Capstone Project Course

The Polytechnic MBA Capstone experience constitutes a unique 3-credit-learning experience, and usually occurs in the final semester. While the Capstone may have some classroom components, the overwhelming part of the Capstone takes place in the field. The Capstone Project Course experience can be local and/or global, i.e. taking place in New York City and/or overseas. The Capstone Project Course also brings together the concepts, theories, and insights gained throughout the Poly MBA Program. Because one of the critical underlying themes of the entire Poly MBA Program is commitment to one's community, service is a major component of the MBA Capstone Project Course. It is assumed that a major part of the Capstone work will entail contribution to the community in some fashion.

POLYTECHNIC MBA ENTRANCE REQUIREMENTS:

- Poly MBA Candidates must hold a four-year bachelor's degree from an accredited college or university
- Official GMAT scores
- Two letters of recommendation
- Professional résumé
- For relevant applicants from abroad: mastery of English—evidenced by TOEFL scores

Note: Graduates of relevant Master's programs may be eligible to complete the Poly MBA by taking a minimum of 10 additional courses (30 credits).

Contact Information for the Poly MBA:

- E-mail: mba@poly.edu
- Tel: (718) 260-4014
- Online: www.poly.edu/mba

COURSES

MG 6013 Organizational Behavior

2½:0:0:3

Introduction to theory, research, and practice to better understand human behavior in organizations. Topics include motivation and job satisfaction; decision-making; group dynamics; work teams; leadership; communication; power, politics and conflict; organization culture, structure and design; impact of technology; management of work stress; organizational change and development; and career management. Analysis of organizational behavior problems by self-assessments, case studies and simulations. On-line version available

MG 6073 Marketing

2½:0:0:3

Marketing concepts, processes and institutions: positioning, segmentation, and product life cycles. Integration of marketing with new product planning, design, and development. Strategies for technology based products, services, and processes. Market research, consumer behavior, advertising, promotion, and sales. The special character of governmental and international markets.

MG 6083 Economics

2½:0:0:3

The fundamentals of microeconomics needed by managers. Demand theory (theory of the consumer) including models of demand, demand elasticities, and demand forecasting. Supply theory (theory of the firm) including diminishing returns, profit maximizing production levels, labor/capital tradeoffs and long-run vs. short-run issues. Market structures and how they affect optimal production and profit levels. Positive and negative externalities and government

intervention including regulation, tariffs, and subsidies. Selected applied topics. All topics are presented with examples and with emphasis on managerial application.

MG 6093 Accounting and Finance

2½:0:0:3

Elements of accounting and finance of importance to managers. Analysis of principles and practices of the finance function. Financing methods for internal and external ventures and innovations; capital budgeting; R&D portfolio analysis. Contrast of strategic perspectives emphasizing innovation and development with those emphasizing short-term return and investment.

MG 6103 Management Science

2½:0:0:3

Introduces major concepts and methods associated with Management Science, which deals with the application of quantitative modeling and analysis to management problems. Students learn to employ important analytical tools, to determine assumptions used and to recognize limitations of such methods. The methods discussed include linear and nonlinear programming, queuing, decision analysis, simulations and game theory. The course also introduces modeling with spreadsheets.

MG 6113 Career Management

2½:0:0:3

Provides an integration of theory, research, and practice pertaining to careers in organizations, particularly as they change through the life span. Examination of careers from the perspectives of both the individual and the organization, including topics such as career stage models, organizational entry, early career development, mid-career transition, career change and career issues for women. Facilitates the development of greater understanding and insight into one's own career growth and development through the use of career assessment techniques and standardized instruments for self-evaluation.

MG 6123 Human Resource Management

2½:0:0:3

Introduction to the broad range of human resource functions and their organizational role. Addresses issues in managing people that impact not only HR professionals but also line managers. The course is divided into four modules: an overview of HRM from a strategic perspective; the management of human resources, including recruitment and selection, performance management, com-

pensation and benefits, training and career support; human resource challenges, including diversity, procedural justice and ethics, collective bargaining, and managing change and innovation; and professional roles in HRM. Online version available

MG 6143* Conflict Management 2½:0:0:3

Investigation of the nature and meaning of conflict in professional and technical organizations as well as in society. Analysis of the design of conflict avoidance and mitigation programs. Alternative dispute resolution modalities are presented and demonstrated. Addresses strategies to build successful relationships on an ongoing basis. Skill building around collaborative conflict resolution. **Online version available.*

MG 6153* Leadership and Team Development 2½:0:0:3

Focuses on the essential role of multifaceted leadership in diverse organizational settings. Explores the nature of leadership and its relationship to team development and organizational effectiveness. Includes a broad survey of theory and research on leadership and teams in organizations. Includes a hands-on approach involving experiential learning and case analyses, which will be conducted in teams, requiring students to be active participants. **Online version available.*

MG 6223* Staffing Organizations 2½:0:0:3

Examination of the design and management of successful staffing practices used to build, deploy and retain a quality workforce in order to achieve organizational effectiveness and individual job satisfaction. Topics include staffing strategy; human resource planning and workforce diversity; job analysis; recruitment; hiring methods; the reliability and validity of employee assessment methods; and retention management. Psychological theories of personnel assessment are reviewed. Legal issues pertaining to staffing practices are integrated. **Online version available.*

MG 6233* Training in Organizations 2½:0:0:3

An overview of the many forms of training and related learning activities found in the modern workplace, including management development, technical training, career planning and mentoring. The course will focus on training as both an asset to the organiza-

tion and a necessity for delivering goods or services that will be valued by the customer. Topics addressed include needs analysis, preparation of employees for jobs, training program design, traditional training methods, computer-based methods, development, implementation and evaluation of training, targeting various groups with special training needs, and management development. **Online version available.*

MG 6243* Organization Development 2½:0:0:3

Survey of theory, research and applications related to the process of managing planned change in organizations. Organization development (OD) encompasses a variety of interventions and techniques, including strategic management sessions, team building, organizational climate studies, career development and job enrichment. Addresses the practical application of group, intergroup and individual changes; planned structural revisions in formal organizations; and the dynamics of organizational change processes. Experiential techniques emphasized. **Online version available.*

MG 6253 Seminar in Organization and Career Change 2½:0:0:3

Examination of organizational restructuring, including downsizing, reengineering, delaying, mergers and acquisitions, focusing on the impact of such change on professional and managerial careers. Emphasis on current organizational and individual management practices in coping with rapid structural and cultural change in the work environment. Experts from the private and public sectors as well as consulting firms address these management practices.

MG 6263* Human Resource Information Systems 2½:0:0:3

Introduction to the design, selection, implementation, enhancement, and operation of human resource information systems (HRIS), a computer-based tool that allows the efficient entry and updating of employee-related information. Focus is on the design and use of HRIS to facilitate the objectives of HR functions as well as the organization. Provides a “hands-on” experience with the design of prototype simulations and database programming systems used to solve common HR problems and efficiently manage employee information. **Online version available.*

MG 6283* Web-Based Human Resource Management 2½:0:0:3

Survey of the effective use and application of Internet and Intranet technologies for HR functions. Topics include employee self-service and online recruiting as well as software that handle peer reviews, applicant tracking, performance management, succession planning, and benefits administration. Issues addressed include Best practices in utilizing web technology for HRM; creating websites to achieve organizational goals; determining HR information to include on an organization website; impact of web technology on organization design; evaluating privacy and security issues; and developing a vision and a plan for utilizing web technology in HRM. **Online version available.*

MG 6303 Operations Management 2½:0:0:3

Analytical techniques for designing and operating production and service systems, including facility layouts and locations, capacity planning, job sequencing, inventory control and quality control. Introductory linear programming and other formal methods. Cases and PC usage.

MG 6353 Quality 2½:0:0:3

Focusing on quality and overall customer satisfaction as a primary objective of manufacturing and service operations is a proven competitive weapon. This course examines the concepts and methods for building quality into the management process. Total quality management (TQM) and similar approaches are covered through readings, cases and examples

MG 6463 Supply Chain Management 2½:0:0:3

Introduction to supply chain management. Both qualitative and quantitative aspects of supply chain management will be covered by this course. The underlying objective is to: (1) introduce students to the standard business concepts (and associated terminology) involved in the retailing and supply chain management arena; (2) develop student skills in understanding and analyzing retailing, marketing, logistics, operations, channel management and allied issues, and the interactions between them; and (3) examine and discuss the important role played by technology and integration at various points in the supply chain.

MG 6503 Management of Information Technology and Information Systems

2¼:0:0:3

This course is designed for managers who need to understand the role and potential contribution of information technologies in organizations. The focus of the course is on different information technologies and their applications in managing business critical data, information, and knowledge. The course concentrates on the current state of IT in organizations, challenges and strategic use of IT, IT infrastructure and architecture, building, implementing, and managing IT applications, and emerging issues such as intelligent systems, business process reengineering, knowledge management, and group support systems.

MG 6523 Telecommunications Policy

2¼:0:0:3

The relationships between the development of the telecommunications industry, national growth and the development of telecommunications policy issues and policy making organizations. Analysis of the major issues that have impact on the telecommunications industry and commerce and society generally. The options and opportunities afforded by recent regulatory and policy issues are also examined.

MG 6543 Economics for Information Sectors

2¼:0:0:3

This course in applied competitive strategy draws upon recent experiences associated with the impact of information technology upon diverse industries. Students completing this course will have mastered a basic understanding of the economic and competitive implications of information technology. This competence in analysis is arrived at through understanding how availability of information (through technology or otherwise) affects the basic strategic options available and how firms and industries are likely to be affected. In addition, students will be introduced to the often poorly structured process of evaluating the economics of potential systems innovations. They will then be able to participate in strategic systems planning from a managerial point of view.

MG 6553 Telecommunications Management I

2¼:0:0:3

Introduction of the fundamentals of modern telecommunications and networking for current and future managers. Covers basic concepts such as components of data-com-

munication, data transmission, Open System Interconnection (OSI), TCP/IP and other models, data link and network layers, and local area networks (LANs). The emphasis is to expand technical knowledge and discuss related managerial issues.

MG 6563 Telecommunications Management II

2¼:0:0:3

Explores advanced issues and trends in modern enterprise networking. Examines the implications of such developments in the business environment and the infrastructural needs of organizations and clusters of organizations. Reviews ramifications of the TCP/IP revolution leading to commercialization of the Internet/World Wide Web. Discusses the network infrastructure required to implement Intranets/Extranets, electronic commerce and interorganizational business communication and collaboration generally. Evaluates emerging technologies (such as electronic payment systems, corporate digital libraries, push technology, multicasting, firewalls and digital signatures). Deals with the implications of internetworking, such as digital cities, smart buildings, distance learning, telecommuting and teleconferencing. *Prerequisite: MG 6553.*

MG 7173 Enterprise Data Systems

2¼:0:0:3

Addresses modern issues of large-scale information and knowledge management through design, development and implementation of different kinds of database technologies. Introduces and elaborates on data modeling through relational models, SQL applications, database architecture, different types of database management systems, data integrity and administration, etc. Also introduces emerging database technologies, such as distributed Internet-based databases, distributed client/server databases, multidimensional databases, groupware, data warehousing and data mining for decision support, etc.

MG 7183 Strategy for the Modern Enterprise

2¼:0:0:3

This course provides an overview of strategic decision making for the modern enterprise. The course introduces general management perspectives of strategy, competitive strategy, emerging analytical characteristics of strategy, and current innovation and global dimensions of strategy. For a business environment that is increasingly fast paced, complex, knowledge-intensive, global, and undergoing continuous change,

the course concludes with an integrative approach for strategic decision making.

MG 7193 Ethical Dimensions of Modern Management

2¼:0:0:3

All managers frequently face ethical challenges. Success often depends on how well managers handle decisions that challenge their own set of values. Ethical dimensions of modern management also increase as competition becomes increasingly global and technology-intensive. This course identifies major ethical issues facing managers today—particularly with regard to technology, innovation and global decision making. The course also provides an opportunity for students to develop effective approaches for dealing with major ethical challenges. Finally, the course gives students a chance to reflect on the efficacy and strength of their own personal set of values.

MG 7203 Intercultural Dimensions of Global Management

2¼:0:0:3

This course focuses on the critical intercultural dimensions of global management. Topics covered include identifying key culture-related factors essential for effective global management, communicating across different cultures, building effective transcultural organizations, developing capable cross-culture managers, and leveraging cultural diversity.

MG 7283 MBA Capstone Project Course

2¼:0:0:3

The MBA Capstone Project Course is largely field based but may have some classroom components. The focal site for this course can be local and/or abroad. This course also brings together the concepts, theories and insights gained throughout the Poly MBA Program. Community service is also a major component of the MBA Capstone Project Course. The course is directed by faculty members working closely with students, often on site. The Capstone usually occurs in the final semester. The Capstone course may be offered for certain individual students or groups of students in collaboration with institutions abroad. Restricted to Polytechnic MBA students

MG 7503 Electronic Business Management

2¼:0:0:3

Investigates the management implications of electronic business. Topics include: (1) accelerated new product development; (2) impact of technology on the value chain: the chang-

ing role of intermediaries; (3) electronic commerce: business models and strategies for survival general lifestyle; (4) implications of “being wired”; and (5) business applications involving collaborative communication, computation and teamwork. Course material is designed to be dynamic and Internet-based, reflecting the nature of change in electronic commerce and the IT industry, and the potential implications of electronic business for managers. Students work on a project that requires: following developments in the business and IT press, interviewing managers and product developers and simultaneously testing and discussing current developments in the e-commerce marketplace. Classes are conducted using the case method, and a high level of class participation is expected.

MG 7693 Managerial Analytics 2½:0:0:3

This course focuses on the use of “analytics” --a fast-growing element in modern management--for achieving both more effective operations and heightened competitive advantage. This course provides a managerial overview of current deployment of a diverse range of analytics--internally-oriented and externally-oriented. The course also identifies the impact of analytics on a firm’s performance; and explores the strengths and weaknesses of analytics. The course also presents best practices of analytics from a range of industries, including retailing, hospitality, financial services, consulting, healthcare, and logistics. *Pre/Co-Requisites: MG6083 Economics AND MG6093 Accounting and Finance.*

MG 7703 Entrepreneurship 2½:0:0:3

Focuses on entrepreneurship and venture creation as key engines for wealth creation and successful business strategy in the modern innovation-intensive, high-tech economy. Deals with such key issues as: (1) assessing attractiveness of opportunities; (2) launching a new venture; (3) nurturing, growing and entrepreneurial venture; (4) obtaining the necessary financial, human, and technology resources; (5) managing the transition from a small entrepreneurial firm to a large, sustainable professionally managed but still entrepreneurial corporation; and (6) being an entrepreneur and promoting entrepreneurship in a large corporation.

MG 7733 Services Innovation 2½:0:0:3

This course deals with services innovation.

Services have eclipsed manufacturing, and are now the dominant part of a modern, advanced economy. According to some estimates, services account for close to 80 percent of US employment. This course examines how value creation occurs in a range of fast-growing services sectors, including retailing, hospitality, financial services, professional services, travel, logistics, and healthcare. The course emphasizes that services are diverse, and explicitly distinguishes traditional and high-value services. This course focuses especially on the latter type of services. A key objective of this course is introducing to course participants best practices for nurturing modern services innovation.

MG 7873 Managing Intellectual Property and Intellectual Capital 2½:0:0:3

Intellectual Property and Intellectual Capital constitute major strategic and financial assets of a modern business. They can be employed to protect existing products, services, and business methods and to accelerate development of new products, services, and business methods. They can also be leveraged to enhance the competitiveness, value and profitability of a firm. This is true in the physical world and in the online world of the Internet and e-business (where traditional principles of Intellectual Property Rights are often stretched and may need reinterpretation and even modification). Intellectual Property is complex and becoming more so as emerging digital technologies advances. This course is intended to be a broad and full survey of main areas and issues of concern associated with Managing Intellectual Property and Intellectual Capital. The course concludes with an examination of how firms can best manage their intellectual capital.

MG 8203 Project Management 2½:0:0:3

Management of technology-based projects ranging from individual research and development to large-scale and complex technological systems. Feasibility and risk analyses. Project selection and portfolio optimization. Functional and administrative structures, coordination and scheduling of activities, personnel planning, negotiations and contracts, cost estimation, capital budgeting, cost controls, effective matrix management. Also listed under CE8203.

MG 8280 Special Immersion Module on Leadership, Global Decision Making and Innovation

The purpose of this Module is to expose Poly MBA students to the most relevant and state-of-the art best practices in modern management, particularly as they relate to technology and innovation management, entrepreneurship, leadership, and global decision making. In this Module the Poly MBA student has direct and continuous contact with leading and forward-thinking practitioners and organizations. This Module may be offered for certain individual students or groups of students in collaboration with institutions abroad. Restricted to Polytechnic MBA students.

MG 8603 Financial Planning and Control 2½:0:0:3

Examines the latest and most relevant approaches for modern financial planning and control. Specific examples of best practices are studied. Topics covered include an overview of financial planning and control, operational-level financial planning and control, management reporting, forecasting, the application of technology and analytics, the relationship between strategic planning and operational-level financial planning and control, the challenges of implementation, and emerging trends in the financial planning and control area. Particular emphasis is placed on trade-offs and balance with regard to the need for financial planning and control and the desire to also have empowerment in modern firms. *Prerequisite: MG6093.*

MG 8643 New Product Development 2½:0:0:3

The dynamics of technology and the pressures of competition are driving enterprises to make their product development and production processes strategically more effective, and economically more efficient in time and cost. Course deals with the state-of-the-art in new product activities for services and manufacturing firms, examining in-depth the marketing, technology, and manufacturing technology linkages.

MG 8653 Managing Technological Change and Innovation 2½:0:0:3

Focuses on the effective management of technological change and innovation, which is accomplished by employing a dual perspective. One perspective is based on individual, group and organizational theory, research and practice. This body of literature, viewpoints, and experience provides essential guides for successfully managing the introduction of new technologies. Realizing the full potential of

new technologies requires effectively managing change to assure the commitment of all stakeholders. The second perspective is based on innovation theory, research, and practice. This body of literature, viewpoints, and experience provides key insights for effectively managing the process of innovation and the impact of innovation on all parts of an enterprise. Specifically, there is explicit consideration of the need within a firm to manage and inspire people so that they can effectively communicate and innovate.

MG 8663 Technology Policy 2½:0:0:3

This course focuses on the macro-environment influencing and relevant to technology decision making, strategy and innovation in firms, government agencies, non-profit institutions and other organizations. Primary concerns include introducing effective approaches for analyzing and evaluating societal-wide factors that influence innovation; assessing various attempts and policies for stimulating innovation in a city, region, nation or on a global basis; exploring the role of technology and innovation in diverse managerial, economic, and social contexts (e.g., advanced economies, rapidly emerging economies and Third World economies); the relationship between business-government and NGOs in promoting and sustaining innovation; the impact of global rivalry and global cooperation in the technology and innovation arena; and the place of technology and innovation in the post-Cold War era and in the early 21st century. Also listed under ST8663.

MG 8673 Technology Strategy 2½:0:0:3

Examines in depth the strategic technological decisions that a general manager faces. From entrepreneurial start-ups to established companies, in dynamic as well as mature environments, there must be a conscious process of formulating and implementing a technology strategy to serve the business interests of the firm. Such a strategy would guide investments in research and development, selection among and timing of alternate technologies, organization and communications, formation of alliances and funding of ventures.

MG 8713 Entrepreneurial Finance 2½:0:0:3

This course focuses on the financial requirements of entrepreneurial ventures and on different sources of finance available to entrepreneurs. The course helps develop an understanding on how to assess various

entrepreneurial financial strategies. The course also examines the unique roles occupied by such factors as retail banks, investment banks, VCs, angels, internal sources of capital, and incubators in the entrepreneurial finance arena.

MG 8723 Managing Growing Enterprises 2½:0:0:3

This course deals with a critical challenge all successful entrepreneurial small or medium-size firms potentially confront: how to sustain and accelerate major growth. At some point in the life of all growing enterprises, a firm usually must change. It can no longer be run in a small-scale and possibly ad hoc and overly responsive fashion. To successfully exploit past success in the marketplace and future attractiveness of innovative products and services such a firm needs to adapt. This course examines the ways a growing firm can transform itself from a smaller to a larger enterprise. In particular, the course focuses on how such companies can maintain the benefits of an entrepreneurial commitment and spirit while still obtaining needed skills associated with professionally managed larger firms. In this way, fast-growing firms can take advantage of innovation-based opportunities while scaling up.

MG 8733 Corporate Entrepreneurship 2½:0:0:3

Although large firms require professional management, to innovate, large corporations also often must practice entrepreneurship. This course focuses on how large corporations nurture and sustain entrepreneurship and on how entrepreneurship is an integral part of a successful large firm's strategy and structure today. Among the topics discussed in this course are forms of internal entrepreneurship, corporate venture capital, and the obtaining of entrepreneurial capabilities via acquisition.

MG 8743 Entrepreneurial Marketing and Sales 2½:0:0:3

This course focuses on critical marketing and sales challenges facing entrepreneurial firms. An underlying theme of this course is that successful innovative enterprises must possess deep familiarity of relevant markets and must be effective in cultivating and reaching such markets. Topics discussed in this course include market identification, segmentation, sales, overall market planning, niche and viral marketing, and customers as sources of innovative ideas.

MG 8763 Knowledge Management 2½:0:0:3

Knowledge workers, who are primarily in professional and technical occupations, increasingly become an important segment of the labor force in the US. The success of innovative organizations today is often a result of the knowledge and skills applied by their professional and technical employees. Effective management of such a work force has become one of the most critical problems faced by organizations in both the private and public sectors. Reflecting this, the course addresses issues relating to the creation, sharing, and application of knowledge in organizations. In the course, we examine knowledge management from various perspectives, focusing primarily on the organizational, managerial, and technological perspectives.

MG 9703 Project in Strategy and Innovation 2½:0:0:3

An integrative course that brings together concepts and theories from a number of individual courses. Usually considers issues from a holistic and top management perspective. Employs case studies and projects in focusing on key interrelationships between strategy, technology, innovation, corporate culture, organization structure, and human factors. Covers domestic and global corporations, large, medium-size, and small firms; and established and new enterprises. *Prerequisite: advanced standing.*

MG 9753 Selected Topics in Management 2½:0:0:3

Current topics in various fields are analyzed and discussed. *Prerequisites: advanced standing and instructor's permission.*

MG 9763 Readings in Management 2½:0:0:3

Directed individual study of supervised readings in advanced areas of management. *Prerequisite: Department Chair's permission.*

Other courses from the Polytechnic University Catalog with advisor's approval.

MATHEMATICS PROGRAM

The Department of Mathematics administers the mathematics degree program. More information can be obtained from the department Website, <http://www.math.poly.edu>, by calling 718/260-3850 or by sending an e-mail to chair@math.poly.edu.

Mathematics comprises abstraction, logic, and quantitative reasoning. It is an indispensable tool for science and engineering. Today, mathematicians are employed by a wide range of companies, including Wall Street investment banks and government agencies, especially the National Security Agency. Polytechnic offers a complete spectrum of mathematics courses leading to bachelor's, master's, and doctoral degrees. The degree programs provide not only a solid foundation in mathematics, but also extensive exposure to how mathematics is used in other fields of science and engineering. The department prides itself on providing each mathematics major, undergraduate or graduate, with extensive individual attention and a program tailored to individual needs.

UNDERGRADUATE PROGRAMS

The undergraduate program in mathematics provides both a background for advanced study or subsequent research in mathematics and training for those students who expect to terminate their formal education with a bachelor's degree.

For science and engineering majors, mathematics provides the theory and methods essential to understanding the mathematical aspects of their respective fields.

With these objectives, the Department of Mathematics offers courses in mathematics and, for the mathematics major, specific programs leading to the Bachelor of Science degree. Students wishing to pursue a bachelor's degree in mathematics may elect to follow either of two courses of study. Students wishing to focus their studies within mathematics or applying mathematics to other fields may elect the program leading to a BS in Mathematics. Students wishing to incorporate extensive physics into their mathematical training may elect the program leading to a BS in Mathematics and Physics. These two programs provide basic grounding in mathematical knowledge.

REQUIREMENTS FOR THE BACHELOR OF SCIENCE

Dept	Courses	Credits
MA	1024/1324, 1124/1424, 2012, 2112, 2122, 2132, 2212, 2222, 2312, 2322, 3012, 3112, 4413, 4423, 4613, 4623	40
CS	1114	4
PH	1004, 2004	8
EN	1014, 1204	8
HI	2104	4
CM	1004	4
	Minor Specialties*	19
	Humanities/Social Science electives	12
	Free electives, with adviser's approval	29
		128

**Minor specialty: at least 9 credits beyond the required courses in a single area of study other than mathematics. The sequence must be well integrated and consistent, thereby enabling the student to gain knowledge in an area other than mathematics. Students should consult the faculty adviser of the department of interest when selecting electives. This requirement may be satisfied by either two minor specialties or one 18-credit specialty. This work must be in addition to courses taken under other categories of the programs (e.g., required courses in physics do not count toward a minor in physics).*

The following are possible minor concentrations:

- Chemical Engineering
- Chemistry
- Computer Engineering
- Computer Science
- Economics
- Electrical Engineering
- Management
- Mechanical Engineering
- Physics
- Psychology
- Statistics
- Technical Writing
- Transportation

DUAL MAJOR IN MATHEMATICS AND PHYSICS

Polytechnic offers undergraduates a dual major in mathematics and physics, according to the general rules described in the section Degree Requirements. Specific course requirements for this 128-credit degree must be approved by advisers from both the mathematics and physics programs. The dual major gives students the opportunity to gain competence in two different and substantial fields of science to such an extent that, upon earning a bachelor's degree, they are able to qualify for industrial positions in two distinct areas or go on to graduate studies in either of the two subjects.

MINOR IN MATHEMATICS

Students may obtain a minor in mathematics by taking 15 credits of mathematics courses, 8 credits of which are in addition to the major department's requirement in mathematics. At least 6 of these 8 credits must be taken by students while enrolled at Polytechnic.

GRADUATE PROGRAMS

The Department of Mathematics offers graduate level mathematics courses in analysis, geometry, topology, algebra, applied mathematics. These courses form a major portion of the work for advanced degrees in mathematics. They may also be taken by students in other departments to satisfy minor and elective requirements and by qualified pre-degree students who desire further study in graduate-level mathematics.

The department offers master's and doctoral degrees in mathematics. Departmental requirements for these degrees are supplemented by general requirements for advanced degrees set forth elsewhere in this catalog.

Outstanding students are advised to apply for research fellowships, teaching fellowships or partial tuition remission.

REQUIREMENTS FOR THE MASTER OF SCIENCE

Bachelor's degrees in mathematics are required for admission to this program. Students with degrees in other fields may be admitted, possibly with undergraduate deficiencies, at the discretion of departmental advisers. Before beginning graduate studies, students are expected to have completed a one-year course in advanced calculus.

Thirty credits are required. Six credits may be devoted to a thesis.

Required (core) courses, 12 credits, 3 credits each:

Course No	Course Title	Credits
MA 7033	Linear Algebra I	3
MA 7043	Linear Algebra II	3
MA 6213	Elements of Real Analysis I	3
MA 6223	Elements of Real Analysis II	3

All options: Minimum of 15 credits (total) in mathematics courses.

There are three options for incoming MS students of Mathematics.

Thesis Option:

Electives: 12 credits
Master's Thesis: 6 credits

Requires an examination of the thesis material by faculty advisors and certification that the work is satisfactory.

Total: 30 credits

By Examination Option:

Electives: 18 credits, possibly with up to 9 from approved sub-specialties in other departments.

Includes a comprehensive oral examination before the degree is awarded. Examinations cover the student's program of study and are scheduled towards the end of the semester in which the work is completed.

Total: 30 credits

By Examination Option + Designated Sub-specialty Option

Elective: 18 credits. At least 9 credits in courses approved for specialization by Department.

Includes a comprehensive oral examination before the degree is awarded. Examinations cover the student's program of study and are scheduled towards the end of the semester in which the work is completed.

Total: 30 credits.

REQUIREMENTS FOR THE DOCTOR OF PHILOSOPHY

Requirements for the doctoral degree are primarily qualitative rather than quantitative. All students' programs must have the approval of the guidance committee.

Number of graduate units usually associated to the PhD in mathematics is 60 credits. (course = 3 credits) The courses are to be selected from a well-balanced program in one major and two minor fields. The minor fields are encouraged to be chosen outside the Department of Mathematics, selected from such fields as applied mechanics, financial engineering, control theory, computer science, traffic engineering, and electrical engineering. Thirty-nine credits of course work and at least 21 credits of thesis are required.

Required (core) courses, 12 credits, 3 credits each:

Course No	Course Title	Credits
MA 7033	Linear Algebra I	3
MA 7043	Linear Algebra II	3
MA 6213	Elements of Real Analysis I	3
MA 6223	Elements of Real Analysis II	3

A grade of A is necessary in these required courses for PhD credit (they may be repeated).

Only courses with grades of B or better can be used to satisfy the PhD requirements.

Students are required to pass a Part 0 written examination covering fundamental topics; a Part 1 written examination covering real and complex analysis and linear and abstract algebra, and a Part 2 oral examination on topics chosen by the student and thesis advisor.

After passing the Part 2 examination, the student writes a dissertation under the supervision of a faculty advisor.

The final requirement for the PhD degree is a public oral exam on the student's dissertation.

Students must demonstrate the ability to read mathematical text written in French, German, or Russian.

UNDERGRADUATE COURSES

MA 0902 Introduction to Precalculus 4:0:0:2

Foundations of Algebra: exponents, multiplication of algebraic expressions, factoring algebraic expressions, working with algebraic fractions, proportionality, rates of change, equation of a line, completing squares, the quadratic formula, solving equations, system of linear equations, inequalities, domain and range of functions. *Prerequisite: placement exam.*

Note: credit for this course may not be used to satisfy the minimum credit requirement for graduation.

MA 0912 Precalculus A 4:0:0:2

Exponential and logarithmic functions, transformations of functions; trigonometric identities. *Prerequisite: placement exam.*
Note: credit for this course may not be used to satisfy the minimum credit requirement for graduation.

MA 0914 Precalculus 4:0:0:4

Foundations of algebra: exponents, multiplication of algebraic expressions, factoring algebraic expressions, working with algebraic fractions, proportionality, rates of change, equation of a line, completing squares, the quadratic formula, solving equations, sys-

tems of linear equations, inequalities, domain and range of functions, exponential and logarithmic functions, compositions, transformations of functions, right triangles, trigonometry of triangles. *Prerequisite: placement exam.* *Note: credit for this course may not be used to satisfy the minimum credit requirement for graduation.*

MA 1024 Calculus I / MA 1324 Integrated Calculus I 4:0:0:4 / 4:0:2:4

Library of Functions: functions of one variable. Limits, derivatives of functions defined by graphs, tables and formulas, differentiation rules for power, polynomial, exponential and logarithmic functions, derivatives of trigonometric functions, the product and quotient rule, the chain rule, applications of the chain rule, maxima and minima, optimization. MA 1324 is designed for students who wish to take MA 1024 but need more review of precalculus. MA1324 covers the same material as MA1024 but with more contact hours a week, incorporating a full discussion of the required precalculus topics. *Prerequisite: Placement Exam or MA 0912 or MA 0914.*

MA 1054 Calculus I with Precalculus 4:0:0:4

Limits, definition of the derivative, differentiation rules for power, polynomial and trigonometric functions, applications of the chain rule and introduction to optimization. This Calculus I course provides an in-depth review of precalculus. *Prerequisite: Placement exam or Equivalent.*

MA 1114 Mathematics for Liberal Studies 4:0:0:4

Management Science - Euler Circuits, Hamiltonian Circuits, Traveling Salesman Problem, Scheduling Tasks; Coding Information - Zip Codes, Bar Codes, Binary Codes, Cryptography; Social Choice and Decision Making - Elections with only two alternatives, three or more alternatives, weighted voting systems; Fair Division - The Adjusted Winner Divorce Procedure, Cake-Division schemes; Consumer Finance Models - Models for savings, arithmetic and geometric growth, compound interest, the number e.

Note: this course applies only to the LS degree. Credit for this course may not be used to satisfy the minimum credit requirement for graduation.

MA 1124 Calculus II /MA 1424 Integrated Calculus II 4:0:0:4 / 4:0:2:4

Definite integrals, theorems about integrals, anti-derivatives, second fundamental theorem of calculus, techniques of integration, introduction to ordinary differential equations, improper integrals, numerical methods of integration, applications of integration, sequences, series, power series, approximations of functions via Taylor polynomials, Taylor series.

MA 1424 is designed for students who wish to take MA 1124 but need more review of precalculus. MA 1424 covers the same material as MA 1124 but with more contact hours a week, incorporating a full discussion of the required precalculus topics.

Prerequisites: For MA 1124: MA 1024 or MA 1324; for MA 1424: MA 1324 or MA 1322 or MA 1024 or MA 1022.

Note: credit for this course may be used to satisfy the minimum credit requirement for graduation.

MA 1154 Calculus II with Precalculus 4:0:0:4

Using the first and second derivative, optimization problems, antiderivatives, fundamental theorem of calculus, techniques of integration, logarithmic and exponential functions, numerical methods of integration, applications of integration, introduction to differential equations, introduction to series. This Calculus II course provides an in-depth review of precalculus. *Prerequisite:* MA 1054.

Note: Course required only for special Majors.

MA 1132 Numerical Methods for Calculus 4:0:0:2

Parametrized family of curves. Elementary Numerical Analysis. Introduction to differential equations. Solution of first and second order linear differential equations with constant coefficients. Use of mathematical software to solve differential equations. Fourier series. *Prerequisite:* AP credit or transfer credit for Calculus I and II.

MA 1252 Calculus for Business & Life Sciences IIA 4:0:2:2

Antidifferentiation, the definite integral, integration by substitution, The Fundamental Theorem of Calculus, Area between curves, average value, integration by parts, introduction to differential equations, improper integrals, numerical integration. *Prerequisite:* MA 1054 or MA 1152.

MA 2012 Elements of Linear Algebra I 4:0:0:2

Introduction to vector concepts. Linear transformations. Matrices and Determinants. Characteristic roots and eigenfunctions. *Prerequisite:* MA 1124 or equivalent.

MA 2054 Applied Business Data Analysis I 4:0:0:4

Applications of theories of random phenomena to problems in business management. Topics include probability theory, discrete and continuous probability distributions, sampling, measures of central value and dispersion, sampling distributions, statistical estimation and introduction to hypothesis testing. Use of statistical software is integrated with the previous topics; examples are drawn from problems in business decision-making. Applications to advanced statistical applications in business management.

Emphasis placed on application of concepts. Use of statistical software integrated with the previous topics. *Prerequisite:* MA 1054 or equivalent. *Note:* This course applies to Management. Credit for this course may not be used to satisfy the requirements for other majors.

MA 2112 Multivariable Calculus A 4:0:0:2

Introduction to Multivariable Calculus. Analysis of functions of several variables, vector valued functions, partial derivatives, and multiple integrals. *Prerequisite:* MA 2012.

MA 2122 Multivariable Calculus B 4:0:0:2

Continuation of Multivariable Calculus. Optimization techniques, parametric equations, line integrals, surface integrals and major theorems concerning their applications. *Prerequisite:* MA 2112.

MA 2132 Ordinary Differential Equations 4:0:0:2

First order differential equations: modeling and solving. Stability of autonomous equations. Higher order linear ordinary differential equations: Solution bases, Wronskian, and initial value problems. Linear system of first order differential equations with constant coefficients: Elimination and eigenvalue method of solution. Elementary concepts of numerical analysis. Numerical solution of initial value problems for ordinary differential equations. *Prerequisites:* MA 2012.

MA 2212 Data Analysis I 4:0:0:2

Basic theory of probability. Random variables. Distributions. Expectation. Functions of a random variable. Descriptive statistics. Data description. Sampling distributions. Use of statistical software is integrated with previous topics. *Prerequisite:* MA 1124 or equivalent.

MA 2222 Data Analysis II 4:0:0:2

Point and interval estimation. Hypothesis testing. Linear regression. One-way analysis of variance. Use of statistical software is integrated with the previous topics. *Prerequisite:* MA 2212.

MA 2312 Discrete Mathematics I 4:0:0:2

Logic and induction. Sets and functions. Recursive definitions. Counting techniques. Inclusion-exclusion principle. *Prerequisite:* MA 1124 or equivalent.

MA 2322 Discrete Mathematics II 4:0:0:2

Recurrence relations and generating functions. Equivalence relations and partial orderings. Graphs and connectivity of graphs. Trees and sorting. Boolean algebra, languages, and finite state machines. *Prerequisite:* MA 2312.

MA 3012 Introduction to Probability I 4:0:0:2

Probability of events. Random variables. Discrete and continuous distributions. Joint distributions. Expectation. Functions of a random variable. Central limit theorem. *Prerequisite:* MA 2112 or equivalent.

MA 3112 Complex Variables I 4:0:0:2

Functions of a complex variable. Derivatives and Cauchy-Riemann equations. Integrals and Cauchy integral theorem. Power and Laurent Series. Residue theory. *Prerequisite:* MA 2122 or equivalent.

MA 3201 Problem Solving and Proofs 3:0:0:3

Mathematical problem-solving, proofs, and innovative reasoning. Discussion of independent challenging problems from Analysis, Complex Analysis, Probability, Combinatorics, Linear Algebra, Number Theory and Graph Theory. *Prerequisites:* MA2312, MA2012

MA 3211 Linear Optimization 3:0:0:3

Linear optimization problems with constraints; optimality conditions and duality theory; the simplex method; complexity of the simplex method; interior point methods; selected applications; network flow problems and the network simplex method. *Prerequisites: MA2312, MA2112*

MA 3914 Reading Seminar in Mathematics I 4:0:0:4

Reading, study, and investigation of selected topics in mathematics. Problem discussions and presentations by participating students. *Prerequisite: approval of departmental adviser.*

MA 4013 Introduction to Number Theory 3:0:0:3

Properties of integers and prime numbers. Congruences. Theorems of Fermat, Euler, and Wilson. Quadratic residues. Diophantine equations. *Prerequisite: MA 1124 or equivalent.*

MA 4023 Elements of Abstract Algebra 3:0:0:3

Basic properties of groups, rings, fields, Euclidean rings, and modules. Field extensions and Galois theory. Finite fields. *Prerequisite: MA 2012.*

MA 4113 Introduction to Mathematical Statistics 3:0:0:3

Standard first course in mathematical statistics, recommended for those planning to take advanced courses in statistics. Sampling distributions, tests of hypotheses, significance tests, point and interval estimation, regression and analysis of variance. *Prerequisite: MA 3012.*

MA 4123 Statistical Methods 3:0:0:3

Analysis of variance with simple experimental designs. Sampling procedures, including sequential analysis. Nonparametric statistical methods. Statistical decisions. *Prerequisite: MA 4113.*

MA 4413 Partial Differential Equations 3:0:0:3

Modeling of physical processes. Classification of equations. Formulation and treatment of boundary- and initial-value problems. Green's functions. Maximum principle. Separation of variables. Fourier series and integrals. Quasilinear first-order

equations and characteristics. D'Alembert solution of wave equation. Conservation laws and shock waves. *Prerequisite: MA 2122 and MA 2132.*

MA 4423 Introductory Numerical Analysis 3:0:0:3

Polynomial interpolation and approximation of functions. Divided differences. Least-squares data fitting, orthogonal polynomials. Numerical differentiation and integration. Solution of nonlinear equations. Gaussian elimination, pivoting, iterative refinement, conditioning of matrices. Numerical solution of ordinary differential equations. *Prerequisites: MA 2132 and some experience in computer programming.*

MA 4433 Complex Variables 3:0:0:3

Functions of a complex variable. Derivatives and Cauchy-Riemann equations. Integrals and Cauchy integral theory. Power and Laurent series. Residue theory. Conformal mappings. Schwarz-Christoffel transformations. *Prerequisite: MA 2122 and MA 2132.*

MA 4613 / 4623 Analysis I/II each 3:0:0:3

Study of basic topics in analysis with emphasis on methods. Sequences, series, functions, uniform convergence, continuity, partial differentiation, extreme value problems with constraints, Riemann integrals, line integrals, improper integrals, integrals with parameters, transformations, Riemann-Stieltjes integral, uniform and absolute convergence of integrals. Beta and Gamma functions. *MA 4613 prerequisite: MA 2122 and MA 2132. MA 4623 prerequisite: MA 4613. Note: This course is required for MA minors.*

MA 4924 Reading Seminar in Mathematics II 4:0:0:4

Reading, study and investigation of selected topics in mathematics. Problem discussions and presentations by participating students. *Prerequisite: departmental adviser's approval. Note: this course is required for MA minors.*

GRADUATE COURSES

MA 5313 Applied Mathematics in Engineering and Science I 3:0:0:3

Use of matrix algebra techniques in applications. Vector spaces. Solutions of linear algebraic equations. Linear independence. Rank of matrix. Linear transformations. Orthogonality. Gram-Schmidt procedure. Orthogonal matrices. Eigenvalues and eigenvectors.

Spectral decomposition. Similarity transformations. Pseudoinverses. Singular value decomposition. Jordan form. Condition numbers of matrices. Iterative methods for eigenvalues of symmetric matrices. *Prerequisite: MA 2122 and MA 2132 or equivalent. Note: Not acceptable for graduate credit in the Department of Mathematics*

MA 5323 Applied Mathematics in Engineering and Science II 3:0:0:3

Some common partial differential equations, boundary conditions, separation of variables. Wave equation, diffusion equation, Laplace equation. Axial symmetry and spherical symmetry. Adjoint operators and Sturm-Liouville problems. Expansions in orthogonal eigenfunctions. Method of Frobenius. Bessel functions. Integral representations. Asymptotic expansions. Legendre polynomials. Spherical harmonics. Spherical Bessel functions. *Prerequisite: MA 5313 Co-Requisite: None Note: Not acceptable for graduate credit in the Department of Mathematics*

MA 5413 Stringology: Mathematics of String Comparisons in Computational Biology 3:0:0:3

The course addresses basic combinatorial problems of string manipulation, string matching, string editing, string distance computations, arising from areas of text processing, computational biology, and genomics. Classical, modern, and entirely new approaches to these problems will be presented with all necessary mathematical and computer science backgrounds (including coding theory and symbolic manipulation). Emphasis is on practical and effective algorithm implementations. *Prerequisite: none Co-Requisite: none*

MA 6003 Elements of Discrete Mathematics 3:0:0:3

Logic, sets, and functions, algorithms, analysis of algorithms. Mathematical models, primitives of naïve set theory. Mathematical reasoning, methods of proof, mathematical induction, recursive definitions, recursive algorithms, Counting, the Pigeonhole principle, discrete probability, recurrence relations, generating functions, inclusion-exclusion. Introduction to graph theory, counting and algorithm analysis, relations, graphs, Boolean algebras, circuits. Turing Machines, algorithm complexity. Introduction to algebraic structures. *Prerequisite: Adviser's approval Co-Requisite: none*

MA 6013 Applied Matrix Theory I 3:0:0:3

Basics of linear algebra and matrix theory. Topics included: Vector Spaces, linear combinations, affine combinations, linear dependence, affine dependence, bases, dimension, isomorphism, subspaces, calculus of subspaces, dimension of subspaces, dual vector spaces and dual bases, direct sums of vector spaces, quotient spaces, bilinear forms, tensor products, permutations, cycles, parity, linear transformations, transformations as vectors, polynomials, inverses, matrices, matrices associated with linear transformations, invariance, reducibility, projections, adjoints, change of basis, similarity. *Prerequisite: MA 2012 and MA 2122 or equivalent Co-Requisite: none*

MA 6023 Applied Matrix Theory II 3:0:0:3

Sequel to MA 6013, basics concepts of linear algebra and matrix theory. Linear mappings, their range and null spaces, tensor product of transformations, determinants, eigenvalues, multiplicities, triangular form, nilpotence, Jordan form, inner products, inner product spaces, orthogonality, completeness Schwarz's inequality, complete orthonormal sets, the projection theorem, linear functionals, self-adjoint transformations, polarization, positive transformations, isometries, change of orthonormal basis, characterization of spectra, the spectral theorem, normal transformations orthogonal transformations, functions of transformations, polar decomposition, commutativity. Applications for matrices and for differential equations. *Prerequisite: MA 6013 Co-Requisite: none*

MA 6103 Graph Theory 3:0:0:3

Graphs and digraphs, subgraphs, paths, cycles, trees and forests. Contraction and minors. Vertex-connectivity and edge-connectivity. Structure of k-connected graphs. Menger's theorem. Planar graphs, drawings and embeddings. Graph colorings: vertex-coloring, edge-coloring, list-coloring. Perfect graphs. Network flows, Ford-Fulkerson Theorem. Matching, Packing, and Covering. Ramsey theory. Extremal graph theory, Szemerédi's regularity lemma. Hamilton cycles. Random graphs. The probabilistic method. Tree-decompositions, tree-width. The graph minor theorem. *Prerequisite: MA 6003 or adviser's approval Co-Requisite: none*

MA 6123 Queuing Theory 3:0:0:3

Steady-state solutions for single and multiple channels. Various arrival and service distributions and queuing disciplines. Transient solutions. Emphasis on theory, with solution techniques given for specific classes of queues. *Prerequisite: MA 6003 or adviser's approval Co-Requisite: none*

MA 6133 Elements of Number Theory 3:0:0:3

Prime numbers, the fundamental theorem of arithmetic, linear Diophantine equations. Fermat's Little Theorem, Wilson's Theorem, Euler's theorem. Linear congruences, Chinese Remainder Theorem, Euler phi function, Moebius inversion. Primitive roots and indices, quadratic congruences, Quadratic reciprocity law. Perfect numbers, sums of squares, Siegel's theorem. The prime number theorem. Computational number theory, primality testing, Cryptography. Elliptic curves. *Prerequisite: MA 6003 or adviser's approval Co-Requisite: none*

MA 6143 Optimization: Linear and Nonlinear Programming 3:0:0:3

Theory and application of linear programming techniques. Simplex and revised simplex algorithms. Duality theory, dual simplex method, post-optimality analysis. Degeneracy. Transportation and assignment problems. Quadratic programming, Kuhn-Tucker conditions. Wolfe's method. *Note: Cross listed CS 9193 Prerequisite: MA 6003 or adviser's approval Co-Requisite: none*

MA 6213 Elements of Real Analysis I 3:0:0:3

This course and its sequel MA6223 provide a rigorous treatment of the basic concepts and results in real analysis. The topics of the course include limits of sequences, topological concepts of sets for real numbers, properties of continuous functions and differentiable functions. Important concepts and theorems include supremum and infimum, Bolzano-Weierstrass theorem, Cauchy sequences, open sets, closed sets, compact sets, topological characterization of continuity, intermediate value theorem, uniform continuity, mean value theorems, and inverse function theorem. *Prerequisite: MA 2122 or permission of advisor Co-Requisite: none*

MA 6223 Elements of Real Analysis II 3:0:0:3

This course is a continuation of MA 6213. The topics are integration, series of real numbers, sequences and series of functions, and Fourier series. Important concepts and theorems include Riemann and Riemann-Stieltjes integral, fundamental theorem of calculus, the mean value theorem of integrals, Dirichlet test, absolute and conditional convergence, uniform convergence, Weierstrass test, power series, orthogonal functions, and Fourier series. *Prerequisite: MA 6213 Co-Requisite: none*

MA 6243 Theory of Ordinary Differential Equations I/II each 3:0:0:3

Ordinary differential equations. Existence and uniqueness theorems. Linear systems. Isolated singularities. Self-adjoint eigenvalue problems. Geometric theory of differential equations in the plane. *Prerequisite: MA 6213 and MA 6223, MA 6233 for MA 6243, Co-Requisite: none*

MA 6253/ MA 6263 Theory of Partial Differential Equations I/II each 3:0:0:3

Partial differential equations. Cauchy-Kowalewski theorem. First-order differential equations, systems of differential equations in two variables, characteristics and classification, hyperbolic, parabolic and elliptic systems. Well-posedness. *Prerequisites: MA 6213 and MA 6223, MA 6253, MA 6263, Co-Requisite: none*

MA 6283 Mathematical Modeling in Biology 3:0:0:3

Linear and nonlinear difference equations for population growth and propagation. Stability. Competitive systems. Growth of microorganisms. Steady states in chemostats. Predator-prey models. Populations of infectious diseases. Michaelis-Menten kinetics. Cooperative reactions. Hodgkin-Huxley equations. Fitzhugh-Nagumo model of nerve impulses. Conservation equations. Convection and diffusion of species. Transport in axon. Slime molds. Aggregation. Morphogenesis. *Prerequisite: MA 2122, MA 2132 Co-Requisite: none*

MA 6303 Elements of Complex Analysis 3:0:0:3

Complex numbers, analytic functions, Cauchy's theorem and consequences, isolated singularities, analytic continuation, open mapping theorem, infinite series and products, harmonic and subharmonic functions, maximum principle, fractional linear transformations, geometric and local properties of analytic functions, Weierstrass Theorem, normal families, residues, conformal mapping, Riemann mapping theorem, branch points, second order linear O.D.E.'s. *Prerequisites: MA2122 and MA2132 or equivalent Co-Requisite: none Notes: Not open to students who have taken MA3112 or MA4433.*

MA 6313 Applications of Complex Analysis 3:0:0:3

Continuation of MA 6303. Residues, complex integration, Laplace transforms, Harmonic functions and classical examples from thermodynamics, electricity and magnetism, fluid flow, The Schwarz-Christoffel transformation. *Prerequisites: MA 6303 Co-Requisite: none*

MA 6403 Elements of Geometry and Topology 3:0:0:3

Differential geometry in the plane. Introduction to transformation groups. Space curves and ruled surfaces. Tensors and exterior forms. Manifolds and tensor fields. Theory of surfaces. Introduction to Riemannian geometry. *Prerequisite: MA2122 and MA2132 or equivalent Co-Requisite: none*

MA 6513 Applied Statistics I (Data Analysis) 3:0:0:3

Treatment of statistical methods and application to analysis of data, fitting of functions to data. Estimation of population parameters, t-tests, chi square tests, rank tests. *Prerequisite: MA1124 or equivalent Co-Requisite: none*

MA 6523 Regression-Analysis of Variance-Time Series Analysis 3:0:0:3

Discussion of models and computational schemes associated with correlation, regression coefficients, analysis of variance and time series models. *Prerequisite: MA 4113 or MA 6513 Co-Requisite: none*

MA 6583 Calculus of Variations 3:0:0:3

Classical problems, such as geodesics, brachistochrones, isoperimetric problems. Euler equations. Geodesic coverings. Weierstrass condition. Hamilton-Jacobi equation. First and second variations. Transversality. Convex sets and functions. Duality. Existence theorems. Generalized curves. Control theory. Time-optimal problems. Optimal processes. Extension of elementary theory of maxima and minima. Euler equations, conditions of Weierstrass, Legendre, and Jacobi; Mayer fields; Hamilton-Jacobi equations; transversality; conjugate and focal points. Applications to geodesics, minimal surfaces, isoperimetric problems, Hamilton's principle, Fermat's principle, brachistochrones. *Prerequisite: MA 4623 or MA 6223 Co-Requisite: none*

MA 6653 Numerical Analysis 3:0:0:3

Interpolation. Approximation of functions by polynomials. Fast Fourier transform. Numerical integration. Solution of nonlinear equations. Iterative improvement of solutions of linear equations. Eigenvalues of matrices. Numerical solution of ordinary differential equations. *Prerequisites: MA 2122, MA 2132 and some experience in computer programming Co-Requisite: none*

MA 6663 Numerical Solution of Partial Differential Equations 3:0:0:3

Stability, consistency, and convergence of finite-difference methods for initial-value problems. Explicit and implicit schemes. Alternating direction methods and fractional-step methods. Iterative solutions of finite-difference equations for elliptic boundary value problems. Finite elements. Integral equation methods. Nonlinear semigroups, conservation laws, and level set methods. *Prerequisites: MA 6013, MA 6653 and some experience in computer programming. Co-Requisite: none*

MA 6683 Partial Differential Equations of Mathematical Physics 3:0:0:3

First and second order partial differential equations and systems of equations. Initial and boundary value problems. Fundamental solutions and Green's functions. Theory of characteristics. Eigenvalue problems. Rayleigh-Ritz and Ritz-Galerkin methods. Approximate and asymptotic methods. Nonlinear equations. Applications. *Prerequisite: MA4623 or equivalent Co-Requisite: none*

MA 6813 Elements of Probability 3:0:0:3

Probability of events, distribution of random variables, joint distribution, transformations. *Prerequisite: MA2122, MA 2132 and MA 3012 or equivalent Co-Requisite: none*

MA 6823 Stochastic Processes 3:0:0:3

Normal and stationary processes, Wiener processes, Poisson and renewal processes, Markov processes. *Prerequisite: MA 6813 or equivalent Co-Requisite: none*

MA 6833/6843 Statistical Inference I/II each 3:0:0:3

Point and interval estimation of statistical parameters. Theory of statistical estimators. Fundamentals of statistical tests of hypotheses. Second semester: extended theory of hypothesis testing, including sequential tests. Non-parametric methods in statistics. *MA 6833 Prerequisite: MA6813 or equivalent; MA 6843 Prerequisite: MA 6833 Co-Requisite: none*

MA 6853 Multivariate Analysis 3:0:0:3

Multivariate normal distribution. Simple, partial, and multiple correlation. Generalization of student's ratio. Tests of significance of sets of means. Tests of general linear hypothesis. Some generalizations of analysis of variance. *Prerequisite: MA 6843 Co-Requisite: none*

MA 6863 Regression and Analysis of Variance 3:0:0:3

Linear regression of one or more independent variables. Least square estimates regression coefficients. Gauss-Markov theorem. Confidence regions for and tests of hypotheses about regression coefficients. Tests of general linear hypothesis. Multiple classification in analysis of variance. Power of F-test. Alternative models: I and II, mixed models, analysis of covariance and components of variance. *Prerequisite: MA 6843 Co-Requisite: none*

MA 6873 Nonparametric Methods in Statistics 3:0:0:3

Statistical methods not bound by assumption of known parametric form of the distribution of observations. Applications to engineering and scientific research in which observations are not ordered on a numerical scale. Order statistics, tolerance regions, permutation tests, goodness of fit tests, limiting distributions and large-sample properties of tests. *Prerequisite: MA6813. Co-Requisite: none*

MA 6913 / MA 6923 Time Series Analysis I/II each 3:0:0:3

Careful study of tractable models for statistical analysis of scalar time series. Models treated: (1) “error plus trend” models, (2) stationary stochastic process models with special emphasis on autoregressive models. Estimation, tests of hypotheses, and multiple-decision procedures for these models. Spectral representation and filtering, estimation of spectral density. *MA 6913 Prerequisite: MA 6813 and MA 6843. MA 6923 Prerequisites: MA 6913 Co-Requisite: none*

MA 7013 Abstract Algebra 3:0:0:3

Basic algebraic structures, groups, rings, fields, integral domains, and modules. Field extensions and Galois theory. *Prerequisite: MA 6013 or equivalent Co-Requisite: none*

MA 7033 Linear Algebra I 3:0:0:3

Basic ideas of linear algebra: Fields, vector spaces, basis, dependence, independence, dimension. Relation to solving systems of linear equations and matrices. Homomorphisms, duality, inner products, adjoints, and, similarity. *Prerequisites: MA 2012 and MA 2122 or equivalent Co-Requisite: none*

MA 7043 Linear Algebra II 3:0:0:3

Continuation of MA 7033. Basic concepts of linear algebra continuing with: Range, nullity, determinants and eigenvalues of matrices and linear homomorphisms, the polar decomposition and spectral properties of linear maps, orthogonality, adjointness, and its applications. *Prerequisite: MA 7033. Co-Requisite: none*

MA 7213 Real and Complex Analysis I 3:0:0:3

This course provides a rigorous and comprehensive treatment of real analysis. The topics of the course are outer measure, Lebesgue measure, Lebesgue integral, convergence theorems, functions of bounded variation, integration in measure spaces, the Radon-Nikodym Theorem, and Fubini’s theorem. *Prerequisites: MA6213 and MA 6223 or equivalent. Co-Requisite: none*

MA 7223 Real and Complex Analysis II 3:0:0:3

Continuation of MA 7213: This course provides a rigorous and comprehensive treatment of complex analysis. It covers analytic and meromorphic functions, differentiation

and integration, Cauchy’s theorem, Morera’s theorem, Power and Laurent series, residue theory, Rouché’s theorem, conformal mappings, the Riemann mapping theorem, and Riemann surfaces. *Prerequisite: MA 7213. Co-Requisite: none*

MA 7313 / MA 7323 Functional Analysis I/II each 3:0:0:3

This course, together with its sequel MA 7323, provides an introduction to the language and methods of functional analysis. It covers normed spaces, Hilbert spaces, bounded linear functionals, Hahn-Banach theorem, the dual space, bounded operators, Fredholm theory of compact operators, self-adjoint operators, and applications to classical analysis. *MA 7313 Prerequisite: MA 6013 and MA 7213. MA 7323 Prerequisite: MA 7313. Co-Requisite: none*

MA 7333 Measure Theory I 3:0:0:3

This course presents a unified treatment of that part of measure theory which is most useful for its application in modern analysis. Topics studied include sets and classes, measures and outer measures, measurable functions, integration, general set functions, product spaces, transformations, probability. The dominated convergence theorem, Riesz Representation Theorem, Vitali-Caratheodory theorem, etc. are covered in conjunction with many examples. *Prerequisite: Graduate status*

MA 7343 Measure Theory II 3:0:0:3

Continuation of MA 7333. This course presents a unified treatment of that part of measure theory which is most useful for in application in modern analysis. Fubini’s theorem, convolutions, and distributions are applied to explicit examples. In this part, Baire’s theorem, the Banach-Steinhaus theorem, the Open Mapping theorem, the Hahn-Banach Theorem are derived with the properties of the Radon-Nikodym derivatives to naturally generalize calculus both differential and integral. *Prerequisite MA 7333*

MA 7353 Fourier and Laplace Transforms 3:0:0:3

This course presents in a unified manner the fundamentals of both continuous and discrete versions of the Fourier and Laplace transforms. Application of transform methods to partial differential equations of mathematical physics. Includes introduction to the Wiener- Hopf technique. *Prerequisite: Graduate status or permission of advisor*

MA 7403 Topology 3:0:0:3

Topological spaces. Compactness, connectedness, continua, extension theorems and metrization theorems. Simplexes, simplicial topology and applications. Fixed point theorems. Graphs and networks. Homology and cohomology theory. Introduction to Morse theory. *Prerequisite: MA6213 and MA6223 or equivalent. Co-Requisite: none*

MA 7503 Manifolds and Lie Groups 3:0:0:3

Elementary theory of manifolds. Tangent space, mappings, submanifolds, fields, fiber bundles, Lie groups, homogeneous spaces. Elements of the theory of connections, Riemannian geometry. Imbedded manifolds. Calculus of variations. Harmonic forms, complex manifolds, and Morse theory. *Prerequisite: MA6213 and MA6223 Co-Requisite: none*

MA 7543 Topological Methods in Analysis 3:0:0:3

Aspects of topological methods and applications to existence theorems in analysis. Use of fixed-point theorems and topological degree to study properties of solutions to ordinary and partial differential equations. No previous courses in topology are required. *Prerequisite: MA4623 or MA6223 Co-Requisite: none*

MA 7603 / MA 7613 Topics in Algebra I/II each 3:0:0:3

Course content varies. In spring of year prior to course offering, a detailed description is posted and mailed to all graduate mathematics students. *Prerequisites: MA 7603: MA 7013 /MA 7613: MA 7603*

MA 7623 / MA 7633 Topics in Linear Algebra I/II each 3:0:0:3

Course content varies. *Prerequisites: MA 7623: MA 7033 and MA7043 / MA 7633 : MA 7623*

MA 7643 / MA 7653 Topics in Real Analysis I/II each 3:0:0:3

Course content varies. *Prerequisites: MA 7643: MA 6213 and MA6223 / MA 7653 : MA 7643*

MA 7663 / MA 7673 Topics in Complex Analysis I/II each 3:0:0:3

Course content varies. *Prerequisites: MA 7663: MA 6303 and MA6313 / MA 7673 : MA 7663*

MATHEMATICS PROGRAM

MA 7683 / MA 7693 Topics in Geometry I/II *each 3:0:0:3*

Course content varies. *Prerequisites:* MA 7683; MA 6403 / MA 7693; MA 7683

MA 7703 / MA 7713 Topics in Topology I/II *each 3:0:0:3*

Course content varies. *Prerequisites:* MA 7703; MA 6403 / MA 7713; MA 7703

MA 7723 / MA 7733 Topics in Applied Mathematics I/II *each 3:0:0:3*

Course content varies. *Prerequisites:* MA 7723; graduate status or permission of advisor / MA 7733; MA 7723

MA 7743 / MA 7753 Topics in Probability I/II *each 3:0:0:3*

Course content varies. *Prerequisites:* MA 7743; MA 6813 / MA 7753 MA 7743

MA 7763 / MA 7773 Topics in Statistics I/II *each 3:0:0:3*

Course content varies. *Prerequisites:* MA 7763; MA 6833 and MA 6843 / MA 7773 MA 7763

MA 7813 Probability *3:0:0:3*

Measure-theoretic foundations of probability. Expectations, distribution functions, characteristic functions. Modes of convergence of random variables and distribution functions. Laws of large numbers. The multidimensional central-limit theorems and related asymptotic expansions. Infinitely divisible distributions. *Prerequisite:* MA 7213 *Co-Requisite:* none

MA 7833 / MA 7843 Stochastic Processes I/II *each 3:0:0:3*

Foundations of stochastic processes. Kolmogorov's extension theorem. Properties of sample paths. Conditional expectation. Martingales. Classes of stochastic processes. Gaussian processes, Markov processes, and others. Second order properties. Stationary processes. Applications. *MA 7833: Prerequisite:* MA 7813. *MA 7843: Prerequisite:* MA 7833, *Co-Requisite:* none

MA 8003 / MA 8013 Advanced Topics in Discrete Mathematics I/II *each 3:0:0:3*

Course content varies. In spring of year prior to course offering, a de-tailed description is posted and mailed to all graduate mathematics students. *Prerequisite:* MA 6003 / MA 8013; MA 8003, *Co-Requisite:* none

MA 8023 / MA 8033 Advanced Topics in Algebra I/II *each 3:0:0:3*

Course content varies. *Prerequisite:* MA 7033 and MA 7043 / MA 8033 : MA 8023 *Co-Requisite:* none

MA 8043 / MA 8053 Advanced Topics in Real Analysis I/II *each 3:0:0:3*

Course content varies. *Prerequisite:* MA 6213 and MA 6223 / MA 8053 : MA 8043, *Co-Requisite:* none

MA 8063 / MA 8073 Advanced Topics in Linear Algebra I/II *each 3:0:0:3*

Course content varies. *Prerequisite:* MA 6303 and MA 6313 / MA 8073 : MA 8063, *Co-Requisite:* none

MA 8103 / MA 8113 Advanced Topics in Complex Analysis I/II *each 3:0:0:3*

Course content varies. *Prerequisite:* MA 7213 and MA 7223, *Co-Requisite:* none

MA 8123 / MA 8133 Advanced Topics in Geometry I/II *each 3:0:0:3*

Course content varies. *Prerequisite:* MA 6403, *Co-Requisite:* none

MA 8143 / MA 8153 Advanced Topics in Topology I/II *each 3:0:0:3*

Course content varies. *Prerequisite:* MA 7403, *Co-Requisite:* none

MA 8163 / MA 8173 Advanced Topics in Applied Mathematics I/II *each 3:0:0:3*

Course content varies. *Prerequisite:* MA 6003, *Co-Requisite:* none

MA 8183 / MA 8193 Advanced Topics in Probability I/II *each 3:0:0:3*

Course content varies. *Prerequisite:* MA 6813, *Co-Requisite:* none

MA 8203 / MA 8213 Advanced Topics in Statistics I/II *each 3:0:0:3*

Course content varies. *Prerequisite:* MA 6833 and MA 6843 , *Co-Requisite:* none

MA 8383 Advanced Topics in Differential Equations *3:0:0:3*

Course content varies. *Prerequisite:* MA 6233 and MA 6243, *Co-Requisite:* none

MA 8583 Advanced Topics in Differential Geometry *3:0:0:3*

Course content varies. *Prerequisite:* MA 6403, *Co-Requisite:* none

MA 9413-9463 Reading in Mathematics I-VI *3:0:0:3*

Reading done under guidance of faculty members and devoted mainly to scholarly papers. *Prerequisite:* Department's permission *Co-Requisite:* none

MA 9583/9593 Selected Topics in Advanced Mathematics I/II *each 3:0:0:3*

Review of current mathematics research. Specific topics vary, depending on instructor. *Prerequisite:* Department's permission *Co-Requisite:* none

MA 9973 Thesis for Master of Science Degree *3:0:0:3*

Thesis to present results of independent investigation of suitable problem in mathematics. Study must include adequate investigation of existing literature relating to subject. Regular reports on progress of work and regular conferences with assigned faculty adviser required. *Note: Re-registration fee, any part: 3-credit charge. Prerequisite:* Degree status, *Co-Requisite:* none

MA 9993 Dissertation for Doctor of Philosophy Degree *3:0:0:3*

Results of independent investigation of some problem in mathematics. The student must demonstrate ability to do creative work and include original research of the caliber deemed worthy of publication in recognized scientific journals. An oral examination on the dissertation subject and related topics is required. *Note: Re-registration fee, any part: 3-credit charge. Prerequisite:* Degree status and qualifying examination. *Co-Requisite:* none

Typical Course of Study for the Bachelor of Science in Mathematics

FRESHMAN YEAR

Fall Semester

Course No.	Course Title	Hours/Week			
		Class	Lab.	Rec.	Cr.
MA1024	Calculus I ¹	4	0	0	4
CS1114	Intro. to Programming & Problem Solving	3	3	0	4
CM1004	General Chemistry	3	2	1	4
EN1014	Writing & Humanities I ²	4	0	0	4
SL1010	Freshman Seminar	1	1	0	0
					16

Spring Semester

Course No.	Course Title	Hours/Week			
		Class	Lab.	Rec.	Cr.
MA1124	Calculus II	4	0	0	4
PH1004	Introductory Physics I	4	1?	1	4
EN1204	Writing & Humanities II ²	4	0	0	4
					16

SOPHOMORE YEAR

Fall Semester

MA2012	Linear Algebra I (? semester)	4	0	0	2
MA2132	Ordin. Diff. Equations (? semester)	4	0	0	2
PH2004	Introductory Physics II	4	1?	1	4
HI2104	Modern World History	4	0	0	4
					16

Spring Semester

	Multi. Calculus A (? semester)	4	0	0	2
	Multi Calculus B (? semester)	4	0	0	2
	Discrete Math. I (? semester)	4	0	0	2
	Discrete Math. II (? semester)	4	0	0	2
	HU/SS Elective ³	4	0	0	4
					16

JUNIOR YEAR

Fall Semester

MA3012	Intro. to Probability I (? semester)	4	0	0	2
MA3112	Complex Variables I (? semester)	4	0	0	2
	HU/SS Elective ³	4	0	0	4
MA3201	Problem Solving	3	0	0	3
					15

Spring Semester

	Data Analysis I (? semester)	4	0	0	2
	Data Analysis II (? semester)	4	0	0	2
	HU/SS Elective ³	4	0	0	4
	Linear Optimization	3	0	0	3
					15

SENIOR YEAR

Fall Semester

	Partial Differential Equations	3	0	0	3
	Analysis I	3	0	0	3
	Math. Substitute ⁵	4	0	0	4
					3
					4
					17

Spring Semester

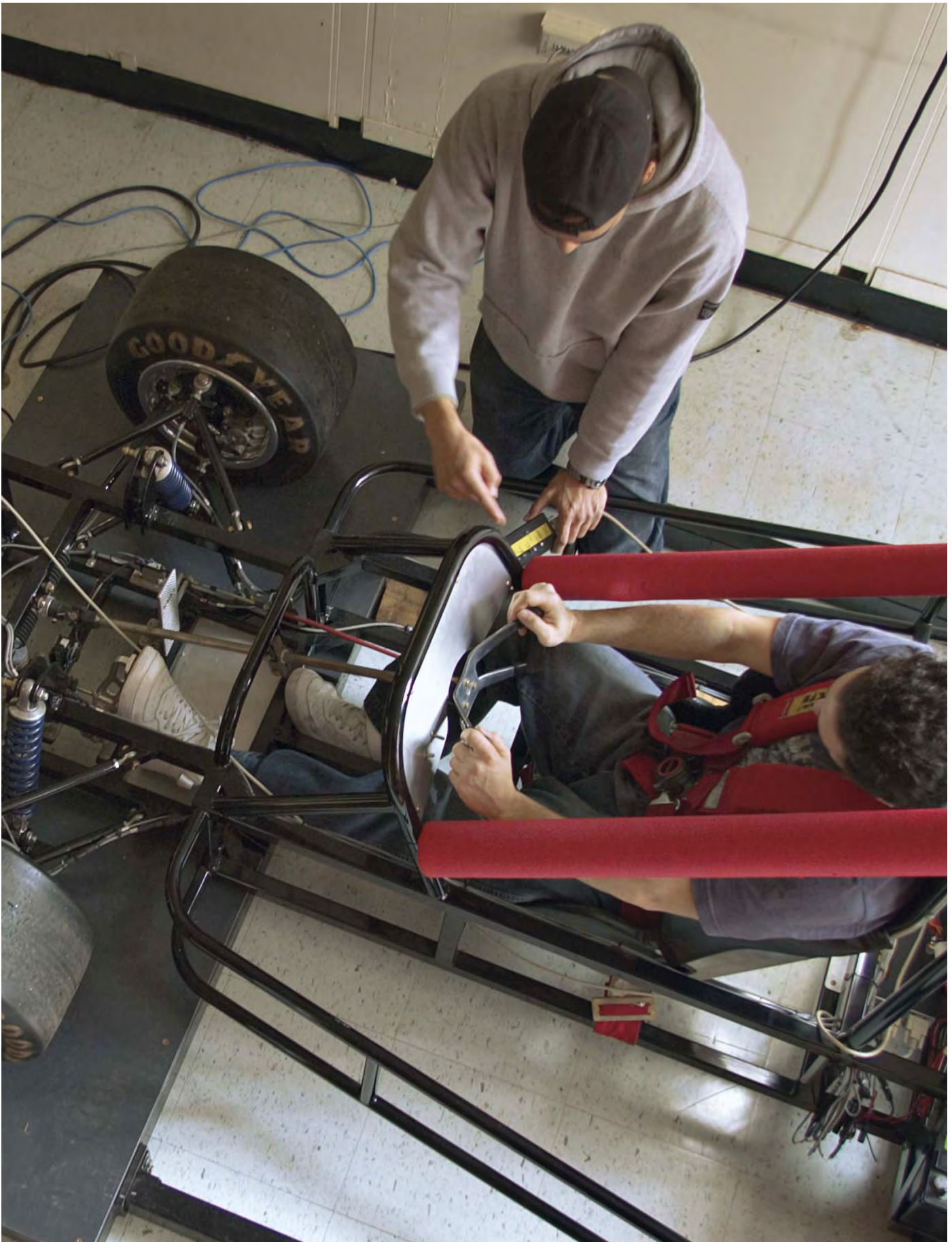
	Intro. Numerical Analysis	3	0	0	3
	Analysis II	3	0	0	3
	Math. Substitute ⁵	4	0	0	4
					7
					17

Total credits required for the degree:

128

1. Students who are placed by examination or by an adviser into MA0902, MA0912 or MA0914 must defer registration for MA1024.
2. Students who are placed by examination or by an adviser into EN1080 must subsequently register for EN1034, rather than EN1014.
3. Approved HU/SS electives are courses with the following prefixes: AH, AN, EC, EN, HI, MU, PL and PS. Two courses must be from Level II Elective courses in different disciplines and one from Level III Advanced Elective courses.
4. The Free Elective can be a course offered by any department, provided it does not duplicate material studied in other courses. Students must meet the prerequisites for the courses.
5. Graduate level Math Substitute can be chosen from EL, CS, MA or ME.

*Course may be accepted for graduate credit in department other than Mathematics.



MECHANICAL ENGINEERING PROGRAM

Program Director: Richard S. Thorsen

The BS in Mechanical Engineering can be completed both in a fulltime or part-time schedule. Students choosing the Co-Op Program are accommodated. There is no evening program, and as a result, part-time students take the same classes as full-time students. Transfer students are welcome and are required to meet the minimum residence requirements set by the University. There are pre-planned programs or articulation agreements with several colleges to ease the transfer. The Office of Admissions should be consulted for details. Polytechnic offers graduate degrees Master of Science and Doctor of Philosophy in Mechanical Engineering. For each level, the student must choose one of three specialty areas:

- (1) Mechanical Analysis and Design
- (2) Systems, Controls and Robotics
- (3) Thermal and Fluid Systems

All mechanical engineering graduate degrees are offered to both fulltime and part-time students at the Brooklyn campus.

MECHANICAL ENGINEERING PROFESSION

Mechanical Engineering is a dynamic and continually evolving profession and the most diverse among the engineering disciplines. Mechanical engineers invent, innovate and create the physical systems and devices that define modern society. These include automobiles to air conditioning, robots to power plants, people movers to artificial limbs and rocket engines to communications satellites. Mechanical engineering also has a long tradition of leadership in helping to develop the natural environment by breaking new ground in such areas as resource conservation, improved efficiency of energy-consuming devices, development of codes for safety in a technology dependent society, new energy sources and the like. Undergraduate and graduate programs in mechanical engineering are designed primarily to develop talents in such areas as design of components, fluid and thermal systems, controls and robotic systems, and computer integrated mechanical and electromechanical systems. However, many graduating students eventually apply their training to the additional diversified fields of computer engineering, nanotechnology, software development, financial engineering, bioengineering, manufacturing, astronautics, systems engineering, and corporate management and law. As students

mature and realize their abilities, they are prepared to invent and innovate new approaches and designs which become the bases for entrepreneurial ventures. For others their professional lives may center on engineering research, government, business or education.

AEROSPACE ENGINEERING PROFESSION

Aerospace engineering is the art and science associated with the design and performance of aircrafts, missiles and spacecraft. The scientific aspects of aircraft and spacecraft design are rooted in the broad areas of the flow of liquids and gases, strength and stability of extremely lightweight structures, propulsion, guidance and control, materials, environmental conditions, thermodynamics and heat transfer.

Vehicles currently being designed or projected for the future challenge the imagination and current base of knowledge and practice pointing terms of the complexity, scope of engineering and scientific challenges and audacity of the mission. Long range missiles, moon vehicles, deep space probes and space habitats once confined to the realm of science fiction are now realities.

To meet these design challenges, aerospace engineers must understand the scientific principles that give them the greatest possible potential, flexibility, and reliability. Conflicting requirements imposed by such considerations as safety, reliability, cost, maintenance, production, and handling often demand compromises to attain optimum design. Aerospace engineers are responsible to resolve such issues. An ability to push the boundaries of knowledge and lead teams of specialists to achieve mission-specific goals are the hallmark of aerospace engineers.

UNDERGRADUATE PROGRAM

The mechanical engineering curriculum achieves balance between principle and practice. Computer and laboratory experiences are an integral part of the curriculum, as is the emphasis on engineering design both the systematic process of design, as well as innovation and creative content. Three aspects of design addressed through the course content are

- (1) the concept of design and the corresponding concept of multiple

- solutions,
- (2) the process of design and
- (3) the tools and skills for design.

The first includes both the creative element and project work, at least when the problem does not have a unique solution. The second includes introduction to the systematic process, as represented by concurrent engineering, quality management and the product realization process, as well as other concepts that set the framework for modern design. The third includes design tools, such as CAD and finite element analysis, as well as the underlying engineering theory for designing and analyzing components and systems.

The integrated design exposure and experience in the curriculum is described as follows: freshman year, students take EG 1004 Introduction to Engineering and ME 1012 Introduction to Mechanical Engineering learn how things are built and why, discuss ethics in engineering, be introduced to computer aided drafting tools and work in team projects. Sophomore year, students take ME 2213 Statics and ME 2211 Statics Laboratory to enhance the understanding of static equilibrium of rigid bodies, and MT 2813 Introduction to Materials Science and MT 2811 Materials Science Laboratory to examine the impact of material properties on design. Junior year, students take ME 3513 Measurement Systems to learn to design experiments; ME 3313 Fluid Mechanics to understand design of fluid and thermal systems; Machine Design to consider the design aspects of machines and systems; and ME 3223 Dynamics to consider the design of systems where motion is involved and ME 3413 Automated Control to understand the control of mechanical, aerospace, robotic, thermofluid, and vibrating systems. Finally, the design experience culminates with the Capstone ME 4111 and ME 41113 Senior Design I and II course, during which students work in teams of two or three or four and design, fabricate and test projects and systems. In addition to the systematic and creative processes of design, the capstone design experience includes engineering consideration of safety, ethics, economy, project planning and budgeting, quality and presentation.

The mechanical engineering electives available to seniors also contain significant design experience. ME 4363 HVAC Systems teaches design aspect of HVAC systems. ME 4353 Internal Combustion Engines ad-

dresses design issues for engines, while MN 3714 and MN 4714 Manufacturing Systems I and II offer the methodology of design via concurrent engineering and other modern concepts.

PLACEMENT

The industries in which most alumni are employed are primarily:

- National defense
- Aerospace
- Energy generation and distribution
- Telecommunications
- Larger consulting firms (infrastructure-related)
- Petrochemical, Pharmaceutical, and other process industries
- A variety of small engineering firms

At the same time, there are emerging opportunities in biomedical systems and devices, nanotechnology and mechatronics. Alumni have also used their basic ME education as a springboard to law, medicine, corporate management, entrepreneurial ventures.

GOALS AND OBJECTIVES

The objectives of the BS in Mechanical Engineering are for its students to acquire and develop the skills necessary to:

- Understand the fundamental principles of mechanical engineering, mathematics, and the sciences that provide a foundation for and to inspire professional development
- Formulate, analyze and design thermal and mechanical components and systems
- Utilize modern engineering tools
- Work collectively in an effective manner in teams
- Compile information and communicate it effectively
- Understand the context within which mechanical engineers practice their profession, particularly as it pertains to the interrelationship of technology and social and ethical issues.

SPECIAL DEPARTMENTAL REQUIREMENTS

Students must meet the University requirement of a 2.0 GPA or better for graduation. For graduation, the students must also earn an average of 2.0 GPA or better in the ME required courses taken at the University. Seniors with GPAs of 3.5 or better may take certain graduate courses as electives with the departmental adviser's approval. Students on academic probation are usually permitted to pre-register for the next semester, but are obliged to consult with their adviser after grades are posted and before classes begin. All students entering the BS in Mechanical Engineering in fall 2004 or later must take the

FE exam prior to graduation, as a degree requirement. All others are strongly encouraged.

TRANSFER STUDENTS

All transfer students are required to meet the University's minimum residency requirement. In addition, transfer students in the Mechanical Engineering Program are required to take all junior and senior mechanical engineering courses and technical electives at Polytechnic. Qualified graduates of two-year pre-engineering programs, such as those offered at several community colleges and four year liberal arts colleges, may often fulfill the requirements for BS in Mechanical Engineering in two additional years. Programs vary from college to college; students should meet with an undergraduate adviser for guidance. With some colleges, there are formal articulation agreements and typical programs of study. Students who have some course work toward a degree may also apply for transfer credit upon application to Polytechnic. In all cases, transfer credit is granted based upon equivalence to Polytechnic courses.

The process is expedited by previous decisions, and past transfer credit granted to students from the same college is a good indicator for prospective students. However, the adviser must be consulted in all cases for a current decision; course content does change over the years at Polytechnic and other colleges, and it is a comparison of content that determines decisions in each case. Transfer students are strongly encouraged to meet with an undergraduate adviser separate and apart from the registration process so that a proper evaluation may be done. The Office of Admissions offers information on past decisions for a given college and can arrange a meeting with a departmental undergraduate adviser. Graduates of technology programs may be able to fulfill the requirements for a BS in Mechanical Engineering in two to three and-one-half years depending upon the scope and level of their previous education. The same is true for graduates of practical engineering and other such programs in various countries. Consult with an undergraduate adviser for details.

TYPICAL PROGRAM OF STUDY FOR THE BACHELOR OF SCIENCE DEGREE

The program consists of four components:

- (1) engineering core, 54 credits,
- (2) mathematics and science, 30 credits,
- (3) humanities and social sciences, 32 credits and
- (4) free and technical electives, 12 credits.

AEROSPACE ENGINEERING CONCENTRATION

The Department of Mechanical and Aerospace Engineering offers a program leading to a Bachelor of Science in Mechanical Engineering with a concentration in aerospace engineering. During the first three years of study, students set the foundation for future professional subjects by following the course work of the mechanical engineering program. Senior year, aerospace concentration students take four courses particular to their concentration:

- (1) AE 4603 Compressible Flow,
- (2) AE 4613 Aerodynamics,
- (3) AE 4633 Aerospace Propulsion and
- (4) AE 4653 Aircraft Flight Mechanics.

These courses provide students with the necessary foundation to pursue a career in the aerospace industry or pursue graduate studies in the field.

GRADUATE PROGRAM

Programs of study leading to degrees MS and PhD in Mechanical Engineering are available in each of three specialty areas:

- Mechanical Analysis and Design (MS and PhD)
- Systems, Controls and Robotics (MS and PhD)
- Thermal and Fluid Sciences (MS and PhD)

Within each of these specialties, students may choose to concentrate some of the electives from the other graduate programs in the department, e.g., aerospace or advisor approved electives outside the department, e.g., industrial and manufacturing engineering.

A bachelor's degree and a good academic record in mechanical engineering from a suitable college or university are generally required for admission to the graduate program. Applicants with degrees from fields other than mechanical engineering may be admitted, but have to undertake additional studies to achieve a comparable background. Courses required to achieve this are specified as part of the admission evaluation or first advising session. Undergraduate courses specified for this purpose cannot count toward credits needed for the graduate degree. Graduate programs are subject to the prior approval of a graduate adviser designated by the department.

All students are required to have a 3.0 GPA or better in each of the following: in the average of all graduate courses taken at Polytechnic (whether or not some of these courses are being used to satisfy specific degree requirements) in the average of all

courses submitted for the graduate degree sought (MS or PhD); in each and every guided studies, readings, projects, thesis, and dissertation courses or credits enrolled.

GOALS AND OBJECTIVES

The objectives of the MS in Mechanical Engineering are for its students to acquire the skills necessary to:

- Develop in-depth expertise in at least one of the sub-disciplines of mechanical engineering (e.g., thermo-fluids, structures and design or controls and robotics) to prepare for either a rewarding professional career or for studies toward a PhD or other degrees
- Diversify their knowledge base by taking advanced courses in other disciplines
- Formulate, analyze and design components and systems through the use of modern advanced analytical and computational tools
- Further professional development through continuous learning across disciplines

The objectives of the PhD in Mechanical Engineering are for its students to master the skills necessary to:

- Obtain deep knowledge in one of the areas of mechanical engineering (e.g., aerospace, thermo-fluids, structures and design and control and robotics) through advanced courses and research
- Identify problems, formulate research programs to address them, conduct research and produce original results that advance the fundamental understanding of a certain sub discipline by completing a dissertation in the chosen sub discipline
- Communicate results of their research and other work effectively through conference presentations and refereed journal publications

REQUIREMENTS FOR THE MASTER OF SCIENCE

Course requirements for the MS in Mechanical Engineering are suited to the applicant's specialty, which is specified by the student in the admissions process or the first advising session. Students must take at least 24 credits out of the 30 credits needed for the degree in the MS at Polytechnic and no more than 6 credits in "Guided Reading" courses are allowed. Validation credit is not allowed, but specific requirements may be waived (and appropriate substitutes designated) by the graduate adviser, based upon the student's prior studies or experience. Transfer credits are not granted for

- (1) undergraduate courses,
- (2) courses counted toward satisfying undergraduate degree requirements,

- (3) courses not related to the graduate program as stated in this catalog and
- (4) courses that received a grade lower than B.

Studies for the MS must be completed within a five-year period, unless there is a formal leave of absence approved prior to the period for which the studies are interrupted. The degree requirements are:

Course No.	Course Title	Credits
ME 6003	Applied Mathematics in Mechanical Engineering	3
ME 6043	Transport Phenomena	3
ME 6213	Introduction to Solid Mechanics	3
ME 6603	Digital Control Systems	3
ME	Required for Specialty Area (see below)	6
ME	Electives, approved by graduate adviser	6
	Free Electives	6
	Total	30

If a student decides to do a ME 9973 Master Thesis (9 credits) as part of his/her work toward the degree, these 9 credits will be counted against 3 credits out of the 6 credits in ME electives, 3 credits out of the 6 credits in ME Required for the Specialty Area credits, and 3 credits out of the 6 credits of Free Electives. Students are not allowed to submit more than three courses (9 credits) starting with a 5 for MS degree requirements satisfaction. Departmental electives include courses from mechanical, industrial, and manufacturing engineering programs, plus thesis or project credits. All courses and program details are subject to advisor approval.

Mechanics and Structural Systems Speciality

In the Mechanics and Structural Systems area at least three graduate courses with last three digits in the range of 2033 to 5933 are required. See courses below.

Controls and Dynamic Systems Speciality

In the Controls and Dynamic Systems area at least three graduate courses with last three digits in the range 6033 to 7933 are required. See courses below.

Fluid Dynamics and Thermal Systems Speciality

In the Fluid Dynamics and Thermal Systems area at least three graduate courses with last three digits in the range 0133 to 1933 are required. See courses below.

REQUIREMENTS FOR THE DOCTOR OF PHILOSOPHY

The PhD degree is a terminal degree beyond the MS and is focused on engineering research. Students are expected to advance the state of the art in their specialty by original and creative work. An MS in Mechanical or Aerospace Engineering or closely related fields in thermal/fluid sciences, mechanical analysis/design or systems/ controls/robotics is required for admission to the PhD degree program. A 3.5 GPA or better in the MS work is generally required for admission. In cases where it is unclear that the required MS specialization has been satisfied, the MS degree requirements of the preceding section shall be used to define the necessary reparation. The same criterion shall be used when the MS degree is in other engineering disciplines. Students have to take a written qualifying examination within the first two offerings of the exam after the date of joining the doctoral program.

The general credit requirements for the PhD degree (beyond the BS degree and including MS degree credits) are:

	Credits
Major work related to specialty	30
Approved courses in two minor areas	21
PhD Dissertation (ME 999)	24
Minimum total required	75

Studies for the PhD degree must be completed within a seven-year period following the MS degree or the date of admission, whichever is later, unless there is a formal leave of absence approved prior to the period for which the studies are interrupted.

Once the dissertation is begun (after the student passes the PhD Qualifying Exam and forms a PhD Guidance Committee), the student must register for at least 3 credits of ME 9999 PhD Dissertation each fall and spring semester. Actual registration should reflect the pace of the work and the activity of the student. An exception to the minimum registration requirement may be made in the last semester of registration if that semester is primarily devoted to finalizing the work and dissertation document. A dissertation grade of U for two consecutive terms will affect whether a student will be permitted to continue doctoral work. Students are required to present the progress in their dissertation work to their guidance committees at least once a year. Details on the PhD degree requirements and additional requirements can be found in the departmental pamphlet on the topic.

UNDERGRADUATE COURSES**AE 4603 Compressible Flow** 3:0:0:3

Conservation equations for inviscid flows, one-dimensional flows, normal shock waves, one-dimensional flow with friction, one-dimensional flow with heat addition, oblique shock waves, Prandtl-Meyer expansion waves. *Prerequisite: ME 2313 and ME 3313.*

AE 4613 Aerodynamics 3:0:0:3

Incompressible inviscid flow, rotational and irrotational flow, elementary flows and their superposition, airfoil and wing geometry, aerodynamic forces and moments, thin airfoil theory, camber effects, incompressible laminar and turbulent boundary layer, vortex system, incompressible flow about wings, wing/body configurations, compressible flows past airfoils and wings, high-lift devices. *Prerequisite: AE 4603.*

AE 4633 Aerospace Propulsion 3:0:0:3

Operation, performance, and design methods for flight vehicle propulsion, air-breathing engines, ramjets, turbojets, turbofans and their components, elements of solid and liquid rocket propulsion system. *Prerequisite: AE 4603.*

AE 4653 Aircraft Flight Mechanics 3:0:0:3

Development of equations of motion Characteristics of aircraft propulsion systems. Level flight performance of turbojet and propeller driven aircraft. Un-accelerated climbing flight and aircraft ceiling. Takeoff and landing performance. Longitudinal and lateral static stability. Linearized equations of motion. Longitudinal and lateral modes of motion. *Prerequisite: ME 3223.*

ME 1012 Introduction to Mechanical Engineering 2:0:0:2

This course introduces the range of mechanical engineering and emphasizes the basic principles and devices for storing and using energy, directing motion and satisfying needs. Case studies in design issues; related ethical and professional practice issues.

Emphasis on a mindset of exploration: the special principles, value and applications of such devices as flywheels, counterweights, and gyroscopes. Two design challenges to be worked on by teams, and presented. Engineering standards and standard parts. *Co-requisites: EG 1004 and ME 1112.*

ME 1112 Computer Aided Design 1:0:3:2

Sketching, drawing and computer aided draft-

ing. Projection theory: multiview, axonometric, oblique. Auxiliaries, sections, isometrics, dimensions, fasteners, detail and assembly drawings. Introduction to blueprint reading. Overview of CIM and CAD integration with other CIM concepts. Design project incorporating developed skills in visualization, drawing techniques, standards and CAD. *Co-requisites: EG 1004 and ME 1012.*

ME 2211 Statics Laboratory 1/2:0:1/2:1

Calculations of bending stress, bending moment, shear forces and deflections in beams, buckling of struts and equilibrium analysis of structures. *Co-requisite: ME 2213.*

ME 2213 Statics 3:0:0:3

Three-dimensional vector treatment of the static equilibrium of particles and rigid bodies. Equivalent force and couple systems. Distributed force systems. Static analysis of trusses, frames and machines. Friction, impending motion. Methods of virtual work. *Prerequisite: PH 1004 and MA 1024. Co-requisite: ME 2211.*

ME 2313 Thermodynamics 3:0:0:3

Properties of pure substances; concepts of work and heat; closed and open systems. The fundamental laws of thermodynamics. Carnot and Clausius statements of the 2nd law; entropy and entropy production; heat engines, refrigerators, heat pumps; efficiencies, coefficients of performance. *Prerequisite: PH 1004 and MA 1124. Co-requisite: MA 2132.*

ME 3211 Mechanics of Materials Laboratory 1/2:0:1/2:1

Measurement of elastic constants for isotropic and anisotropic materials, verification of stress and strain transformation equations, stress concentration concept, unsymmetric bending of beams and torsion of shafts. *Co-requisite: ME 3213.*

ME 3213 Mechanics of Materials 3:0:0:3

Concept of Stresses and strains in two and three dimensions, Stress-strain relationships, Stress transformation, Strain transformation, Axial members, Torsion of shafts, Bending of beams. *Prerequisites: ME 2213, ME 2211 and MA 2132. Co-requisite: ME 3211.*

ME 3223 Dynamics 3:0:0:3

Three-dimensional treatment of the kinematics of particles and rigid bodies using various coordinate systems Newton's laws,

work, energy, impulse, momentum, conservative force fields, impact. Rotation and plane motion of rigid bodies. *Prerequisite: MA 2132 and ME 2213.*

ME 3233 Machine Design 3:0:0:3

This course introduces students to the fundamentals of machine elements thus enabling them to employ the knowledge gained to design machines for various practical applications. The course begins with a brief review of stress, deformation, and failure, followed by friction and wear. Subsequently, loaded columns, pressurized cylinders, and shafts are presented. Bearings, gears, screws, springs, brakes, clutches, and belts are discussed. The course ends with an introduction to MEMS, Micro-Electro Mechanical Systems. *Prerequisite: ME 3213.*

ME 3311 Fluid Mechanics Laboratory 1/2:0:1/2:1

Fluid mechanics instrumentation and principles. This course consists of a set of laboratory experiments designed to reinforce the concepts presented in ME 3313 Fluid Mechanics. In addition this course involves team work, report writing and oral presentation. *Prerequisite: ME 3511. Co-requisite: ME 3313.*

ME 3313 Fluid Mechanics 3:0:0:3

Introduction to fluid, kinematics, hydrostatics, thermodynamics. Basic conservation laws in integral form for a control volume. Conservation of mass, momentum, angular momentum and energy for flow. Inviscid flow: Bernoulli's and Euler's equations. Viscous flow: flows in pipes and ducts, head loss and friction factor. *Prerequisites: PH 2004, MA 2132 and MA 2122.*

ME 3323 Energy Systems 3:0:0:3

A first course in power generation focusing on the analysis and design of energy conversion systems. It will introduce students in fossil, nuclear, and renewable-energy (including wind and solar) power plants with equal emphasis on all. Students will obtain a comprehensive and detailed understanding of the fundamentals of such systems and the issues related to their operation from an economic, environmental, and safety point of view.

ME 3411 Automatic Control Laboratory 1/2:0:1/2:1

System ID, modeling, identification, and control of RC electrical network, and a DC

servo motor, modeling and control of a maglev system, rotary inverted pendulum, and a coupled water tank system. *Prerequisite:* ME 3511. *Co-requisite:* ME 3413.

ME 3413 Automatic Control 3:0:0:3

Dynamic system modeling, analysis, and feedback control design with extensive, hands-on computer simulation. Modeling and analysis of dynamic systems. Description of interconnected systems via transfer functions and block/signalflow diagrams. System response characterization as transient and steady-state responses and error considerations. Stability of dynamical systems: Routh-Hurwitz criterion and Nyquist criterion. Graphical methods for dynamical system analysis and design: root locus and Bode plot. Computer-aided feedback control design for mechanical, aerospace, robotic, thermo-fluid, and vibratory systems. *Prerequisite:* ME 3513 and ME 3223.

ME 3483 Mechatronics 3:0:0:3

Mechatronics is the synergistic integration of mechanical engineering, control theory, computer science, and electronics to manage complexity, uncertainty, and communication in engineered systems. Mechatronics is an exciting, "high-tech," and inherently multidisciplinary application, whose underlying concepts can be understood by practicing engineers of diverse academic backgrounds. The typical knowledgebase for the design and operation of mechatronic systems comprise of dynamic system modeling and analysis, decision and control theory, sensor and signal conditioning, actuators and power electronics, hardware interfacing, rapid control prototyping, and embedded computing. This course will provide a balanced introduction to the theory, simulation, hardware, and software elements of mechatronics. The exposure to computer hardware/software for measurement and control will introduce the student to modern tools such as data acquisition and control board microcontrollers, LabVIEW, Matlab, etc. Finally, planned project activities will enable the students to integrate measurement, control, computer hardware, and software components to develop prototype mechatronic systems. *Prerequisite:* MA 2132, PH 2004

ME 3511 Measurement Systems Laboratory 1/2:0:1/2:1

Electric measurements, data acquisition, passive and active filters for signal conditioning, temperature, position, velocity, and acceleration measurements. *Co-requisite:* ME 3513.

ME 3513 Measurement Systems 3:0:0:3

Electrical circuits and components, filtering, dynamic measurement system response characteristics, analog signal processing, digital representation, data acquisition, sensors. Study of measurement systems via computer simulation. *Prerequisites:* MA 2132 and PH 2004.

ME 4111 Senior Design I 1:0:0:1

This section will emphasize manufacturing, product realization and customer satisfaction concern. Building effective teams/teamwork. Communication skills. Ethical issues. *Prerequisites:* ME 3233, ME 3411, ME 3413 and ME 4311. *Corequisite:* ME 4214.

ME 4114 Senior Design II 4:0:0:4

This is the Capstone Engineering Design Course based on knowledge and skills acquired in earlier coursework. Product design, development, building and testing prototype hardware, with an emphasis on teamwork. The Product Realization Process emphasizing incorporation of engineering standards and realistic constraints. Emphasis on communication skills. Students' project is a major component of the course. *Prerequisites:* ME 4111, ME 4214, ME 4311 and ME 4313.

ME 4213 Design and Fabrication of Composite Materials 3:0:0:3

Introduction to composite materials. Introduction to types of reinforcements and matrix materials. Various applications in mechanical engineering. Manufacturing of polymer, metal, and ceramic matrix materials. Analysis of laminated composites for mechanical properties. *Prerequisites:* MT 2813, MT 2811 and ME 3213.

ME 4214 Finite Element Modeling, Design and Analysis 3:3:0:4

The analysis of complex static and dynamic problems involves, in essence, three steps: selection of a mathematical model; analysis of the model; interpretation of the predicted response. The course deals with deriving analytical solutions and comparing them with Finite Element Analysis results. *Prerequisites:* ME 3213, ME 3313, MA 2122 and MA 2132.

ME 4223 Vibrations 3:0:0:3

Undamped and damped vibrating systems.

Free vibrations. Harmonic, periodic, and transient forces. Force responses. Accelerometers. Two- and multi-degree-of-freedom systems. *Prerequisite:* ME 3223 Dynamics

ME 4311 Heat Transfer Laboratory 1/2:0:1/2:1

Heat transfer instrumentation and principles. This course consists of a set of laboratory experiments designed to reinforce the concepts presented in ME 4313 Heat Transfer. In addition, this course involves team work, report writing, and oral presentation. *Prerequisite:* ME 3311. *Co-requisite:* ME 4313.

ME 4313 Heat Transfer 3:0:0:3

Introduction to the modes of conduction, convection, and radiation heat transfer. Analysis of multidimensional geometries for the conduction mode. Unsteady conduction. Numerical methods of analysis. Introduction to convection. Internal and external convection. Natural convection and boiling and condensation. Principles of radiative heat transfer. *Prerequisites:* ME 2313 and ME 3313.

ME 4353 Internal Combustion Engines 3:0:0:3

Introduction and definitions, engine operating characteristics. Thermodynamics of internal combustion engines. Thermodynamics of combustion. Combustion in spark ignition engines. Design for performance and efficiency. Pollutant formation and controls, emissions tests. *Prerequisites:* ME 2313, ME 3313 and ME 4313.

ME 4363 Heating, Ventilation and Air Conditioning 3:0:0:3

Review of thermodynamic principles, psychrometric chart and psychrometric analysis, comfort air conditioning and indoor air quality, heating and cooling system, HVAC system design and equipment selection. *Prerequisites:* ME 2313, ME 3313 and ME 4313.

ME 4484 Smart Systems 4:0:0:4

Smart engineering products and decision aids (e.g., computational agents) abound in society. This course equips the students with essential tools frequently used to impart intelligence to a variety of systems. Specifically, after reviewing examples of smart systems found in consumer/ industrial products and software agents, the course provides introduction to fundamentals of optimization theory, signal processing, system identifica-

tion, estimation and control theory, condition monitoring, fault diagnostic, neuro-systems, decision systems (hierarchical, decentralized), distributed computing, etc. Applications of these tools in the design and development of smart systems are illustrated. The course gives a balanced introduction to the theory, simulation, hardware and software elements of smart systems. Students are expected to gain expertise in at least one aspect of smart systems. Simulation and hardware projects enable students to develop prototype smart products. *Prerequisites: MA 2132 and PH 2004.*

MT 2811 Materials Science Laboratory
1/2:0:1/2:1

Students learn how to characterize the microstructure and crystal structure of a material by optical and scanning electron microscopy and X-ray diffraction. The mechanical characterization is accomplished by hardness, tensile and yield strength, impact and fatigue testing. *Prerequisites: PH 1004, CM 1004 and MT 2813.*

MT 2813 Introduction to Materials Science
3:0:0:3

Students in this course become familiar with atomic structure and bonding, atomic arrangement in crystals, crystal imperfections, mechanical behavior and failure of materials and binary phase diagrams. *Prerequisites: PH 1004 and CM 1004. Corequisite: MT 2811.*

MN 3713 Manufacturing Systems I
3:0:0:3

A product must meet both a customer need and goals of performance, cost, quality, reliability, safety, and the environment to be successful in the marketplace. The course addresses the issues that are critical to the design of a product for manufacture and the methods that have been found to be successful in addressing these issues. The design process is studied and illustrated by means of class exercises and a term project. Selected manufacturing processes are studied to establish the relationship between product design and manufacturing process complexity. Economic feasibility, entrepreneurship, and bringing products (and services) to the market are emphasized. *Prerequisites: PH 1004 and MA 1024 or MA 1324*

MN 4713 Manufacturing Systems II
3:0:0:3

This course is a continuation of MN 3713.

The techniques addressed in this course in the context of manufacturing systems can be applied to business processes in a variety of industries addressing bottlenecks, simulation, economic computations, design process, and applications. This course will continue to build from the readings, and emphasize project work (2 projects). The course will depend on effective teamwork, centered on project work and presentations. *Prerequisite: MN 3713.*

MT 4853 Manufacturing Engineering and Processes
3:0:0:3

This course introduces the students to the manufacturing processes involved in fabricating components used in mechanical systems; casting processes; bulk metal deformation and sheet metal forming processes; materials removal processes; Joining and fastening processes; manufacturing automation; and integrated manufacturing systems. *Prerequisites: MT 2811 and 2813.*

GRADUATE COURSES

ME 6003 Applied Mathematics in Mechanical Engineering
3:0:0:3

Vector and tensor calculus. Ordinary differential equations. Laplace and Fourier Transforms. Sturm-Liouville problems. Partial differential equations. Applications to structural analysis, fluid mechanics, and dynamical systems. *Prerequisite: Advisor's approval.*

ME 7003 Finite Element Methods
3:0:0:3

Derivation of element stiffness matrices for spring, bar, and beam elements. Finite element formulation to determine many unknowns such as displacements, forces, and reactions. Application to trusses, frames, and two dimensional problems in plane stress and plane strain under static loading conditions. Applications in thermal, heat transfer, and fluid mechanics. Interpreting the results, convergence of solution, and effect of meshing and symmetry conditions. Introduction to modern meshless techniques. *Prerequisite: Advisor's approval.*

FLUID DYNAMICS AND THERMAL SYSTEMS

ME 5103 Biomedical Fluid Dynamics
3:0:0:3

Principles of fluid flow and transport in the human body, emphasizing vascular circulation and hemodynamics. Topics include: physics of pulsatile flow, introductory biol-

ogy and physiology of the circulatory system, blood flow in vessels, microcirculation, blood rheology, fluid dynamics of vasculature under physiological and pathological conditions, mass transport to vessel walls, mechanics of blood cells, cellular mechanotransduction and biochemical signaling, and microfluidics in biomedical devices. *Prerequisite: Advisor's approval.*

ME 6013 Thermodynamics 3:0:0:3

Availability functions, general thermodynamic relations, equations of state, general thermodynamic equilibrium criteria, power production, thermodynamics of reacting systems, energy of formation, chemical equilibrium, applications in combustion systems. *Prerequisite: Advisor's approval.*

ME 6043 Transport Phenomena 3:0:0:3

Fourier, Newton and Ficks flux laws. Conservation of energy, mass and momentum. Eulerian and Lagrangian frames. Momentum transfer: concept of viscosity, molecular transport of momentum, convective transport in laminar flows and concepts of turbulent transport. Energy transfer: molecular (conduction) transfer of heat, convective transfer of heat and radiative heat transfer. Mass transfer: molecular diffusion of mass, convective mass transfer. *Prerequisite: Advisor's approval.*

ME 7063 Convective Heat Transfer
3:0:0:3

Developments and applications of laminar hydrodynamic and thermal boundary layer equations for fluid media. Mechanics of turbulence; formulation and analysis of turbulent hydrodynamics and thermal applications; natural convection and film evaporation and condensation. *Prerequisite: ME 6043 or Advisor's approval.*

ME 7073 Conductive Heat Transfer
3:0:0:3

Theoretical development of transient and steady-state temperature distributions in finite and infinite solids. Appropriate mathematical techniques introduced as required. Solids undergoing phase change and two dimensional fields. *Prerequisite: ME 6003, and ME 6043 or Advisor's approval.*

ME 7083 Radiative Heat Transfer
3:0:0:3

Fundamentals of radiative mechanisms of energy transfer. Definitions of basic qualities.

Equations of transfer, radiative heat flux vector and conservation equations. Properties of surfaces and participating media. Applications to engineering systems. *Prerequisite: ME 6003, and ME 6043 or Advisor's approval.*

ME 7113 Viscous Flow and Boundary Layers 3:0:0:3

Introduction to molecular and macroscopic transport. Reynold's transport theorem. Concepts of stress and strain and derivation of the Navier-Stokes equations. Similarity principle. Exact solutions to the Navier-Stokes equations. Low Reynolds number flows. Boundary layer theory. Momentum integral equation. Introduction to turbulence. *Prerequisite: ME 6003 and ME 6043.*

ME 7123 Turbulent Flow 3:0:0:3

Nature and origin of turbulence. Instability and transition, Taylor and Grtler vortices. Vorticity dynamics, homogeneous and isotropic turbulence. Reynolds decomposition, turbulent stress tensor and Reynolds-averaged Navier-Stokes equations. Computational modeling of turbulence. Analysis of turbulent boundary layers. Turbulent heat and mass transfer, measurement of turbulence. *Prerequisite: ME 6043 and ME 7113.*

ME 7133 Compressible Flow 3:0:0:3

Fundamentals of compressible fluid flow including subsonic, transonic, supersonic, and hypersonic flows over two-dimensional and axisymmetric bodies. One dimensional flows with friction and heat addition. Shock wave development in both two dimensional steady and one-dimensional unsteady flow systems including flow in shock tubes. Quasi-one-dimensional compressible flow including flows in inlets, nozzles and diffusers. Introduction to numerical solution of compressible fluid flow. *Prerequisite: ME 6043.*

ME 7153 Computational Fluid Mechanics and Heat Transfer 3:0:0:3

Engineering solution of thermo-fluid problems by finite-difference methods, error and stability analyses, numerical dispersion and damping, matrix inversion methods, solution of model equations: wave, heat, Laplace, viscous and inviscid Burger's equations. Implicit and explicit procedures, SOR, ADI, hopscotch and direct solvers for evaluating linear and nonlinear diffusion and convection problems. *Prerequisite: ME 6003 and ME 6043.*

ME 7163 Experimental Methods in Thermal-Fluid Sciences 3:0:0:3

Discussion of basic measurement techniques in thermal and flow sciences and a survey of the modern developments in measurement technology including optical methods. Planning of experimental programs, calibration, measurement uncertainty, noise, generalized performance characteristics, various devices for measuring mass and volume flow rate, velocity, pressure, temperature, density and heat flux, computerized data acquisition and statistical analysis. *Prerequisite: ME 6043 or Advisor's approval.*

ME 8033 Combustion 3:0:0:3

Chemical characteristics of flames. Heat of formation and of reaction; phase and reaction equilibrium and adiabatic flame temperature; and special concentration in stationary and flowing reacting systems. Chemical kinetics of homogeneous and heterogeneous reacting systems. Branching chain reactions and explosion limits. Diffusion and remixed combustion systems. *Prerequisite: ME 6043, and ME 6013 or Advisor's approval.*

ME 8043 Theory of Propulsion 3:0:0:3

Principles of high-speed propulsion based on chemical energy sources. Air breathing engines and their components: ramjet, scramjet, turbojet and turbofan, combustion thermodynamics, flows with chemical reactions, thermo-chemistry of solid and liquid rocket engines. Engineering parameters in engine design. *Prerequisite: ME 7133.*

MECHANICS AND STRUCTURAL SYSTEMS[A1]

ME 5243 Composite Materials 3:0:0:3

Introduction to modern polymeric, metallic and ceramic composite materials, fabrication techniques, mechanical property characterization. Introduction to matrix and reinforcement materials, material selection, and composite design criteria. Mechanics based analysis of continuous fiber reinforced unidirectional plies and woven fabrics. Applications of advanced composites in car, aircraft, construction, and sports industries. *Prerequisite: Advisor's approval.*

ME 5443 Vibrations 3:0:0:3

Dynamics of one-, two-, and multidegree of freedom systems with and without damping. Vibrations of distributed parameter systems:

bars, beams and plates. Numerical methods. Introduction to nonlinear oscillations. *Prerequisite: Advisor's approval.*

ME 6213 Introduction to Solid Mechanics 3:0:0:3

Fundamentals of kinematics of solid bodies; displacement and strain measures, introduction to statics of solid bodies, stress tensor, equilibrium equations. Analysis of columns, beams, and beams on elastic foundations. *Prerequisite: Advisor's approval.*

ME6223 Advanced Mechanics of Materials 3:0:0:3

Two-dimensional stress and strain analysis, applications of energy methods, Reyleighitz method. Applications of energy methods to beams, frames, laminates and sandwich structures. Torsion of prismatic bars, open and closed thin-walled cylinders, unsymmetric bending and shear center, curved bars. *Prerequisite: ME 6213.*

ME 6253 Mechanics of Nanomaterials 3:0:0:3

Introduction to nanosized and nanoscale materials: nanoparticles, nanotubes, nanowires, nanorods. Classical molecular dynamics, lattice mechanics, methods of thermodynamics and statistical mechanics, introduction to multiple scale modeling, and introduction to bridging scale. Characterization techniques for nanomaterials.

Applications in nanosystems such as nanocars, nanobots, and nanoelectronics. *Prerequisite: Advisor's approval.*

ME 6513 Advanced Dynamics 3:0:0:3

Kinematics and dynamics of a particle in space. Systems of particles. Two-body central force problem. Kinematics and dynamics of rigid bodies. Euler's equations. Eulergrange equations with holonomic and nonholonomic constraints. Stability analysis. Introduction to calculus of variations. Hamilton's principle. Hamilton's equations. *Prerequisite: Advisor's approval.*

ME 7213 Elasticity I 3:0:0:3

Stress and strain tensors, generalized Hooke's law. Formulation of elasticity problems. Plane stress and plane strain concepts; solution by complex variables; stress concentrations. Rotating Discs and cylinders of uniform thickness and variable thickness. Deformation symmetrical about an axis. *Prerequisite: ME 6213.*

ME 7243 Advanced Composite Materials 3:0:0:3

Mechanics based analysis of fibrous (continuous and discontinuous) and particulate composites, generalized Hooke's law for anisotropic and orthotropic materials. Stress strain transformations and failure criterion for anisotropic materials. Analysis of composite beams in tension, flexure, and torsion. Analysis of composite shells and grid stiffened structures. *Prerequisite: ME 5243 and ME 6213.*

ME 7323 Failure Mechanics 3:0:0:3

Introduction to fracture mechanics. Linear elastic, elastic-plastic and fully plastic fracture mechanics modeling and design. Fatigue and design against fatigue failures. Standard fracture mechanics testing procedures and related material properties. Micro-mechanics of fracture. Dynamic fracture. Continuum damage mechanics. *Prerequisite: ME 6213 or Advisor's approval.*

ME 7333 Non-Destructive Evaluation (NDE) 3:0:0:3

Introduction to various NDE techniques used in engineering applications, x-ray radiography, ultrasonic imaging, acoustic emission, optical interferometry, magnetic resonance imaging. Introduction to embedded optical and electromechanical sensors for continuous health monitoring and defect detection. *Prerequisite: ME 6003 and Advisor's approval.*

ME 7353 Fracture Mechanics 3:0:0:3

Introduction to fracture mechanics. Linear elastic, elastic-plastic and fully plastic fracture mechanics modeling and design. Fatigue and design against fatigue failures. Standard fracture mechanics testing procedures and related material properties. Micro-mechanics of fracture. Dynamic fracture. Continuum damage mechanics. *Prerequisite: ME 6213 or Advisor's approval.*

ME 7443 Advanced Vibrations 3:0:0:3

Review of analytical dynamics and vibrations of lumped parameter systems. Vibrations of distributed parameter systems. Approximate solution methods. Introduction to nonlinear vibrations and analysis tools. Advanced topics. *Prerequisite: ME 5443 or Advisor's approval.*

ME 8213 Elasticity II 3:0:0:3

Continuation of studies in elasticity problems. Three dimensional problems; St. Venant problems, extension, flexure, tension. Energy principles and variational methods; approximation techniques. *Prerequisite: ME 7213.*

ME 8273 Mechanics of Cellular Materials 3:0:0:3

Structure of cellular composites and natural cellular materials including single phase open and closed cell foams, and two-phase closed cell foams. Mechanics of honeycombs and foams, mechanics of wood and bones, effect of density, cell size and cell periodicity, introduction to homogenization techniques for cellular composites. *Prerequisite: ME 7213.*

CONTROLS AND DYNAMIC SYSTEMS**ME 5643 Mechatronics** 3:0:0:3

Introduction to theoretical and applied mechatronics, design and operation of mechatronics systems; mechanical, electrical, electronic, and optoelectronic components; sensors and actuators including signal conditioning and power electronics; microcontrollers, fundamentals, programming, and interfacing; and feedback control. Includes structured and term projects in the design and development of prototype integrated mechatronic systems. *Prerequisite: Advisor's approval.*

ME 5653 Microelectromechanical Systems 3:0:0:3

Materials for MEMS, fundamental of solid mechanics, electrostatics and electromagnetics. Electromechanical modeling and design of micromachined sensors and actuators. Microscale physics of microsystems. Overview of MEMS applications. Packaging and testing. *Prerequisite: Advisor's approval.*

ME 6603 Digital Control Systems 3:0:0:3

Introduction to digital systems, signal conversion techniques, z-transform and inverse z-transform, transfer function and block diagrams, state-variable techniques, controllability, observability, stability, and control design techniques. *Prerequisite: Advisor's approval.*

ME 6613 Sensor Based Robotics 3:0:0:3

Robot mechanisms, robot arm kinematics (direct and inverse kinematics), robot arm dynamics (Euler Lagrange, Newton-Euler, and Hamiltonian Formulations), six degree-of-freedom rigid body kinematics and dynamics, quaternion, nonholonomic systems, trajectory planning, various sensors and actuators for robotic applications, end-effector mechanisms, force and moment analysis, introduction to control of robotic manipulators. Co-listed as EL 5223 *Prerequisite: Graduate status.*

ME 6703 Linear Control Theory and Design I 3:0:0:3

Modeling of mechanical systems (e.g., mechatronic, vibrational, robotic, and smart systems) in state-space. Description and analysis of linear mechanical systems, transform and transition matrix methods, and properties such as stability, controllability/stabilizability, observability/detectability. *Prerequisite: advisor's approval, ME 6703.*

ME 6713 Linear Control Theory and Design II 3:0:0:3

Fundamentals of system realizations and random processes. Performance objectives for mechanical systems (e.g., mechatronic, vibrational, robotic, and smart systems). Optimal design of state feedback controllers, observers, and output feedback controllers for mechanical systems.

ME 7613 Nonlinear Systems: Analysis and Control 3:0:0:3

Introduction to nonlinear phenomenon, behavior, and analysis of second-order nonlinear systems, fundamental properties of solutions of nonlinear ordinary differential equations, Lyapunov stability theory, absolute stability theory, describing functions, dissipativity, advanced topics. *Prerequisite: ME 6003 and ME 6713.*

ME 7623 Cooperative Control 3:0:0:3

Fundamentals of set theory, metric spaces, linear spaces, matrix theory, and differential equations. Lyapunov stability. Algebraic graph theory. Consensus theory. Linear switched systems. Stochastic convergence. Averaging methods. Synchronization problems. Applications to multivehicle robotic teams, epidemic spreading, and opinion dynamics. *Prerequisite: ME 6003, and ME 6703 or Advisor's approval.*

ME 7703 Optimal Robust Control

3:0:0:3

Mathematical preliminaries, matrix theory fundamentals, linear system properties, stability theory, constrained optimization, performance characterization: deterministic/stochastic formulations, Lagrange multiplier versus linear-matrix-inequality formulation of linear quadratic regulation (LQR), state estimation, and dynamic output feedback control problems, static output feedback, regulation versus tracking problems, robustness properties of LQR, on lack of robustness of LQG controllers, loop transfer recovery, small gain theorem, introduction to H-infinity and multi-objective robust control. *Prerequisite: ME 6703.*

SELECTED TOPICS, PROJECTS, THESIS AND DISSERTATION**ME 7863 / ME 7873 Special Topics**

3:0:0:3

These numbers are reserved for special topics that are offered periodically by the Mechanical Engineering Program and are open to first-year graduate students. When offered, the specific subject matter is indicated as part of the title after the words "Special Topics" and the more complete title appears on the student's transcript. *Prerequisite: tailored to the offering.*

ME 8863 / ME 8873 Advanced Topics

3:0:0:3

These numbers are reserved for advanced topics that are offered periodically by the Mechanical Engineering Program and are open to second-year and more advanced graduate students. When offered, the specific subject matter is indicated as part of the title after the words "Advanced Topic" and the more complete title appears on the student's transcript. *Prerequisite: tailored to the offering.*

ME 9013-9043 Guided Readings I-IV

each 3 credits

Open to qualified graduate students interested in special advanced topics. Directed study, including analytical work and/or laboratory investigations. *Prerequisite: Advisor's and Instructor's approval.*

ME 9963 MS Project

each 3 credits

Engineering project pursued with the guidance of a faculty member. Project proposal and final report must be submitted in writing to the department head and the advisor. May be extended to thesis with project adviser's recommendation. Credit only upon completion of project. *Prerequisite: Degree status.*

ME 997x MS Thesis

variable credit

Master's thesis to present results of original investigation in field of student's specialty. This can be an extension of ME 9963, on approval of the project advisor. Continuous registration required. Maximum of 9 credits of ME 9963 / ME 9973 counted toward degree. *Prerequisite: Degree status.*

ME 9999 PhD Dissertation each 3 credits

Doctoral dissertation evincing independent study and original contributions in field of specialization. Oral examination on subject of dissertation and related topics required. Minimum of 24 credits; also continuous registration at minimum of 3 credits per semester required until dissertation completed. *Prerequisite: Passage of Ph.D. Qualifying exam and Ph.D. Dissertation Advisor's approval.*

Typical Course of Study for the Bachelor of Science in Mechanical Engineering

FRESHMAN YEAR**Fall Semester**

Course No.	Course Title	Hours/Week			
		Class	Lab.	Rec.	Cr.
EG 1004	Intro Engineering & Design	1	3	2	4
MA 1024	Calculus I	4	0	0	4
CM 1004	General Chemistry	3	2	1	4
EN 1014	Writing & Humanities I ²	4	0	0	4
SL 1010	Freshman Seminar	1	1	0	0
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16					

Spring Semester

Course No.	Course Title	Hours/Week			
		Class	Lab.	Rec.	Cr.
MA 1124	Calculus II	4	0	0	4
PH 1004	Introductory Physics I	4	1½	1	4
ME 1012	Intro Mechanical Engineering	2	0	0	2
ME 1112	Computer Aided Design	1	0	3	2
EN 1204	Writing & Humanities II	4	0	0	4
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16					

SOPHOMORE YEAR**Fall Semester**

MA 2012	Linear Algebra I (½semester)	4	0	0	2
MA 2132	Ordinary Diff. Equ. (½semester)	4	0	0	2
PH 2004	Introductory Physics II	4	1½	1	4
MT 2811	Materials Science Lab	½	1½	0	1
MT 2813	Intro Materials Science ³				3
HI 2104	Modern World History	4	0	0	4
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16					

Spring Semester

MA 2112	Multi. Calculus A (½semester)	4	0	0	2
MA 2122	Multi Calculus B (½semester)	4	0	0	2
MA 2212	Data Analysis I (½semester)	4	0	0	2
ME 2211	Statics Lab	0	0	3	1
ME 2213	Statics	3	0	0	3
ME 2313	Thermodynamics	3	0	0	3
	HU/SS Elective ³	4	0	0	4
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17					

JUNIOR YEAR**Fall Semester**

ME 3211	Mechanics of Materials Lab	½	1½	0	1
ME 3213	Mechanics of Materials	3	0	0	3
ME 3511	Measurement Systems Lab	½	1½	0	1
ME 3513	Measurement Systems	3	0	0	3
ME 3223	Dynamics	3	0	0	3
	HU/SS Elective ³	4	0	0	4
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15					

Spring Semester

ME 3233	Machine Design	3	0	0	3
ME 3311	Fluids Lab	½	1½	0	1
ME 3313	Fluids	3	0	0	3
ME 3411	Controls Lab	½	1½	0	1
ME 3413	Controls	3	0	0	3
	University Sequence ⁴	4	0	0	4
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15					

SENIOR YEAR**Fall Semester**

ME 4111	Senior Design I	1	0	0	1
ME 4214	Finite Element Design	3	3	0	4
ME 4311	Heat Transfer Lab	½	1½	0	1
ME 4313	Heat Transfer	3	0	0	3
	ME Elective ⁵	3	0	0	3
	University Sequence ⁴	4	0	0	4
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16					

Spring Semester

ME 4113	Senior Design II	4	0	0	4
	ME Elective ⁵	3	0	0	3
	ME Elective ⁵	3	0	0	3
	Technical Elective ⁵	3	0	0	3
	HU/SS Elective ³	4	0	0	4
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17					

Total credits required for the degree:**128**

1. Students who are placed by examination or by an adviser into MA 0902, MA 0912 or MA 0922 must defer registration for MA 1024.
2. Students who are placed by examination or by an adviser into EN 1080 or EN 1090 must subsequently register for EN 1034, rather than EN 1014.
3. Approved HU/SS electives are courses with the following prefixes: AH, AN, EC, EN, HI, MU, PL and PS. Two courses must be from Level II. Elective courses in different disciplines and one from Level III Advanced Elective courses.
4. A list of approved Sequence Electives is available from the department.
5. A total of 12 credits are required for ME and Technical electives. Mix of 3 and 4 credits are allowed. Out of the 12 credits, 8 or more must be in ME.

Typical Course of Study for the Bachelor of Science in Mechanical Engineering with Concentration in Aerospace

FRESHMAN YEAR

Fall Semester

Course No.	Course Title	Hours/Week			
		Class	Lab.	Rec.	Cr.
EG 1004	Intro Engineering & Design	1	3	2	4
MA 1024	Calculus I	4	0	0	4
CM 1004	General Chemistry	3	2	1	4
EN 1014	Writing & Humanities I ²	4	0	0	4
SL 1010	Freshman Seminar	1	1	0	0
					16

Spring Semester

Course No.	Course Title	Hours/Week			
		Class	Lab.	Rec.	Cr.
MA 1124	Calculus II	4	0	0	4
PH 1004	Introductory Physics I	4	1½	1	4
ME 1012	Intro Mechanical Engineering	2	0	0	2
ME 1112	Computer Aided Design	1	0	3	2
EN 1204	Writing & Humanities II	4	0	0	4
					16

SOPHOMORE YEAR

Fall Semester

MA 2012	Linear Algebra I (1/2semester)	4	0	0	2
MA 2132	Ordinary Diff. Equ. (1/2semester)	4	0	0	2
PH 2004	Introductory Physics II	4	1½	1	4
MT 2811	Materials Science Lab	½	1½	0	1
MT 2813	Intro Materials Science	3	0	0	3
HI 2104	Modern World History	4	0	0	4
					16

Spring Semester

MA 2112	Multi. Calculus A (1/2semester)	4	0	0	2
MA 2122	Multi Calculus B (1/2semester)	4	0	0	2
MA 2212	Data Analysis I (1/2semester)	4	0	0	2
ME 2211	Statics Lab	0	0	3	1
ME 2213	Statics	3	0	0	3
ME 2313	Thermodynamics	3	0	0	3
	HU/SS Elective ³	4	0	0	4
					17

JUNIOR YEAR

Fall Semester

ME 3211	Mechanics of Materials Lab	½	1½	0	1
ME 3213	Mechanics of Materials	3	0	0	3
ME 3511	Measurement Systems Lab	½	1½	0	1
ME 3513	Measurement Systems	3	0	0	3
ME 3223	Dynamics	3	0	0	3
	HU/SS Elective ³	4	0	0	4
					15

Spring Semester

ME 3233	Machine Design	3	0	0	3
ME 3311	Fluids Lab	½	1½	0	1
ME 3313	Fluids	3	0	0	3
ME 3411	Controls Lab	½	1½	0	1
ME 3413	Controls	3	0	0	3
	University Sequence ⁴	4	0	0	4
					15

SENIOR YEAR

Fall Semester

ME 4111	Senior Design I	1	0	0	1
ME 4214	Finite Element Design	3	3	0	4
ME 4311	Heat Transfer Lab	½	1½	0	1
ME 4313	Heat Transfer	3	0	0	3
AE 4603	Compressible Flow	3	0	0	3
	University Sequence ⁴	4	0	0	4
					16

Spring Semester

ME 4113	Senior Design II	4	0	0	4
AE 4613	Aerodynamics	3	0	0	3
AE 4633	Aerospace Propulsion	3	0	0	3
AE 4653	Aircraft Flight Mechanics	3	0	0	3
	HU/SS Elective ³	4	0	0	4
					17

Total credits required for the degree:

128

1. Students who are placed by examination or by an adviser into MA 0902, MA 0912 or MA 0922 must defer registration for MA 1024.
2. Students who are placed by examination or by an adviser into EN 1080 or EN 1090 must subsequently register for EN 1034, rather than EN 1014.
3. Approved HU/SS electives are courses with the following prefixes: AH, AN, EC, EN, HI, MU, PL and PS. Two courses must be from Level II Elective courses in different disciplines and one from Level III Advanced Elective courses.
4. A list of approved Sequence Electives is available from the department.



ORGANIZATIONAL BEHAVIOR GRADUATE PROGRAM

Academic Director: Harold G. Kaufman

GOALS AND OBJECTIVES

The graduate program in Organizational Behavior is a unique and pioneering curriculum that prepares professionals and managers to address critical human problems in rapidly changing organizations, often in a technology-driven climate. The program provides the knowledge, skills and technologies to deal effectively with human resource issues and to achieve high quality innovation and productivity as well as job satisfaction in turbulent organizational settings. The changing nature of work and shifting professional needs are addressed by the continuous updating of the curriculum and addition of cutting-edge courses that focus on the effective management of people and organizations.

GRADUATE PROGRAM

The course of study for the Master of Science in Organizational Behavior is designed for individuals with a wide variety of experience and needs. These range from human resource practitioners who need to update and broaden their qualifications to those with diverse backgrounds who wish to acquire the expertise to enter a field related to one of the following concentrations:

- Human Resource Management
- Management of Change
- Training and Development
- Human Resource Information Systems

In addition, those pursuing careers as managers in a variety of functions, benefit greatly from this program. The courses provide the knowledge and skills needed to effectively manage people, which is essential to being a successful manager.

Some of the unique aspects of the program focus on topics that address rapidly changing organizational environments, such as:

- Managing the impact of changing technology on people and organizations
- Motivating knowledge workers to stay up-to-date with developments in their field
- Conflict resolution in turbulent and uncertain environments
- Designing new organizational structures that are more responsive to rapid change
- Improving utilization of knowledge workers through talent management and coaching
- Training and development innovations to cope with changing job requirements
- Utilizing job and workplace design to im-

prove motivation and performance

- Applying career management to knowledge workers in restructuring firms
- Addressing human resource issues in organizations affected by globalization
- Developing effective leadership and teamwork in dealing with change
- Outsourcing as a human capital strategy to deal with changing organizational needs
- Enhancing organizational effectiveness through human resource information systems and web-based human resource technologies

Because most Polytechnic students are working professionals, many with managerial responsibilities, class schedules are offered in the evenings after normal office hours. Seminar-style classes, emphasizing participation and discussion, enable Organizational Behavior students to receive individual attention from faculty and to work closely with classmates, often in teams. The degree can be completed in one to two years.

An active, award-winning student chapter of the Society for Human Resource Management (SHRM) provides extra-curricular opportunities for professional seminars, workshops, networking and mentoring to enhance individual career development. With the unique knowledge and skills acquired from the Organizational Behavior Program, graduates have been able to pursue successful careers in prestigious firms ranging from high-tech to financial institutions as well as in the public sector, or as private consultants.

ADMISSION AND DEGREE REQUIREMENTS

Criteria for admission include a bachelor's degree with at least a B average from an accredited college or university and demonstrated evidence of motivation, maturity and the ability to benefit from and contribute to professional graduate studies in Organizational Behavior. Applicants who do not meet all the criteria may be admitted as non-degree students with the opportunity, subsequently, to become a degree candidate. Satisfactory scores on the Graduate Management Admission Test (GMAT) or an acceptable equivalent test such as the Graduate Record Examination (GRE) may be used as additional support for admission to degree studies.

Students who have not completed an undergraduate course in statistics must enroll in MG 5050 Probability and Managerial Statistics or its equivalent. Students without an adequate background in computers may be required to enroll in one or more of the

preparatory courses offered by the Department of Computer and Information Sciences. These courses are in addition to the degree requirements of 12 courses or 36 credits, which must be completed with an average of B or better.

A maximum of 9 transfer credits may be granted for graduate courses completed elsewhere, as evaluated by the Academic Director.

For the most current information on the Master of Science program in Organizational Behavior, please visit www.ob.poly.edu, the program's web site.

ADVANCED CERTIFICATE PROGRAMS

Graduate certificate programs, designed primarily for professionals and managers with work experience, are offered in the two following fields:

- Organizational Behavior
- Human Resource Management.

Individualized programs make it highly appropriate for specialists as well as generalists to improve and update their knowledge and skills in critical areas ranging from talent management to the redesign of jobs and organizations to human resource information systems.

Applicants for certificate programs must hold a bachelor's degree. A certificate program requires five courses, (see Requirements for Advanced Certificates below). Elective courses may be selected according to individual needs.

In consultation with the academic director, students may design a custom-made certificate program with appropriate courses to meet their professional development requirements.

Those who choose to apply for a Master of Science in Organizational Behavior are able, upon admission, to apply all courses completed for a certificate toward fulfillment of the graduate degree requirements. Additional information may be obtained from the Academic Director of the Organizational Behavior Program.

ONLINE MASTER OF SCIENCE DEGREE & CERTIFICATE PROGRAMS

The Master of Science in Organizational Behavior as well as the advanced certificate programs may be completed with online courses. These are fully accredited graduate courses which are blended in a unique for-

mat to allow online students the opportunity to participate in classroom lectures and discussions via teleconferencing. For further information, refer to e-Poly at <http://www.poly.edu/epoly/>.

THE CURRICULUM*

In any concentration there are four components to the Master of Science in Organizational Behavior degree:

1. Core Courses (required)
2. Concentration Courses (required electives)
3. Free Electives
4. Research Project

**Course descriptions can be found in the Management section of this catalogue, except for 1.5 credit courses, which are listed in this section.*

A total of 12 courses (36 credits) are required in these four components, as described below.

1. CORE COURSES

Core courses provide an introduction to the theory, research, and practice basic to the field of organizational behavior. This scientific foundation consists of three core courses upon which the student can build a more applied cutting-edge specialization within the degree program.

Students who have previously completed courses as undergraduates in any of these areas may be excused from taking them by presenting proof of competence and receiving waivers from the Academic Director. Other courses must be substituted with permission of the Academic Director. The core courses should be taken as early in the program as possible.

Required Core Courses (9 credits)

- MG 6013 Organizational Behavior
- MG 6313 Organization Theory & Design
- MG 6333 Research Methods

2. AREAS OF CONCENTRATION

Students are expected to choose an area of concentration, representing the applications or technology built on the scientific foundation in the field of Organizational Behavior. This may be one of the four concentrations listed below or, with the Academic Director's approval, a concentration may be revised to consist of 18 credits of courses designed to meet a student's particular needs.

Each concentration consists of 9 credits of required courses plus 9 credits of elective courses selected from a list in each concentration. Courses in each concentration may consist of both 3 credit and 1.5 credit courses.

Students who have previously completed a specific course as undergraduates in any of the areas of concentration may be excused from taking that course by presenting proof of competence and receiving a waiver from the Academic Director. Other courses must be substituted, with permission of the Academic Director.

Courses in each of the four areas of concentration are shown below:

Human Resource Management (18 credits)

The concentration in human resource management prepares professionals to deal with the critical human issues involved in staffing, evaluating, and rewarding employees in an era of rapidly changing work environments.

Required:

- MG 6123 Human Resource Management
- MG 6173 Performance Measurement & Reward Systems
- MG 6223 Staffing Organizations

Electives, select nine credits:

- MG 6113 Career Management
- MG 6133 Labor Relations
- MG 6143 Conflict Management
- MG 6181 Talent Management (1.5 credit)
- MG 6191 Coaching in Organizations (1.5 credit)
- MG 6211 Outsourcing: A Human Capital Strategy (1.5 credit)
- MG 6253 Seminar in Organization & Career Change
- MG 6263 Human Resource Information Systems
- MG 6271 Managing New Technology in Human Resources (1.5 credit)
- MG 6283 Web-Based Human Resource Management
- MG 6321 Global Human Resource Management (1.5 credit)
- MG 8653 Managing Technological Change & Innovation

Management of Change (18 credits)

The concentration in management of change provides human resource professionals and managers with the latest tools and techniques necessary to guide organizations and their employees through periods of rapid, potentially disruptive change, especially transitions created by changing technologies.

Required:

- MG 6163 Job & Workplace Design
- MG 6243 Organization Development
- MG 6253 Seminar in Organization & Career Change

Electives, select nine credits:

- MG 6113 Career Management
- MG 6123 Human Resource Management
- MG 6143 Conflict Management
- MG 6153 Leadership & Team Development
- MG 6181 Talent Management (1.5 credit)
- MG 6191 Coaching in Organizations (1.5 credit)
- MG 6201 Consulting in Organizations (1.5 credit)
- MG 6211 Outsourcing: A Human Capital Strategy (1.5 credit)
- MG 6233 Training in Organizations
- MG 6271 Managing New Technology in Human Resources (1.5 credit)
- MG 6321 Global Human Resource Management (1.5 credit)
- MG 8653 Managing Technological Change & Innovation

Training and Development (18 credits)

The concentration in training and development prepares human resource professionals to design, administer, and evaluate complex training and development programs, particularly in organizations affected by the introduction of new technology.

Required:

- MG 6113 Career Management
- MG 6233 Training in Organizations
- MG 6243 Organization Development

Electives, select nine credits:

- MG 6123 Human Resource Management
- MG 6143 Conflict Management
- MG 6153 Leadership & Team Development
- MG 6163 Job & Workplace Design
- MG 6181 Talent Management (1.5 credit)
- MG 6191 Coaching in Organizations (1.5 credit)
- MG 6201 Consulting in Organizations (1.5 credit)
- MG 6253 Seminar in Organization & Career Change
- MG 6271 Managing New Technology in Human Resources (1.5 credit)
- MG 6321 Global Human Resource Management (1.5 credit)
- MG 8653 Managing Technological Change & Innovation

Human Resource Information Systems (18 credits)

The concentration in human resource information systems integrates knowledge and skills in information systems and web-based technologies together with human resource management to achieve organizational effectiveness in the new economy.

Required:

- MG 6123 Human Resource Management
- MG 6263 Human Resource Information Systems
- MG 6283 Web-Based Human Resource Management

Electives, select nine credits:

- MG 6163 Job & Workplace Design
- MG 6173 Performance Measurement & Reward Systems
- MG 6181 Talent Management (1.5 credit)
- MG 6223 Staffing Organizations
- MG 6271 Managing New Technology in Human Resources (1.5 credit)
- MG 6503 Management of Information & Information Technology
- MG 7173 Enterprise Data Systems
- MG 8653 Managing Technological Change & Innovation

3. FREE ELECTIVES (6 credits maximum)

Up to six credits of appropriate graduate courses may be chosen from any program at Polytechnic with the Academic Director's permission.

4. RESEARCH PROJECT (3 credits)

- MG 9343 Research Project in Organizational Behavior
- All students must submit an independent research project, especially during the final semester.

REQUIREMENTS FOR ADVANCED CERTIFICATES

ADVANCED CERTIFICATE IN ORGANIZATIONAL BEHAVIOR (15 CREDITS):

Required (6 credits):

- MG 6013 Organizational Behavior
- MG 6313 Organization Theory & Design

Electives (9 credits) Selected from the following:

- MG 6143 Conflict Management
- MG 6153 Leadership and Team Development
- MG 6163 Job & Workplace Design
- MG 6181 Talent Management (1.5 credit)
- MG 6201 Consulting in Organizations (1.5 credit)
- MG 6243 Organization Development
- MG 6253 Seminar in Organization & Career Change
- MG 8653 Managing Technological Change & Innovation

Other MG courses may be substituted with the permission of the Academic Director.

ADVANCED CERTIFICATE IN HUMAN RESOURCE MANAGEMENT (15 CREDITS):

Required (9 credits):

- MG 6123 Human Resource Management
- MG 6173 Performance Measurement and Reward Systems
- MG 6223 Staffing Organizations

Electives (6 credits) Selected from the following:

- MG 6133 Labor Relations
- MG 6181 Talent Management (1.5 credit)
- MG 6201 Consulting in Organizations (1.5 credit)
- MG 6211 Outsourcing: A Human Capital Strategy (1.5 credits)
- MG 6233 Training in Organizations
- MG 6263 Human Resource Information Systems
- MG 6271 Managing New Technology in Human Resources (1.5 credit)
- MG 6283 Web-Based Human Resource Management
- MG 6321 Global Human Resource Management (1.5 credit)
- MG 8653 Managing Technological Change & Innovation

Other MG courses may be substituted with the permission of the Academic Director.

BS/MS ACCELERATED HONORS PROGRAM

The Department of Technology Management and the Department of Humanities and Social Sciences offer an honors program for exceptional first year or advanced undergraduate students.

Through this program, students can earn a Bachelor of Science in Liberal Studies (with a concentration in behavioral sciences) and a Master of Science in Organizational Behavior in four to five years. For further information please refer to the description in the catalog section of the Department of Humanities and Social Sciences.

For further information on any aspect of the Organizational Behavior Program, contact the Academic Director, Professor Harold G. Kaufman at ob@poly.edu.

COURSES

MG 6181 Talent Management 1.5:0:0:1.5

A survey course that provides a knowledge and understanding of the strategies and range of processes, methods and tools that are currently used by organizations in effective Talent Management programs. Includes a focus on the development and management of leadership talent as well as Talent Management practices for general management, pro-

fessional, technical and other positions. Topics include identifying and competing for critical talent pools; alignment and integration of HR practices; recruiting and employment branding; identifying, selecting, developing, reviewing and managing leadership talent; retention and recognition strategies; and career paths and career planning.

MG 6191 Coaching in Organizations 1.5:0:0:1.5

Focuses on the role of coaching in organizations as part of a talent management program to develop human resources. Provides an understanding of the definition, theoretical basis, functions and models of coaching. Examines how coaching is linked to the adult development lifecycle and the range of contexts in which coaching is applied. Addresses how coaching is used in leadership development as well as performance management, the multicultural aspects of coaching and the access minorities have to coaching. Provides a familiarity with the different coaching tools and instruments as well as how leading organizations are using coaching in their talent management programs. Issues related to certification as a coach are addressed.

MG 6201 Consulting in Organizations 1.5:0:0:1.5

Provides a practical orientation to consulting in organizations within an academic framework. Prepares students from a variety of disciplines for roles as internal as well as external consultants by building knowledge and skills to successfully take a client and project from entry through termination and evaluation. Each student is required to take a project from conception to presentation, thereby providing an in-depth understanding of the details and issues that need to be addressed in the consulting role. Online version available

MG 6211 Outsourcing: A Human Capital Strategy 1.5:0:0:1.5

A comprehensive course that prepares students from a variety of disciplines with the knowledge and skills necessary to make the "build" or "buy" decision when considering outsourcing as an appropriate alternative. Topics covered include strategic implications, financial aspects, project management, internal consulting, metrics, legal considerations, development of an effective template RFP (request for proposal), internal communication details and management of the vendor/provider relationship. Online version available

**MG 6271 Managing Human Resource
Technology in Organizations** 1.5:0:0:1.5

Examination of factors critical to the effective organizational adoption and utilization of technology in human resource applications. Topics covered include: project management; HR data and process standardization; organizational governance; the unique security requirements of HR data; metrics; and HR process and technology outsourcing. By understanding these issues and how organizations can address them, students will be better prepared to more effectively plan and implement HR process re-engineering and technology enablement.

**MG 6321 Global Human Resource
Management** 1.5:0:0:1.5

An overview of human resource management practices in today's global work environment. Topics addressed include international/socio-cultural diversity; key characteristics of select countries international business behavior; international strategic alliances; identification, recruiting, and selection of international personnel; training and development of expatriates and home country nationals; evaluation and coaching of employees in international organizations; intercultural skills acquisition for the line manager and human resources professional; team development strategies; and design of practical language learning tools for the HR professional and the line manager.

**MG 9861 Readings in Organizational
Behavior** 1.5:0:0:1.5

Each 1.5 credits

Directed individual study or supervised readings in advanced areas of organizational behavior. *Prerequisite: Program Director's permission.*

PHYSICS PROGRAM

Academic Adviser: Edward L. Wolf

Physics is the basic science for the natural world the science of matter, energy, and motion. Worthy of study for its own beauty, physics is also the foundation of engineering and the sciences.

GOALS AND OBJECTIVES

The mission of the Physics Program is to provide Polytechnic undergraduates with a strong foundation in physics, suited to the discipline, and to offer advanced opportunities for formal study in physics.

UNDERGRADUATE PROGRAM

The aim of the four-year Bachelor of Science program in Physics is to prepare students thoroughly for any one of the many careers for which a concentration in physics forms the base. For some students, this means preparation for graduate school and further study leading to the master or doctor's degree. For many others, it means professional work in industry, government or in high school teaching. Some students use their major in physics as preparation for work in mathematics, chemistry, biology, medicine, engineering, law, history of science, writing or business.

The program's emphasis on fundamental knowledge, thorough analytic training and the universal logic of science enables physics students to take these different paths. A typical program of study for this degree is at the end of this section. The great advantage of this program over more traditional approaches is its highly flexible and interdisciplinary nature. Students learn physics and at the same time become accustomed to working with engineers. The basic concepts of physics have a lasting value which makes graduates more able to alter their career as opportunities become available. At the same time, students can choose, with the help of their adviser, from the wide range of technical material available at the university, to make their own unique career preparation. The 128-credit program consists of three components: The first includes the science, computer science, humanities and math core courses required of all engineering students, plus an added 4-credit course on programming or computation (64 credits). The second component, in contrast, deals with advanced topics in physics (28 credits) which include, thermodynamics, covered in ME 3314; electromagnetic waves, covered in EE 3604; electrical circuits, covered in EE 2004;

dynamics and vibrations, covered in ME 3414; and quantum mechanics of atoms and molecules, covered in CM 703. Concepts of modern solid-state physics and modern optics are covered by PH 2344 and PH 4474, respectively. A capstone experience in Interdisciplinary Physics is provided in IDP Seminar (2 credits) and Senior Project (6 credits), as a part of the requirement. The third component of the curriculum (34 credits) differs from a traditional BS program in Physics in that students can choose courses according to their career interests. For instance, recommended for a pre-PhD track are CM 704 Statistical Mechanics and ME 2514 Measurement Instrumentation. However, these optional 8 credits, along with 12 credits of technical electives and the 8-credit sequence (for a total of 34 credits, including the Senior Project) can be tailored to meet the needs of students interested in entrepreneurship, teaching, biophysics, biomedical instrumentation, integrated circuit electronics (ic electronics), scanning probe metrology and computational science and engineering. For strong students, this program offers opportunities for dual degrees, especially the combinations PH/EE, PH/CM, PH/CH and PH/ME, because EE, CM and ME courses are built into the IPD programs. Dual degrees may be awarded, with approval of both of the departmental advisers involved, for students with as few as one additional year of credits. In the past, strong students have achieved dual degrees in four years of study by taking extra courses and sometimes including a summer course.

MINOR IN PHYSICS

The undergraduate physics minor consists of a set of four or more physics courses, totaling at least 15 credits. The courses should be at intermediate or advanced level and have the introductory physics sequence, PH 1004 and PH 2004, as prerequisites. An overall GPA of 2.0 is required in these courses to earn the minor. For transfer students, at least 8 credits must be earned at Polytechnic, with a 2.0 GPA. Suitable courses include:

- PH 2344 Introduction to Modern & Solid State Physics
- PH 2814 Astronomy & Astrophysics
- PH 3244 Concepts of Nanotechnology
- PH 4244 Techniques & Applications of Nanotechnology
- PH 5473 Modern Optics

UNDERGRADUATE COURSES

EG 1004 Introduction to Engineering and Design

1:3:2:4

An introduction to selected aspects of the history, philosophy, methodology, tools, and contemporary topics in engineering. Basic engineering experimentation and data analysis. Team design project. Analysis and presentation of engineering data and designs.

PH 1004 Introductory Physics I

4:1½:1:4

First of two introductory courses in general physics. One-dimensional motions. Vectors and two-dimensional motions. Newtons laws of motion. Conservation of energy and momentum. Rotational motions. Gravity. Statics and elasticity. Fluids. Oscillations. Heat and the laws of thermodynamics. *Prerequisite:* MA 1024 or an approved equivalent. *Co-requisite:* MA 1124 or an approved equivalent.

PH 1214 Physics of Motion and Sound

4:0:0:4

First of a two courses introductory sequence in general physics for majors other than science or engineering. One-dimensional motions. Vectors and Two-Dimensional Motions. Newtons Laws of motion. Conservation Laws of Energy and Momentum. Collisions. Rotational motions. Gravity. Statics and Elasticity. Fluids. Oscillations. Mechanical Waves. Superposition and Standing Waves. Sound and Acoustics. *Co-requisites:* MA 1114. Not acceptable substitute for majors where PH 1004 is required

PH 2004 Introductory Physics II

4:1½:1:4

Second of two introductory courses in general physics. Electric forces and fields. Electric potential and capacitance. Electric current. Magnetic forces and fields. Faradays law and inductance. Maxwells equations. Mechanical and electromagnetic waves. Geometrical optics. Interference and diffraction. *Prerequisites:* PH 1004, MA 1124 or an approved equivalent.

PH 2344 Introduction to Modern and Solid State Physics 4:0:0:4

Special theory of relativity, Michelson Morley experiment. Planck's quantum hypothesis, photoelectric effect, Compton effect, Rutherford scattering, Bohr's atom, de-Broglie wavelength, electron diffraction, wave function, uncertainty principle, Schrodinger equation. Application to: square well potential, one electron atom. Atomic nucleus, fission and fusion. Energy bands in a periodic lattice, Kronig Penney model, valence, conduction bands, impurity states, electron mobility. Semiconductor properties. Introduction to superconductivity; electron pairs, energy gap, Josephson effect. *Prerequisite: PH 2004.*

PH 2814 Astronomy and Astrophysics 4:0:0:4

Historical development of observational astronomy. Traditional and modern observational techniques. Theories of formation and evolution of stars, planets and galaxies. Current developments in astronomy, cosmology and astrophysics. *Prerequisite: PH 2004.*

PH 3104 Analytical Mechanics 4:0:0:4

Statics by virtual work and potential energy methods. Stability of equilibrium. Particle dynamics, harmonic oscillator and planetary motion. Rigid body dynamics in two and three dimensions. Lagrangian mechanics. Dynamics of oscillating systems. *Prerequisites: MA 2122 and PH 2004.*

PH 3124 Thermodynamics and Statistical Physics 4:0:0:4

Fundamental laws of macroscopic thermodynamics, heat, internal energy, entropy. Introduction to statistical physics, including applications of Maxwell, Fermi-Dirac and Bose-Einstein distributions. *Prerequisites: MA 2122 and PH 2344.*

PH 3234 Electricity and Magnetism 4:0:0:4

Properties of the electrostatic, magnetostatic and electromagnetic field in vacuum and in material media. Maxwell's equations with applications to elementary problems. *Prerequisites: MA 2122 and PH 2004.*

PH 3244 Concepts of Nanotechnology 3:0:1:4

The first of an interdisciplinary, two-semester sequence on concepts, techniques and ap-

plications of nanotechnology. Introduction to nanotechnology, examples of nanoscale systems. Systematics in miniaturization from the mm to the nm scale. Limits to miniaturization. Quantum concepts and elementary Schrodinger theory. Quantum effects in the behavior of chemical matter. Examples of self-assembled nanosystems from nature and from contemporary industrial products. *Prerequisite: PH 2004.*

PH 3811-3848 Reading Courses in Inter-disciplinary Physics 1:0:0:1- 4:0:0:4

Special topics in interdisciplinary physics supervised by staff member. *Prerequisites: PH 2344, must be an interdisciplinary physics major.*

PH 4244 Techniques and Applications of Nanotechnology 3:0:1:4

The second of a two-course sequence on concepts and techniques of nanotechnology. Novel function and performance can occur with materials or devices of size scales of one to 100 nanometers, a range extending from molecular scale to that of typical linewidths in contemporary microelectronics. Nanosystems may provide entirely new functions, by virtue of access enabled by the small size. Photo and x-ray lithographic patterning. Scanning probe microscopes for observation and for fabrication. Molecular machines as envisioned by Drexler. The role of an der Waals force. Questions of machine manufacturability on the nm scale. The IBM GMR hard-drive read head. Micro- and nano-electromechanical devices and systems. Single-electron electronics. Molecular electronics. *Prerequisite: PH 3244.*

PH 4364 Introduction to the Quantum Theory 4:0:0:4

Quantitative introduction to the quantum theory, which describes understanding light, electrons, atoms, nuclei and solid matter. Superposition principle, expectation values, momentum operator and wave function, duality, current vector, hermitian operators, angular momentum, solution of the radial equation, electron in a magnetic field, perturbation theory, WKB approximation, identical particles. Applications include alpha decay, electrons in a periodic lattice, hydrogen spectrum, helium atom, neutron-proton scattering, and quark model of baryons. *Prerequisites: MA 2122 and PH 2344.*

PH 4474 Modern Optics 4:0:0:4

The physics of optics using both classical and semi-classical descriptions. The classical and quantum interactions of light with matter. Diffraction of waves and wave packets by obstacles. Fourier transform optics, holography, Fourier transform spectroscopy. Coherence and quantum aspects of light. Geometrical optics. Matrix optics. Crystal optics. Introduction to electro-optics and nonlinear optics. *Prerequisite: PH 3234 or equivalent.*

PH 4902 Introduction to Senior Project in Interdisciplinary Physics 0:4:0:2

A qualified senior physics student or several such students work with a faculty member (and perhaps graduate students as well) on an advanced problem in interdisciplinary physics. In this introductory phase the student(s) and adviser select a suitable theoretical or experimental problem in the subject area and cognizant of resources at hand, make plans for its solution.

PH 4904 Senior Project in Interdisciplinary Physics 0:8:0:4

Concluding phase of the project; senior physics students or several such students work with a faculty member (and perhaps graduate students as well) to solve an advanced problem in interdisciplinary physics. The conclusion of the project is a written report and an oral presentation made to the supervising faculty.

PH 4912 Senior Seminar in Interdisciplinary Physics 2:0:0:2

Senior physics students, in consultation with the instructor, study and prepare presentations, several current research topics in the general area of interdisciplinary physics. Students' performance in this course is based on the mastery of the material chosen and also on the quality of the presentation made to the instructor and the seminar members.

GRADUATE COURSES

PH 5343 Physical Basis of Nanotechnology 3:0:0:3

This course focuses on the underlying physical basis of nanotechnology. Introduction to nanotechnology, examples of nanoscale systems. Systematics in miniaturization from the mm to the nm scale. Limits to miniaturization. Quantum concepts and elementary Schrodinger theory. Quantum effects in the behavior of chemical matter. Examples of self-assembled nanosystems from nature and

from contemporary industrial products. *Prerequisite: PH2004 Introductory Physics II*

PH 5443 Physical Techniques and Applications of Nanotechnology 3:0:0:3

This course focuses on physical techniques and applications of nanotechnology. Scanning probe microscopes for observation and fabrication. Photolithographic methods of patterning, deposition techniques. Dense memory based on arrays of cantilevers. Magnetic Tunnel Junctions as elements of magnetic disc memory read heads and in Magnetic Random Access Memory. Nanoscale high-electric-field devices. Nanoscale confinement techniques and devices. Applications of carbon nanotubes and semiconductor nanowires. Assembly methods for nanoscale objects. *Prerequisite: PH 2004 Introductory Physics II*

PH 5473 Modern Optics 3:0:0:3

The physics of optics using both classical and semi-classical descriptions. The classical and quantum interactions of light with matter. Diffraction of waves and wave packets by obstacles. Fourier transforms optics, holography, Fourier transform spectroscopy. Coherence and quantum aspects of light. Geometrical optics. Matrix optics. Crystal optics. Introduction to electro-optics and nonlinear optics. *Prerequisites: MA 2122, PH 3234 equivalent.*

PH 5483 Modern Optics Lab 0:3:0:1

The modern optics laboratory includes experimental investigations into laser modes, velocity of light by time-of-flight, Fourier optics, holography, Fourier transform spectroscopy, crystal optics and nonlinear optics. *Co-Prerequisite: PH 547 or equivalent.*

PH 6513 / PH 6523 Introduction to Solid-State Physics I/II each 3:0:0:3

Phenomena and theory of physics of crystalline solids. Topics from thermal, magnetic, electrical and optical properties of metals, insulators and semiconductors. PH 6513 prerequisite: PH 2344 or equivalent. PH 6523 prerequisite: PH 6513.

PH 6673 / PH 6683 Quantum Mechanics I/II each 3:0:0:3

Quantum mechanics with applications to atomic systems. The use of Schrodinger's equations. Angular momentum and spin. Problems and approximation methods. Semi-classical theory of field-matter interaction. Also listed under EL 6553/ EL 6563, *Prerequisites: MA 2122, PH 3234 or equivalents. PH 6683, prerequisite: PH 6673*

PH 8013 / PH 8023 Selected Topics in Advanced Physics I/II each 3:0:0:3

Current or advanced topics of particular interest to graduate students. Subject matter determined each year by students and faculty. May be given in more than one section. Consult department office for current offerings. Note: this course is not offered every semester, Prerequisite: Permission of instructor

PH 9993 Research in Physics each 3 units

An original investigation in some branch of physics or chemical physics, which may serve as basis for the MS or PhD degree, to be performed under the direction of a member of the department. The number of research credits registered for each semester should realistically reflect the time devoted to research. *Prerequisites: degree status and graduate adviser's and research director's consent.*

Typical Course of Study for the Bachelor of Science in Physics

FRESHMAN YEAR

Fall Semester

Course No.	Course Title	Hours/Week			
		Class	Lab.	Rec.	Cr.
MA 1024	Calculus I	4	0	0	4
CM 1004	General Chemistry	3	2	1	4
EG 1004	Intro. Engineer. Design	1	3	2	4
EN 1014	Writing & Humanities I	4	0	0	4
SL 1010	Freshman Seminar	1	1	0	0
					16

Spring Semester

Course No.	Course Title	Hours/Week			
		Class	Lab.	Rec.	Cr.
MA 1124	Calculus II	4	0	0	4
PH 1004	Intro. Physics I	4	1½	1	4
CS 1114	Intro. Prog. & Problem Solving	3	3	0	4
EN 1204	Writing & Humanities II	4	0	0	4
					16

SOPHOMORE YEAR

Fall Semester

MA 2012	Linear Algebra	4	0	0	2
MA 2132	Ordinary Diff. Equ. (1/2 semester)	4	0	0	2
PH 2004	Intro. Physics II	4	2	1	4
CS 1124	Object. Orien. Prog.	4	0	0	4
or					
ME 2114	Comp. ME Engineer. Design	4	0	0	4
HI 2104	Modern World History	4	0	0	4
					16

Spring Semester

MA 2112	Multi. Calculus A (1/2 semester)	4	0	0	2
MA 2122	Multi. Calculus B	4	0	0	2
EE 2004	Fund. El. Ckts	3½	1½	1	4
PH 2344	Int.Mod/SolStPh Technical Elective ³	4	0	0	4
or					
CM 2614	Phys. Chemistry I ³	4	0	0	4
					16

JUNIOR YEAR

Fall Semester

EE 3604	Electromag. Waves	4	2	1	4
ME 3314	Flow/Thermal Systems	4	0	0	4
or					
CM 3614	Physical Chemistry II ³	2	6	0	4
ME 3414	Dynamics, Vibr.	3	0	0	4
	HU/SS Elective	4	0	0	4
					16

Spring Semester

ME 2514	Measurement/Instrum. Technical Elective	3½	1½	0	4
		4	0	0	4
HU/SS	Elective1 Sequence A	4	0	0	4
		4	0	0	4
					16

SENIOR YEAR

Fall Semester

CM 703	Chemical Physics I	4	0	0	4½
PH 4902	Intro. Senior Project		4		2
PH 4912	Seminar Cont. IDP	2			2
PH 4474	Mod. Optics Sequence B	4	0	0	4
		4			4
					16½

Spring Semester

CM 704	Chem. Physics II ²	3½	0	0	4½
or					
CM 5714	Mol.Mod.Sim. ³ Technical Elective	3	3	0	4
		4	0	0	4
PH 4904	Senior Project HU/SS Elective		8		4
		4	0	0	4
					16½

Total credits required for graduation:

128

- For students on the Entrepreneurial Track, HI 3165 is recommended.
- For students on the Entrepreneurial Track, recommended substitution and elective choices include MG 1002, MG 2304, MG 3204 and others in the Technology and Information Management Program section.
- For students on the Computational Science and Engineering Track, the recommendation for the Technical Elective in the sophomore spring semester is shifted to junior fall semester; and EE 3604 is shifted to the junior spring semester; and ME 2514 is deleted.

SYSTEMS ENGINEERING PROGRAM

Program Co-Director: Zhong-Ping Jiang and Farshad Khorrami

Systems engineering is based on the body of theoretical knowledge that underlies the engineering of modern complex systems. Systems engineering applies this body of knowledge to designing systems, usually involving the integration of several disciplines to achieve the desired design objective. The theoretical resources of these fields include selections from among the newer branches of applied mathematics, methods of modeling and simulation, methods for the analysis of signals and systems, the theories of communication and control, the techniques of optimization and of decision-making and many of the facets of computer science.

Faced with a diverse and complex scientific environment, systems engineers may receive assignments crossing traditional lines of engineering applications. Systems engineering is presently applied in such areas as communications, networking, transportation, urban services, bioengineering, resource management, power and energy, and environmental and pollution control.

The Systems Engineering Program stresses computer use. It covers, in an interdisciplinary manner, the viewpoints, tools of analysis and mathematical techniques of signals and systems, feedback control, analysis of data, optimization and simulation, communication of information, instrumentation and measurement. The orientation and training that systems engineering students receive at Polytechnic enable them to analyze and solve today's complex technological and societal problems.

The Department of Electrical and Computer Engineering administers the program leading to the degree Master of Science in Systems Engineering. Outstanding students should apply for financial aid in the form of research fellowships, teaching fellowships or partial tuition remission. Students wishing to continue graduate study towards a PhD in the area of systems may do so in the Electrical Engineering Program.

GOALS AND OBJECTIVES

The Master of Science program in System Engineering has the following specific objectives to provide students with the following:

- Skills and advanced knowledge in the design and analysis of engineering systems, including methods of modeling and simulation, methods for the analysis of signals and systems, theories of communication and control and techniques of optimization and of decision-making
- Training in using modern computers to perform analysis and simulation and to solve real system problems
- Baseline skills and knowledge in system engineering project management
- A basis for continued, lifelong learning in the system engineering profession

REQUIREMENTS FOR THE MASTER OF SCIENCE

The entrance requirement for a Master of Science in Systems Engineering is a Bachelor's degree in engineering or science from an accredited institution, with at least a B average in undergraduate technical courses. It is noted that for some tracks, students should have taken undergraduate courses in differential equations, probability, linear systems, feedback control, and computer programming. Deficiencies in any of the subject matters should be addressed by taking the required courses for any particular track.

To satisfy the requirements for an MS in Systems Engineering, students must complete three core courses and two tracks, at least one of which must be a core track. A minimum of three courses should be taken in a track. One course in each track may be a core course. The remaining credits (up to 9 credits) can be chosen from any science, engineering and management courses. If a student elects to write a MS thesis (6 credits), then only two courses in a track are required. The total number of credits required is 30 and at least 15 credits should be from EL prefixed courses. A GPA of 3.0 or above is required in all graduate courses.

Core Courses

Three courses from among the following:
EL 5213 Introduction to Systems Engineering
EL 6213 System Modeling, Analysis and Design
EL 6233 Systems Optimization Methods
EL 6253 Linear Systems
EL 6303 Probability
MG 8203 Project Management
Total = 9 Credits

Core Tracks:

- Network Management (EL5363, 5373, 6373, 7353, 7363)
- Mobile Communications (EL5013, 5023, 6013, 6023, 6033)
- Systems and Automation (EL5223, 5253, 6253, 8223)
- Energy Systems (EL5613, 6623, 6633, 6653)
- Large Scale Systems Modeling and Control (EL6253, 7253, 8253, 92x3)
- Multimedia Applications (EL5123, 5143, 6113, 6123, CS6643)

Total = 6-18 Credits

Elective Tracks:

Computer Systems and Security (CS6813, CS6823, CS9043, EL6393)
Software Engineering (CS6063, CS6073, CS6083, CS6183)
Operations Research and Management (MG6303, MG6461, MG8203, FE6023)
Financial Engineering (FE6023, FE6083, FE6103, FE6411, FE6291)
Biological Systems (Selected courses with prefix BE, CH, CM, subject to advisor approval)

Total = 0-9 Credits

Free Electives

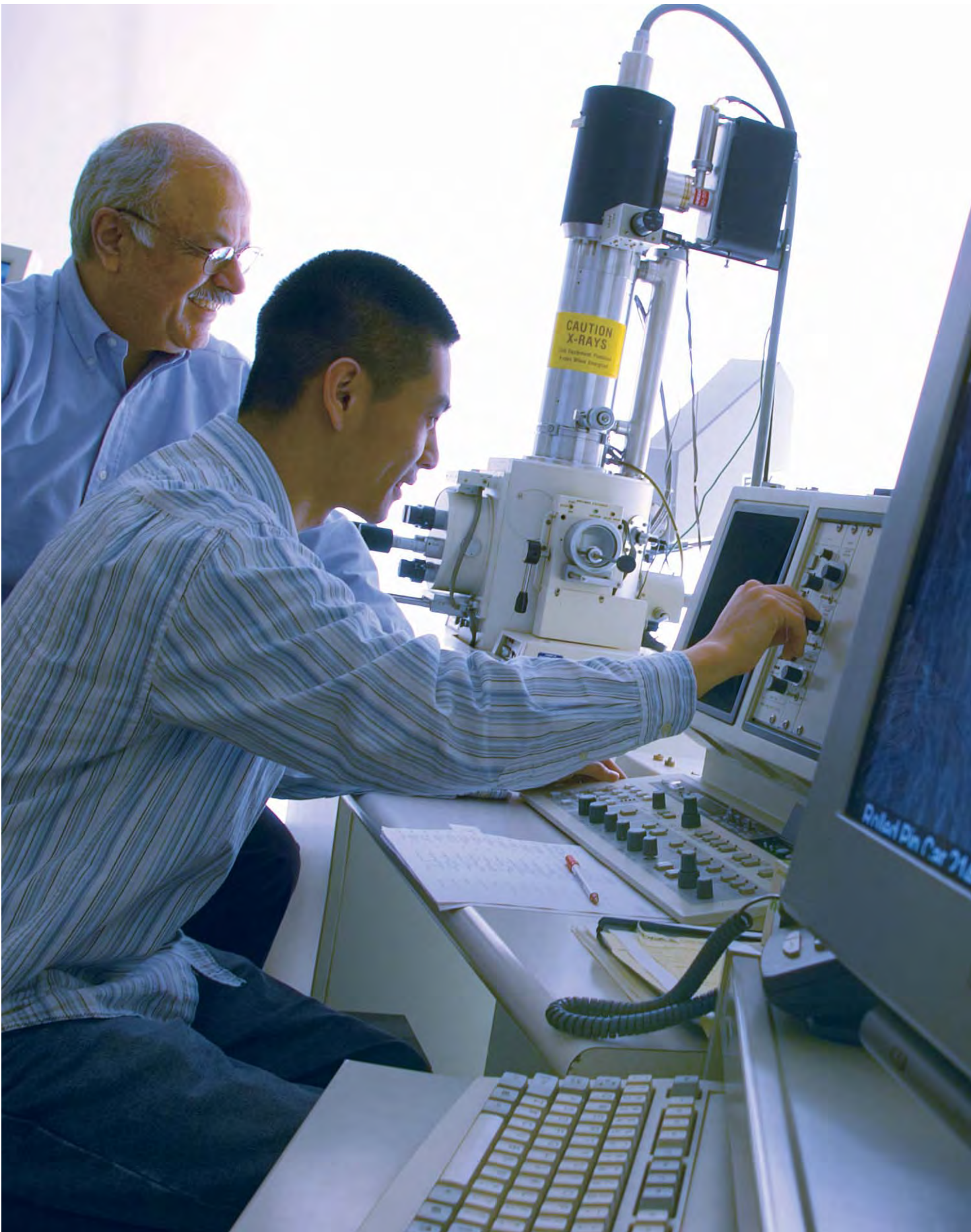
Any courses in science, engineering or management

Total = 0-9 credits

Grand Total = 30 Credits

The list of tracks and approved courses in a track may be updated after the publication of this catalog. Students should consult the Department of Electrical and Computer Engineering's Graduate Student Manual (www.poly.edu/ece/graduate) for the updated list. The Graduate Manual also contains more detailed rules and procedures including student status, transfer credits, recommended electives, current areas of research, and disqualification for low grades.

Descriptions of graduate courses in engineering, science, and management used in the Systems Engineering Program are located in the relevant program sections of this catalog.



TECHNICAL COMMUNICATION PROGRAM

Academic Adviser: Elisa Linsky

While the demands for technology are constantly in flux, there is one resource that is always in demand: people who are able to communicate clearly and effectively. Technical communicators create and design work that helps people solve problems and learn new things. Their skill lies in the ability to determine the best way to present information to a specific audience. Their job is to creatively construct new knowledge from existing information.

The Department of Humanities and Social Sciences at Polytechnic University has developed a Bachelor of Science in Technical Communication to address this need. Through course projects and internships, students build a solid portfolio that demonstrates a wide range of writing, editing, and design skills as well as in-depth knowledge within an area of specialization.

The following programs of study are available to our students:

- Bachelor of Science in Technical Communication
- BS/MS Accelerated Degree
- Minor in Technical Communication
- Master of Science in Specialized Journalism
- Graduate Certificate in Technical Communication

The Technical Communication Program is designed to train students to translate technical information so that it can be easily understood. Students develop their writing, editing, research and design skills and their interpersonal, organizational and management abilities. Students should have strong communication skills as well as a keen interest in, or aptitude for, technology, science and business. The curriculum explores the theoretical foundations of contemporary communications and the advancement of new media, with a strong emphasis on the practice of effective communication.

BACHELOR OF SCIENCE

See requirements for BS in Liberal Studies in the Liberal Studies Program section of this catalog. Students earning the BS in Technical Communication complete a series of 36 credits in technical communications courses. Up to 20 credits of other professional courses may be substituted, with approval of the academic adviser, for liberal studies focus courses.

GOALS AND OBJECTIVES

The specific goals and objectives of the Technical Communication Program are to provide the following:

- The fundamental skills that allow technical communicators to creatively construct new knowledge from existing information
- A solid foundation in the technology required to advance communication beyond its traditional confines
- An advanced understanding of user centered design and its implications in the creation of new media

BS/MS ACCELERATED HONORS PROGRAM

The Technical Communications Program offers a BS/MS honors program for exceptional first year students and advanced undergraduates. Through this unique program, students can earn both a Bachelor of Science and a Master of Science in Technical Communication/ Specialized Journalism in just four to five years. The accelerated program allows students to take up to 9 credits that fulfill both undergraduate and graduate degree requirements. In addition, credit may be granted for high school Advanced Placement courses where a student earns a 4 or 5 on the AP test. Students accepted into the program may also earn up to 18 credits through one or more undergraduate and graduate internship opportunities. To be eligible for this program, high school students must meet the following criteria:

- A minimum 3.33 (B+) GPA
- A minimum 600 verbal SAT score (1200+ overall score preferred)

Polytechnic freshmen, sophomores, and juniors must meet the following requirements:

- A minimum 3.33 (B+) GPA
- Two letters of recommendation from Polytechnic faculty

All candidates for the program must pass an entrance examination administered by the department and be interviewed by the program adviser. Once enrolled in the program, students are expected to maintain a 3.0 GPA.

MINORS IN TECHNICAL COMMUNICATION

A minor in technical communication is awarded to students who complete 16 credits (four courses) in technical communications. Any combination of courses may be taken.

The following combinations are recommended:

Technical Communication for Computer Professionals

- TC 2314 Computer Documentation
- TC 2324 Human Factors for Technical Communicators
- TC 3324 Writing for New Media
- TC 3134 Interactive Design for the Web and CDROM

Print and Digital Design

- TC 2114 Introduction to Visual Communication Design
- TC 2124 Digital Graphics
- TC 3124 Advanced Visual Communication Design
- TC 3134 Interactive Design for the Web and CDROM

Integrated Business Communication

- TC 2514 Marketing and Public Relations Writing
- TC 2114 Introduction to Visual Communication Design
- TC 2514 Technical Presentations
- TC 2524 Copyediting for Technical, Scientific and Business Publications

MASTER OF SCIENCE

GOALS AND OBJECTIVES

The specific goals of the MS in Specialized Journalism are to do the following:

- Provide the advanced communication skills necessary to create new knowledge from existing information in order to help others solve problems and learn new things
- Allow students to expand beyond a solid foundation in the essentials of technical communication and explore a specific area within the discipline: specialized journalism, writing for business, documentation, and user centered design, or writing for new media
- Train students to translate technical information so that it can be easily understood by others

REQUIREMENTS

The Master of Science in Specialized Journalism is awarded to students who complete a minimum of 30 credits. Students enrolled in the program are required to complete the following core courses:

TECHNICAL COMMUNICATION PROGRAM

Course No.	Course Title	Credits
JW 6003	Introduction to Technical Communication	3
JW 6013	Style for the Professional Writer	3
JW 6023	Copyediting for Technical, Scientific & Business Publications	3
JW 7043	Master's Project	3

Electives: Six courses: 18 credits At least four electives (12 credits) must be chosen from JW 6003-JW 6473. The two other electives (6 credits) may be chosen from another department with the approval of the graduate adviser in specialized journalism.

Total credits: 30 credits. Part-time students:
Required Subjects: as above: 12 credits
Electives: as above: 18 credits
Total credits: 30 credits

AREAS OF SPECIALIZATION

Recommended Courses for Specializations
All these courses are 3 credits:

JW 6033 Reporting on Medicine, Science & Technology

JW 6053	Libel Law
JW 6063	Technical Presentations
JW 6073	Writing News for Radio & Television
JW 6213	Reporting and Editing for the Trade Press
JW 6253	Corporate Communications in Medicine, Science & Technology
JW 6273	Writing Copy on Pharmaceuticals & Biotechnology
JW 6353	Online Journalism
JW 6363	The Feature Article
JW 6373	Computer Assisted Reporting
JW 6043	Graphic Design & Technical Illustration
JW 6063	Technical Presentations
JW 6183	Interactive Web Design
JW 6213	Reporting & Editing for the Trade Press
JW 6233	Project Management
JW 6243	Writing Product Information Copy
JW 6263	Public Relations for Medicine, Science & Technology
JW 6273	Writing Copy on Pharmaceuticals & Biotechnology
JW 6283	Business to Business Advertising
JW 6313	Proposal Writing
JW 6323	Writing Technical Manuals & Procedures
JW 6413	Desktop Production Workshop: Documentation Training and the New Media
JW 6043	Graphic Design & Technical Illustration
JW 6083	Computer Documentation I
JW 6093	Computer Documentation II
JW 6113	Technical Translation & Localization Practices
JW 6133	Human Factors & Product Design
JW 6153	Multimedia Technologies
JW 6183	Interactive Web Design

JW 6233	Project Management
JW 6323	Writing Technical Manuals & Procedures
JW 6413	Desktop Production Workshop
JW 6453	Instructional Design & Development
JW 6463	End User Training
JW 6473	Computer Based End User Training

GRADUATE CERTIFICATE

The Graduate Certificate Program in Technical Communication trains students in the fundamentals of technical communication through a combination of core courses and electives. To earn a certificate, students must complete 15 credits. All units earned in the graduate certificate program are transferable to the Master of Science in Specialized Journalism. In general, all certificate students should take the following core courses. All these courses are 3 credits:

JW 6003	Intro. to Technical Communication
JW 6013	Style for the Professional Writer
JW 6023	Copyediting for Technical, Scientific & Business Publications
Electives:	two courses: 6 credits. Both electives (6 credits) must be chosen from JW 6003-JW 6473.

Total credits: 15 credits

ePOLY ONLINE GRADUATE CERTIFICATE

A Graduate Certificate in Documentation, Web Usability and Human Factors Engineering is available online. The following courses are required for the certificate: JW 6003*, JW 6083* and JW 6093.

Two electives must be taken from the following: JW 6023*, JW 6133 and JW 6233.

**Available online.*

UNDERGRADUATE COURSES

TC 1014 Introduction to Technical Communication I 4:0:0:4

Introduction to the research, writing and design principles and practices of technical communication, particularly in the fields of specialized journalism, documentation, advertising and public relations, corporate communications, training and instructional design and new media. Emphasis on clarity and control in writing and effective information design; also covers the basic elements of effective document design. The focus is on traditional media. *Prerequisite: EN 1024.*

TC 1024 Introduction to Technical Communication II 4:0:0:4

Introduction to the research, writing and design principles and practices of technical communication, particularly in the fields of specialized journalism, software documentation, advertising and public relations, corporate communications, training and instructional design, and new media. Emphasis on clarity and control in writing and effective information design; also covers the basic elements of effective document design. The focus is on the new and digital media. *Prerequisite: EN 1024; course does not require TC 1014, but both courses must be taken before taking 2000-level courses.*

TC 2104 Writing for Engineers and Scientists 4:0:0:4

Engineers and scientists must become adept at communicating their ideas in writing. In actual business situations, they are called upon to present their work to colleagues and management frequently. This workshop course focuses on the skills that must be acquired to succeed professionally. Course covers proposals, reports, new product reviews, technical descriptions and instructions as well as the basics of successful professional communication in the form of emails and memos. Students learn how to design documents. Style and organization are stressed. *Prerequisite: EN 1204.*

TC 2114 Introduction to Visual Communication Design 4:0:0:4

An introduction to the principles of design and how to apply these principles for effective visual communication. Students study the physiology and psychology of perception and the psychological, sociological, and educational impact of design. During workshop sessions, students critique and create numerous design projects, including business documents, logos, brochures, and product packages. The fundamentals of desktop publishing are covered. Students begin to develop a portfolio of class projects. *Prerequisites: EN 1024.*

TC 2124 Digital Graphics 4:0:0:4

An introduction to image creation and editing: Photoshop, Illustrator, and a bit of Flash. Participants learn to optimize files for the Internet, color correct and manipulate digital photographs, and work with vector graphics. *Prerequisite: EN 1204.*

TC 2214 News and Feature Writing
4:0:0:4

A workshop in basic news and feature writing techniques. Students learn methods of information gathering and interviewing for different types of news articles, including current events, meetings, speeches, human interest, and news analyses. Students also learn the style and structure of news stories and feature stories, how to write effective leads and the basics of libel law and press ethics. Students learn how to write headlines, leads, decks, and subheads for general, technical, and industrial publications. Newspaper, magazine, and online layout and design. The course includes practice in basic copyediting techniques, including editing, revising, and rewriting copy intended for a variety of audiences, publications, and media. Peer and self-editing projects and assignments. *Prerequisite: EN 1024.*

TC 2224 Introduction to Communication
4:0:0:4

Communication theory is the silent partner of all writing and media professions. It helps people to plan projects that must be communicated. At the same time, it helps people to be more astute readers of communication initiated by others. This course develops strategies for the critical understanding of communication through the study of fundamental topics in its history and theory. Students consider how conceptions of the public sphere, freedom of expression, and intercultural exchange have shaped mass media. Of particular concern is an understanding of fact, identity, and entertainment in the age of instantaneous communication. Students seek answers to the following questions:

What terminology and philosophical frameworks can provide people with a deeper understanding of communication? What is mass media and what are its effects on society? What legal and ethical considerations should be brought to the study of media? How have ideas of copyright and trademark influenced media and what are the effects of global English? How have computers and the age of new media transformed (or failed to transform) communications? *Prerequisite: EN 1204.*

TC 2314 Computer Documentation
4:0:0:4

Introduction to the field of computer documentation. Students learn systems and software documentation procedures and techniques; computer documentation tools;

and the fundamentals of project management, from needs analysis to usability testing. A portion of course is devoted to the fundamentals of online documentation. A major documentation project is required. *Prerequisites: EN 1204.*

TC 2324 Human Factors for Technical Communicators
4:0:0:4

This course focuses on designing, developing and testing technical information pertaining to the ergonomics of information design. Technical writers rely on a relationship between themselves and the people who use the information they disseminate. This course will teach the techniques human factors engineers take into account. Students learn to consider both the ergonomics of design as well as its cognitive implications. *Prerequisite: EN 1204.*

TC 2414 Technical Presentations 4:0:0:4

Principles of effective scientific and technical presentations. This skills based course focuses on effective ways to convey technical information to both professional and lay audiences by asking students to prepare weekly presentations they will deliver in class.

Audience analysis, research, organization of material, the selection of appropriate media, and the use of graphics are taught. Emphasis is placed on successful strategies for dealing with the presentation of numbers and other technical data. *Prerequisite: EN 1204.*

TC 2514 Marketing and Public Relations Writing
4:0:0:4

Almost all businesses depend on effective marketing for their survival. And many organizations seek to increase their visibility, heighten their profile and modify public perception of what they do by mounting public relations campaigns. In this course, students are introduced to, and experiment with, producing a full range of print based marketing and public relations materials, including resumes, brochures, project proposals, newsletters and other direct mail advertising, commercial print advertisements, press releases, and story proposals for the trade press. The course examines the differing goals of marketing versus PR, explores the challenges of successfully “branding” an organization, and emphasizes the importance of strategic, targeted marketing and PR efforts. Connections are made, where appropriate, to marketing and PR writing for electronic and nonprint media. *Prerequisite: EN 1204.*

TC 2524 Copyediting for Technical, Scientific and Business Publications 4:0:0:4

Copy editors play a crucial role in any media organization that conveys information through text. Beginning with an overview of the editorial process, this course addresses the many skills that copy editors must master to produce clean, readable, internally consistent copy. Topics covered include using references, imposing editorial style, marking up manuscripts, organizing text, handling proper names and specialized terms, crediting sources, checking facts, and resolving conflicts between an author’s voice and that of the editor or publication. Specific issues of grammar, punctuation and style are dealt with in a series of presentations (three or four each week) over the course of the semester. *Prerequisites: EN 1204 and TC 1014.*

TC 3124 Introduction to Visual Communication Design II
4:0:0:4

The purpose of this course is to apply previously gained knowledge of design and design software to more complex design problems. Students create magazine layouts, package designs, promotional pieces, and multiple page booklets using primarily QuarkXPress and Adobe In Design, along with Adobe Illustrator and Adobe Photoshop. In-class critiques and computer exercises also play an important role in the classroom. Trips to design related exhibits complement ideas discussed in class. *Prerequisites: EN 1204 and TC 2114.*

TC 3134 Interactive Design for the Web and CDROM
4:0:0:4

An advanced seminar for those seriously interested in web design: interactivity, usability and the quality and appropriateness of look and feel are stressed, but participating students are also expected to develop content and complete a professional quality site for the class. *Prerequisite: TC 2124.*

TC 3224 Critical Writing
4:0:0:4

Students learn how to research, structure, and write critical, analytic and interpretive texts, including such genres as book reviews, journal articles, product reviews, and scientific reports. For example, they may write about technical, scientific, medical, business, industrial or digital subjects for the lay audience. Particular attention is paid to assessing audience and purpose and constructing analytic arguments. Students hone revision and copyediting skills, as well as learning how to work as peer reviewers, editors and proof

readers. For final project, students research and write text targeted for specific publications. *Prerequisites: EN 1204.*

TC 3324 Writing for New Media 4:0:0:4

Planning, writing, and designing an effective project for digital or new media formats such as intranet, Internet, newsgroups and kiosks. Students learn HTML and software applications for web-page development, integration of graphics and text, and effective use of hypertext linking and structures. Students examine new media and the effects they have on reading, writing, and information processing. Class is a hands-on lab, supplemented by discussion and short presentations of key writing concepts. Final project required. *Prerequisite: EN 1204.*

TC 3404 Special Topics in Technical Communication 4:0:0:4

Independent or small group work in an area of technical and professional communication selected by students in consultation with instructor. *Prerequisites: for majors only, TC 1014, TC 1024, TC 2114, TC 2214, TC 3XX4 and instructor's permission.*

TC 4404 Internship 4:0:0:4

Full- or part-time placement as a technical/professional communication intern. Intense, practical work experience focusing on students area of specialization. Students work with a professional adviser within the sponsoring organization and a faculty adviser within the department. Weekly progress reports and a final report required. *Prerequisites: for Technical Communication majors and minors only, junior or senior standing, appropriate courses for internship project and approval of the sponsoring organization and the department.*

TC 4504 Senior Project and Portfolio Review 4:0:0:4

In this Capstone course, students develop a major project that integrates the knowledge and skills they have acquired through the program. Students manage the project from start to finish under the guidance of their project adviser. In addition, students revise selected projects from previous classes to develop a professional portfolio of writing samples. *Prerequisites: for Technical Communication majors only, senior status and completion of 1000-, 2000- and 3000-level course requirements.*

GRADUATE COURSES

JW 6003* Introduction to Technical Communication 3:0:0:3

An overview of the research, writing, editing, and design principles of technical and professional communication. Students learn how to gather, organize, and present information effectively, according to audience and purpose. Writing projects range from procedures and explanations to articles and advertisements. **Online version available.*

JW 6013* Style for the Professional Writer 3:0:0:3

As applied to writing, the word *style* can mean many different things—from the standard rules of good grammar and clear expression, to a set of conventions imposed on a text by a particular publishing organization, to the idiosyncrasies of a writer's own distinctive voice. Although this online course attends to all these meanings, it focuses primarily on style as genre, introducing students to several of the different kinds of written documents that a versatile professional writer might be commissioned to prepare, and exploring the prevailing stylistic conventions in each of these genres. **Online version available. Prerequisite: Graduate status.*

JW 6023* Copy Editing for Technical, Scientific and Business Publications 3:0:0:3

Copy editors are at the center of any print media organization. Course addresses skills copy editors must have to produce clean copy: correct grammar and punctuation; a precise and consistent style; fact checking, including the use of both standard references and electronic databases; editing leads; making news judgments when editing stories; legal concerns affecting writers and editors, including libel, invasion of privacy, and copyright infringement; writing headlines; handling photographs and informational graphics; and designing and laying out pages. **Online version available.*

JW 6033 Reporting on Medicine, Science and Technology 3:0:0:3

Researching and reporting on medicine, science, and technology. Students interview recognized medical, scientific, and technology authorities in a given discipline to write and edit news and feature articles for a general audience. Course considers how science writers develop feature articles, how they translate technical information effectively and engagingly to the lay audience and how

they follow articles through to publication. Students analyze several scientific, medical, and technical magazines for content, style, and editorial practices. Students are encouraged to submit the work they do in the course for publication. *Prerequisite: JW 6013 or instructor's permission.*

JW 6043 Graphic Design and Technical Illustration 3:0:0:3

Elements of design, especially as they apply to technical communications. Course covers design in print, on computer, and in other media; components of the human visual system; perception; psychological and sociological impact of design. Students use design theory to develop effective two-dimensional technical communications design projects. *Prerequisite: Graduate status.*

JW 6053 Libel Law and Press Ethics 3:0:0:3

Based on a study of some classic cases, course familiarizes students with the essentials of libel law. Topics include journalistic ethics; writer's responsibilities to sources and readers; avoiding libel pitfalls.

JW 6063 Technical Presentations 3:0:0:3

This skills-based course will focus on effective ways to convey technical information to both professional and lay audiences by asking students to prepare weekly presentations they will deliver in class. Audience analysis, research, organization of material, the selection of appropriate media, and the use of graphics will be taught. Emphasis will be placed on successful strategies for dealing with the presentation of numbers and other technical data. *JW 6003 or JW 6023, or permission of the instructor.*

JW 6073 Writing News for Radio and Television 3:0:0:3

Writing news for the electronic media. Focus on science and business news stories. Intensive practice in writing for radio and television; emphasis on format and style of broadcast news writing; and requirements and limitations of the media and how these must be taken into account in TV and radio news writing. Students use video and audio technology in class. *Prerequisite: JW 6013 or instructor's permission.*

JW 6083* Computer Documentation I
3:0:0:3

This writing intensive class pairs a hands-on, practical approach to software documentation with a rigorous examination of the theoretical underpinnings of technical writing and communication theory. It shores up students' technical skills by focusing on editing and language while also delving into the latest thinking about the impact of technology on the way people interact. It also encourages students to work both alone and in groups, simulating as much as possible the work environment they are likely to find in the field. **Online version available. Prerequisite: JW 6003 or instructor's permission.*

JW 6093* Computer Documentation II
3:0:0:3

This writing-intensive class pairs hands-on practice in software documentation with a rigorous examination of the theoretical underpinnings of technical writing and communication theory. It shores up students' technical skills by focusing on grammar and language while delving into the latest thinking about the impact of technology on the way people interact. Students are encouraged to think of themselves as communications professionals while learning about how programmers think. Picking up where the introductory class leaves off, it examines the world of software documentation beyond writing standard tutorials, procedures, and reference documentation. Topics covered include work flow, management consulting, writing collaboratively, human factors design, usability testing, user-oriented design concepts, and writing for an online environment. **Online version available. Prerequisite: JW 6083 or instructor's permission.*

JW 6103* DITA: Darwin Information Typing Architecture: An Introduction
3:0:0:3

DITA is an XML-based architecture for producing and delivering technical information. This introductory online workshop will begin by exploring the theory of content management, and continues with a discussion of how DITA fits in. Hands-on training in the skills and techniques necessary to master this essential new tool will be emphasized. **Online course.*

JW 6113 Technical Translation and Localization Practices
3:0:0:3

Students learn and practice concepts of writing and revising technical communication for effective translation. They explore elements of translatability, especially cultural concerns, syntactic structures, and style. Course includes case studies and a translation project. *Prerequisite: JW 6003 or instructor's permission.*

JW 6123 Information Design 3:0:0:3

Students will be introduced to the field of information design. The course will examine the combination of organization, labeling, and navigation schemes within information systems in order to facilitate intuitive access to content. The art and science of structuring and classifying websites will be examined. *Prerequisite: JW 6003 or instructor's permission.*

JW 6133 Human Factors and Product Design
3:0:0:3

Examines the elements of human computer interaction and how it affects knowledge transfer and product design. Students learn how to design user-friendly programs by studying perception, cognition and software psychology. *Prerequisites: Graduate Status, JW 6003.*

JW 6153 Multimedia Technologies
3:0:0:3

Covers various multimedia technologies and their applications in technical communications. Content includes elements of each medium, methods of media selection, media production, design coordination, and media integration. Importance of audience analysis, clear understanding of goals and objectives, and project evaluation. Requires major multimedia project. *Prerequisite: Graduate status.*

JW 6183 Interactive Web Design 3:0:0:3

Workshop in writing and designing a World Wide Web page. Students examine elements of effective World Wide Web page authorship and design, including coding, linking, information hierarch, and effective integration of graphics, text and sound. Students write and produce Web pages for a mock organization. *Prerequisite: JW 6003 and JW 6043 or instructor's permission.*

JW 6193* Writing for New Media 3:0:0:3

This course considers how hypertext is different from traditional text and how that difference impacts project design. We investigate how new media affects readers, writers, artists, and communities, studying how to assess these effects and what measures must be taken in the new media environment. Additionally, we evaluate new media's potential as a form of mass media (including and beyond the World Wide Web), and what possibilities exist for it as a micromedia. Course requirements include website reviews, an original website, online participation, quizzes and exams. **Online course.*

JW 6203 Financial and Business Reporting
3:0:0:3

Workshop in business and financial news writing. Students write news reports and interpretive pieces for business periodicals and the financial sections of newspapers. Topics include economic trends, marketing, corporate activities, the stock market, government regulations, industrial technology, labor-management relations, advertising, energy, industry developments, and the environment. Students analyze corporate annual reports, analysts research reports, 10-K forms, financial press releases, and the editorial practices of several financial and business publications. *Prerequisite: JW 6003 or instructor's permission.*

JW 6213 Reporting and Editing for the Trade Press
3:0:0:3

Survey of the diverse editorial opportunities in trade press journalism. Students learn to write, edit, and interview for trade publications. Among the assignments are writing short news stories; copyediting (including the writing of heads and decks); rewriting weak copy for a magazine's departments (new products, books and literature, case histories, news, company and personality profiles, etc.); and short features describing plant layouts, machine operation, maintenance procedures, and business conditions. Consideration will be given also to the longer feature article, often referred to as the roundup story. Since most trade magazines serve a particular field of industry (computers, electronics, petrochemicals, pharmaceuticals, automotive, etc.), many of the articles appearing in them are contributed by industry authorities. Course emphasizes responsibility of the editor to cultivate good working relationships with such people to induce them to write for publication in trade journals. *Prerequisite: JW 6013 or instructor's permission.*

JW 6233 Project Management 3:0:0:3

Managing publication projects for scientific and technical organizations. All phases of publication: project conception, design, coordination, production, and costs; planning, organizing, staffing; directing and budgeting. *Prerequisite: JW 6003 or instructor's permission.*

JW 6243 Writing Product-Information Copy 3:0:0:3

Consideration of the mass of sales-promotional and technical catalogues, brochures, manuals, spec sheets, flyers, and news releases that promote a company's products. Emphasis is on approaches to writing such material. In addition to preparing copy for the shorter product promotion bulletins, students are responsible for providing text for a major catalogue or brochure promoting a given product or technology and based on raw data either provided by the instructor or gathered by students. Course stresses need for product information of varying degrees of technical complexity to suit the technical competency of the prospective customer for whom the literature is intended. *Prerequisite: JW 6013 or instructor's permission.*

JW 6253 Corporate Communications in Medicine, Science and Technology 3:0:0:3

Considers the corporate communications writing tasks specific to a pharmaceutical, biotechnology or technology firm. Topics include in-house technical and semitechnical reports, liaisons between researchers and management, writing and editing for scientists. *Prerequisite: JW 6013 or instructor's permission.*

JW 6263 Public Relations for Medicine, Science and Technology 3:0:0:3

In this laboratory-style seminar, students work as creative teams to plan and execute a comprehensive marketing and public relations campaign for a product or service defined at the beginning of the term. For this product or service, the teams develop a set of related "deliverables," including print and Internet ads, copy for radio commercials, storyboards for TV commercials, press releases, story proposals, and speeches. Topics include the naming and branding of products and services, the differences and connections between marketing and public relations, direct versus indirect strategies for influencing opinion and behavior, focus groups, the use of media (print, broadcast, and electronic) for the dissemination of marketing/PR messages, "damage control," and the ethics of marketing and PR. *Prerequisite: JW 6003 or instructor's permission.*

JW 6273 Writing Copy on Pharmaceuticals and Biotechnology 3:0:0:3

Course prepares students for expanding opportunities in writing copy for pharmaceutical and drug companies. Intensive practice in writing new product data sheets, bulletins, and other technical literature generally used by "detail" men; research reports, progress reports and other technical papers based on information supplied by the instructor and gathered on trips to local pharmaceutical companies; technical speeches; advertising and public relations copy. A major paper will be assigned as a term project. *Prerequisite: JW 6243 or JW 6263 or instructor's permission.*

JW 6283 Business-to-Business Advertising 3:0:0:3

Covers the objectives of business-to-business advertising and how to achieve them through three basic ingredients of the magazine ad: copy, artwork, and layout. Emphasis is on principles of writing effective copy and heads, the process of media selection for a given ad (product promotion, institutional), the preparation of an ad campaign, how to set up booths for industrial displays and exhibits, conducting the direct mail campaign, the value and preparation of sales literature, and an analysis of business publication advertising today. The roles of the company advertising manager and the agency's account executive and their interrelationship are delineated. Completion of a special project and several ad writing assignments are required. *Prerequisite: JW6013 or instructor's permission.*

JW 6313 Proposal Writing 3:0:0:3

Writing proposals in government and industry. Students analyze the components of specific in-depth proposals and then research and write their own as a major course project. Course content: analysis of parts of text, including statement of problem, methods, key personnel and budgeting; use of graphic and tabular material; organization, clarity, layout, and editing. *Prerequisite: JW 6003 or instructor's permission.*

JW 6323 Writing Technical Manuals and Procedures 3:0:0:3

Intensive practice in preparing industrial, technical, administrative, and instructional manuals and procedures. Training in how to write these documents according to government and client specifications. Integration of text with graphics, tables and lists; organization, indexing, and parts lists.

Every aspect from compiling information to evaluating final product. Major project required on subject in student's area of specialization. *Prerequisite: JW 6013 or instructor's permission.*

JW 6353 Online Journalism 3:0:0:3

Examination of the growing field of online journalism. Similarities to and differences from traditional print journalism; available markets in electronic journalism, such as electronic publishing, videotext publications and electronic magazines; techniques for writing for the videotext market, including digest techniques and writing to fit the format of an electronic publication. *JW 6023 or permission of instructor*

JW 6363 The Feature Article 3:0:0:3

The practice and principles of good, solid feature articles about science, technology, and business. Students learn how to write several specific types of feature articles through weekly writing assignments and the creation of their own magazine (print or online). Types of articles may include book reviews, product reviews, "how-to" articles, profiles, and columns. Topics include effective interview techniques and online journalism applications and concerns. *Prerequisite: JW 6003 or instructor's permission*

JW 6373 Computer-Assisted Reporting (CAR) 3:0:0:3

Workshop focusing on using the computer as a key newsgathering tool. Students learn techniques involved in finding, analyzing, and using databases on the World Wide Web when researching technical and nontechnical news and feature stories. Course explains how reporters and editors use CAR methods not only for essential online research but also with spreadsheet software, CD-ROMS, mapping, and electronic mail. Students write articles that depend heavily, but not exclusively, on CAR-based research. *Prerequisite: JW 6003 or instructor's permission.*

JW 6413 Desktop-Production Workshop 3:0:0:3

Workshop in desktop publishing software and applications. Students use QuarkXPress, PageMaker, InDesign, and other desktop publishing tools to write, design, and produce effective business and technical documents: newsletters, brochures, etc.

JW 6453 Instruction Design and Development 3:0:0:3

Fundamentals of computer-assisted instructional design and curriculum development. Topics include the different learning modalities, how to organize information into lessons, how to develop effective exercises and tests, and elements of effective instruction.

Students create a training curriculum as a semester project. Scope of project includes needs analysis, project planning and management, and usability testing. *Prerequisite: JW 6003 or instructor's permission.*

JW 6463 End-User Training 3:0:0:3

Workshop on the effective delivery of training programs. Students go through training development process from program assessment and design to delivery and evaluation. Course reviews elements of effective instructional design (with an emphasis on different learning styles) and then focuses on choosing appropriate methods of instruction and elements of effective instruction. Students conduct several training sessions throughout the semester. *Prerequisite: JW 6453 or instructor's permission.*

JW 6473 Computer-Based End-User Training 3:0:0:3

Workshop in using computer-based training programs to develop a tutorial training package. Students learn and practice principles of effective computer-based training, including breakdown of steps and skills, formulation of questions and answers, and use of graphics. *Prerequisite: JW 6093, JW 6453, JW 6463 or instructor's permission.*

JW 6503 Special Topics in Writing about Medicine, Science and Technology 3:0:0:3

Special topics courses are offered periodically by the department to address topics in science journalism not currently covered in the curriculum. Topics, faculty, and prerequisites may vary. *Prerequisite: JW 6003 or instructor's permission.*

JW 6513 Special Topics in Writing for Business 3:0:0:3

Special topics courses are offered periodically by the department to address topics in business writing not currently covered in the curriculum. Topics, faculty, and prerequisites may vary. *Prerequisite: JW 6013 or instructor's permission.*

JW 6523 Special Topics in Documentation, Training and New Media 3:0:0:3

Special topics courses are offered periodically by department to address topics in documentation, training, and new media not currently covered in the curriculum. Topics, faculty, and prerequisites may vary. *Prerequisite: JW 6013 or instructor's permission.*

JW 7013 Special Projects in Technical Communication 3:0:0:3

Students, working in conjunction with a faculty member, pursue independent study in a special facet of technical and professional communication. Students produce an original, thought-provoking interpretive project or report to be submitted to department for faculty review and approval. *Prerequisite: adviser's approval.*

JW 7023 Special Topics in Technical Communication 3:0:0:3

Special topics course is offered from time to time by faculty members, visiting scholars and professionals. Special titles and prerequisites are announced prior to registration. May be repeated for credit. *Prerequisite: JW 6013 or instructor's permission.*

JW 7033 Internship 0:0:3:9

Full or part-time placement as a technical and professional communication intern. Intense, practical work experience focusing on student's area of specialization. Students work with a professional adviser within the sponsoring organization and a faculty adviser within the department. Weekly progress reports and term project required. *Prerequisites: completion of four or more graduate courses in technical communication; approval of sponsoring organization and department.*

JW 7043 Master's Project 3:0:0:3

Students work with faculty adviser to write and produce master's project in technical communication. After project proposal is approved, students research and develop technical communication project in area of specialization. *Prerequisites: completion of 21 credits or more toward MS in Specialized Journalism and instructor's permission.*



TECHNOLOGY MANAGEMENT DOCTORAL PROGRAM

Academic Director: Bharat Rao

Modern technologies are redefining products, services, processes, organizational forms, business models, and industry structures. Understanding the managerial implications of these technologies has become a fast-growing and highly important arena for business research. High-quality scholars, capable researchers, and expert professionals are needed to expand the knowledge base in technology management through significant intellectual and educational contributions. Additionally, these developments have created a huge international demand for new kinds of managers who can strategically integrate technology and management to innovate and achieve a sustainable competitive advantage for a company. To prepare these managers, qualified educators with the ability to teach technology management are increasingly in demand.

The Doctor of Philosophy in Technology Management (PhD-TM) Program focuses on the increasingly important technology management field and develops scholars, researchers, and other academics who aim to contribute to knowledge-generation and education relevant for the technology-centered business environment. The program is under the auspices of the Department of Technology Management and is currently offered under the full-time and part-time formats.

Faculty in the Department of Technology Management possess significant research strengths in a diverse range of technology management-related fields. The faculty's major professional commitment is to research, thereby contributing to the theory and practice of technology management in important and fundamental ways.

Located in the high-technology heart of New York City, the PhD-TM Program provides immediate access to the world-leading business community and industries (such as financial services, entertainment and media, health care and pharmaceuticals, publishing, advertising, and fashion). This broad industrial base serves as a platform for conducting research, obtaining research support, and discovering diverse opportunities for scholarly and educational collaboration.

The department's Institute for Technology and Enterprise (ITE) is a New York City research and educational hub for bridging management and innovation. ITE is a focal point where practitioners, researchers and professionals can interact and learn from one

another. ITE offers a portfolio of round tables, seminars, leadership forums, and other research-based activities.

The Department of Technology Management offers a full range of academic programs and knowledge-generation activities all related to technology management in some essential fashion. These programs include the executive master's programs Management of Technology (MOT) and Telecommunications and Information Management (TIM); evening master's programs in management, and organizational behavior; and the BS in Business and Technology Management (BTM). Together, these programs create a broad value chain of educational efforts in which courses and students with a strong interest in technology management provide PhD-TM students with a host of opportunities for intellectual and educational experiences.

This terminal degree program is designed for research-oriented students who are largely interested in research-based positions at academic and research institutions. Universities with undergraduate and graduate programs that emphasize the integration of technology and management will be a primary source of career opportunities for PhD-TM graduates. In addition, government agencies, not-for-profit research organizations, corporate research centers and research-based consulting firms will also seek PhD-TM graduates.

For more information, please visit www.phd-tm.poly.edu.

SAMPLE THEMES

The following are examples of the themes that a PhD-TM student can select:

- Innovation strategy and management
- Sector-specific patterns of innovations
- Disruptive technologies and innovations
- Information technology-enabled innovations
- High-tech marketing and innovation diffusion
- Strategic alliances for innovation
- Technology life cycle
- Technology strategy
- Supply-chain management and integration
- Knowledge management
- Management of information systems and technologies
- Strategic uses of information technologies
- Information economics and strategy
- Leadership in high-tech firms

- Cross-cultural leadership
- Leadership measurement
- Management of knowledge workers
- Managing the human aspects of technological change
- Impacts of technology upon individuals, organizations, and society
- Technical competencies
- Design patterns for information-less trading
- Global technology management

ADMISSION INFORMATION

Admission to the PhD-TM Program is based on an in-depth evaluation of an applicant's academic record, professional experience, research potential, interest in the doctoral study, and overall intellectual and professional qualifications. Students must submit the following to be considered for admission:

- Application form with required application fee.
- Official transcripts of all previous undergraduate and graduate records indicating a bachelor's degree with at least a B average from an accredited college or university. The transcripts must be sent directly to the Office of Graduate Admissions.
- Official score from either the Graduate Management Aptitude Test (GMAT) or Graduate Record Examination (GRE).
- Official score from the Test of English as a Foreign Language (TOEFL) if the applicant earned a bachelor's degree from an institution in a non-English-speaking country or if English is the second language. A minimum score of 600 for the paper test (250 for the computer test) is required for admission.
- Three letters of recommendations from persons qualified to comment on the applicant's aptitude for doctoral study and research. Preferably two should be from academics.
- A statement of purpose that at least covers why applicants wants to pursue the PhD-TM at Polytechnic University and how well they are prepared for this study.

Note that part-time and full-time students have to submit the same documentation. There is no financial aid available for part-time students.

In some cases, applicants are contacted for a telephone or face-to-face interview.

In rare cases, the PhD-TM Admissions Committee may admit an applicant who

does not meet all required admissions criteria as a non-degree student. Such a student will then have a subsequent opportunity to apply for admission to the PhD-TM Program.

DEGREE REQUIREMENTS AND CURRICULUM

The curriculum for the PhD-TM Program is designed to foster a research-intensive doctoral education relevant for the rapidly emerging area of technology management. Management core courses provide a necessary foundation in management. Technology management courses provide the exposure to the fundamental and most current research and thinking in the broadly defined technology management field. Research methods courses help students develop quantitative and qualitative research skills and management research methods. Thematic elective courses help students gain in-depth knowledge in a focused thematic area related to technology management. Working together, students and doctoral advisers select which of these courses are appropriate for the student's course of study in the PhD-TM Program. As part of each thematic elective course, students also take an associated thematic independent research course in order to thoroughly investigate previous research works in the selected theme. All PhD students are required to undertake a doctoral research project, preferably in the second summer semester of the study. This course will introduce students to research requirements of management research. Finally, students work on the dissertation, an original investigation of a research question(s) related to technology management. Students are required to complete 75 credits, including 51 credits from the coursework and 24 credits from the dissertation.

1. Management Core Courses

(15 credits)

Management core courses should be taken as early in the program as possible. Choose five courses.

- MG 6013 Organizational Behavior
- MG 6073 Marketing
- MG 6083 Economics
- MG 6093 Accounting and Finance
- MG 6303 Operations Management
- MG 6503 Management of Information Technology and Information Systems

2. Technology Management Courses

Choose three courses (9 Credits)

- MG 6313 Organization Theory and Design
- MG 6543 Economics for Information Sectors
- MG 6603 Management of New and Emerging Technologies

- MG 8653 Managing Technological Change and Innovation
- MG 8693 Special Topics

Associated Doctoral Seminars

(12 Credits)

Four 3-credit doctoral seminar courses must be taken with an associated technology management course. These seminars provide strong research background required for doctoral studies in technology management area. Choose four seminars.

- MG 9203 Seminar in Managing Knowledge-Workers in Innovative Organizations
- MG 9213 Seminar in Information Systems Management
- MG 9223 Seminar in Business Process Innovation
- MG 9233 Seminar in Managing Technological Change and Innovation
- MG 9243 Technology Management and Policy
- MG 9253 Technology Strategy, Structure, and Decision Making
- MG 9263 Strategic Marketing Seminar
- MG 9273 Doctoral Seminar on Technology Adoption & Diffusion
- MG 9283 Doctoral Seminar on Entrepreneurship
- MG 9293 Seminar on Content Innovation
- MG 9303 Advanced Topics – Organizational Behavior and Organizational Theory
- MG 9313 Introduction to Behavioral Sciences
- MG 9323 Special Topics

Note: Doctoral seminars will be offered on a rotating basis. Not all the course options will be available to all PhD-TM students going through their course of study

3. Research Methods Courses

(12 Credits)

Must take all four courses.

- MG 9403 Business Research Methods
- MG 9413 Quantitative Research Methods I
- MG 9233 Quantitative Research Methods II
- MG 9433 Qualitative Research Methods

4. Independent Research Project

(3 Credits)

MG 9913 Independent Research

5. Comprehensive Examinations

Each student must successfully pass two comprehensive examinations before starting the dissertation.

Part One: This examination includes material covered in the master's level management core and technology management courses. It can be taken after 30 graduate units are accumulated.

Part Two: This examination includes material from the thematic elective and associated thematic research courses, doctoral seminars, and research methods courses. It

can be taken after the completion of the required coursework.

Students can take both examinations together. Results are provided within one month of the examination. Students have only two chances to pass each examination.

6. Doctoral Dissertation (24 credits)

The dissertation will be evaluated in two parts: Proposal Defense and Final Defense. For details, contact the PhD-TM Program academic director.

MG 9993 Doctoral Dissertation Research

Total Credits for PhD-TM Program: 75

8. Prerequisites

All PhD-TM students should have a fundamental knowledge of probability and statistics. Students without such a background are required to take MG 5050 Probability and Managerial Statistics. Students without any background in professional writing and communications are required to take JW 6003 Introduction to Technical and Professional Communications or JW 6313 Proposal Writing. Students who already have a master's degree or who are transferring from other institutions (or other departments within Polytechnic) are admitted based on the same qualification standards as for new students. For each required MS- or PhD-level course, if students have taken a similar course, they are eligible to transfer units for the course. However, students still have to take and pass both qualifying exams. A minimum of 30 credits, including all dissertation credits, must be taken at Polytechnic University. No dissertation unit from other institutions can be transferred.

All students must take the required coursework as assigned and follow the curriculum as stipulated. The coursework must be finished within the first three years and the dissertation thesis within the next three years. Thus, all students (full-time and part-time) must complete all the work for the doctorate within six years of initiation.

COURSE DESCRIPTIONS

The following courses are courses required or specifically associated with this doctoral program. For course descriptions of other relevant courses, please refer to the Master of Science in Management [MSM] Program section of this catalog.

MANAGEMENT CORE COURSES**MG 6013* Organizational Behavior**

3:0:0:3

Introduction to theory, research, and practice to better understand human behavior in organizations. Topics include motivation and job satisfaction; decision-making; group dynamics; work teams; leadership; communication; power, politics, and conflict; organization culture, structure, and design; impact of technology; management of work stress; organizational change and development; and career management. Analysis of organizational behavior problems by self-assessments, case studies and simulations. *Online version available. *Prerequisite: doctoral standing or instructor's permission. Co-Requisite: none.*

MG 6073 Marketing

3:0:0:3

Marketing concepts, processes, and institutions: positioning, segmentation, and product life cycles. Integration of marketing with new product planning, design, and development. Strategies for technology-based products, services, and processes. Market research, consumer behavior, advertising, promotion, and sales. The special character of industrial, governmental, and international markets. *Prerequisite: doctoral standing or instructor's permission. Co-Requisite: none.*

MG 6083 Economics

3:0:0:3

The fundamentals of microeconomics needed by managers. Demand theory (theory of the consumer) including models of demand, demand elasticity, and demand forecasting. Supply theory (theory of the firm) including diminishing returns, profit maximizing production levels, labor/capital tradeoffs, and long-run vs. short-run issues. Market structures and how they affect optimal production and profit levels. Positive and negative externalities and government intervention including regulation, tariffs, and subsidies. Selected applied topics. All topics are presented with emphasis on managerial application in industries that create or intensely use technology. *Prerequisite: doctoral standing or instructor's permission. Co-Requisite: none.*

MG 6093 Accounting and Finance

3:0:0:3

Elements of accounting and finance of importance to managers. Analysis of principles and practices of the finance function. Financing methods for internal and external

ventures and innovations; capital budgeting; R&D portfolio analysis. Contrast of strategic perspectives emphasizing innovation and development with those emphasizing short-term return and investment. *Prerequisite: doctoral standing or instructor's permission. Co-Requisite: none.*

MG 6503 - Management of Information Technology and Information Systems

3:0:0:3

This course is designed for managers who need to understand the role and potential contribution of information technologies in organizations. The focus of the course is on different information technologies and their applications in managing business critical data, information, and knowledge. The course concentrates on the current state of IT in organizations, challenges and strategic use of IT, IT infrastructure and architecture, building, implementing, and managing IT applications, and emerging issues such as intelligent systems, business process reengineering, knowledge management, and group support systems. *Prerequisite: doctoral standing or instructor's permission. Co-Requisite: none.*

MG 6303 Operations Management

3:0:0:3

Analytical techniques for designing and operating production and service systems, including facility layouts and locations, capacity planning, job sequencing, inventory control, and quality control. Introductory linear programming and other formal methods. Cases and PC usage. *Prerequisite: doctoral standing or instructor's permission. Co-Requisite: none.*

TECHNOLOGY MANAGEMENT COURSES**MG 6313 Organization Theory and Design**

3:0:0:3

Analysis of theories of large-scale organizations focusing on their structure and culture. Includes characteristics of bureaucracy, ad-hocracy, sub optimization, human dynamics and informal systems, influence and control systems, and planned change. Examination of both formal and informal organizations through case studies and discussion. *Prerequisite: doctoral standing or instructor's permission. Co-Requisite: none.*

MG 6543 Economics for Information Sectors

3:0:0:3

This course in applied competitive strategy draws upon recent experiences associated with the impact of information technology upon diverse industries. Students completing this course will have mastered a basic understanding of the economic and competitive implications of information technology. This competence in analysis is arrived at through understanding how availability of information (through technology or otherwise) affects the basic strategic options available and how firms and industries are likely to be affected. In addition, students will be introduced to the often poorly structured process of evaluating the economics of potential systems innovations. They will then be able to participate in strategic systems planning from a managerial point of view. *Prerequisite: doctoral standing or instructor's permission. Co-Requisite: none.*

MG 6603 Management of New and Emerging Technologies

3:0:0:3

A survey and exploration of the business implications of selected new and emerging technologies that have the potential to change business practices and create new industries. Technologies discussed include new Internet architectures, Wikis, Open Source, security issues, new web services, social networking, and Web 2.0. This course is for the manager who is interested in staying current with and learning about new technologies for use in business. No specific engineering background is required. A variety of reference texts, journals, cases, and websites will be used throughout the course. *Prerequisite: doctoral standing or instructor's permission. Co-Requisite: none.*

MG 8653 Managing Technological Change and Innovation

3:0:0:3

Focuses on the effective management of technological change and innovation, which is accomplished by employing a dual perspective. One perspective is based on individual, group and organizational theory, research, and practice. This body of literature, viewpoints, and experience provides essential guides for successfully managing the introduction of new technologies. Realizing the full potential of new technologies requires effectively managing change to assure the commitment of all stakeholders. The second perspective is based on innovation theory, research, and practice. This body of literature, viewpoints, and experience provides key insights for effectively managing

the process of innovation and the impact of innovation on all parts of an enterprise. Specifically, there is explicit consideration of the need within a firm to manage and inspire people so that they can effectively communicate and innovate. *Prerequisite: doctoral standing or instructor's permission. Co-Req-uisite: none.*

MG 8693 Special Topics 3:0:0:3

Individualized readings on special topics assigned by instructor. *Prerequisite: doctoral standing or instructor's permission. Co-Req-uisite: none.*

ASSOCIATED DOCTORAL SEMINARS

MG 9203 Seminar in Managing Knowledge-Workers in Innovative Organizations 3:0:0:3

Knowledge workers, who are primarily in professional and technical occupations, have come to represent the most important segment of the labor force in the United States. The success of innovative organizations today is largely a result of the knowledge and skills applied by their professional and technical employees. The effective management of such a work force has become one of the most critical problems faced by innovative organizations in both the private and public sectors. This seminar closely examines theory and research as well as various management techniques that can improve the utilization and development of knowledge workers in innovative organizations. *Prerequisite: doctoral standing or instructor's permission. Co-Req-uisite: none.*

MG 9213 Seminar in Information Systems Management 3:0:0:3

This course provides PhD-TM students and other related fields with a perspective on modern information systems methodologies, technologies and practices. State-of-the-art research on frameworks for analysis, design and implementation of various types of information systems is presented. Economic and strategic issues related to information technology are presented, with emphasis on research in organizational, inter-organizational and strategic settings. The course follows a seminar format; paper-based and Web-based assigned readings are assigned, and student contribution during class sessions (both as participant and, for one class, as moderator.) is expected. *Prerequisite: doctoral standing or instructor's permission. Co-Req-uisite: none.*

MG 9223 Seminar in Business Process Innovation 3:0:0:3

This Doctoral seminar explores dimensions and issues pertaining to the technology-business process interface that are critical to superior performance in today's modern networked corporations. We discuss how technology has impacted everything from common business tasks to complex and global supply chain integration. Qualitative and quantitative aspects in these areas will be addressed. Articles pertaining to leading-edge research and management thought will be discussed in class. The underlying objective is to expose the student to the rich and emergent literature in modern supply chain management, technology integration, and business model evolution. Major themes addressed by this seminar include technology integration, product and process innovation, marketing, logistics, operations, IT, and channel management issues in supply chains across various industries. There will be a strong emphasis on understanding the role of technology in the supply chain, and its relation to business processes and innovation. *Prerequisite: doctoral standing or instructor's permission. Co-Req-uisite: none.*

MG 9233 Seminar in Managing Technological Change and Innovation 3:0:0:3

The objectives of this seminar are to familiarize you with the key viewpoints in the literature on technological innovation. The readings are selected to highlight the most important contributions to the literature by past and current academics. A critical analysis and review of this body of literature will set the stage for future research work in this important area of management. *Prerequisite: doctoral standing or instructor's permission. Co-Req-uisite: none.*

MG 9243 Technology Management and Policy 3:0:0:3

This course focuses on the research related to macro-environment influencing and relevant to technology decision making, strategy and innovation in firms, government agencies, non-profit institutions and other organizations. Primary concerns include: introducing effective approaches for analyzing and evaluating societal-wide factors that influence innovation; assessing various attempts and policies for stimulating innovation in a city, region, nation or on a global basis; exploring the role of technology and innovation in diverse managerial, economic, and social contexts (e.g. advanced

economies, rapidly emerging economies, and Third World economies); the relationship between business-government and NGOs in promoting and sustaining innovation; the impact of global rivalry and global cooperation in the technology and innovation arena; and the place of technology and innovation in the post-Cold War era and in the early Twenty-First century. *Prerequisite: doctoral standing or instructor's permission. Co-Req-uisite: none.*

MG 9253 Technology Strategy, Structure, and Decision Making 3:0:0:3

This course explores the most important and relevant theories and concepts related to technology strategy, structure, and decision making. The emphasis is on understanding the useful application of such ideas for modern technology management and for the design of effective scholarly research that deals with the strategic, structural, and decision-making aspects of innovation and technology management. *Prerequisite: doctoral standing or instructor's permission. Co-Req-uisite: none.*

MG 9263 Strategic Marketing Seminar 3:0:0:3

The purpose of this course is to look at strategic issues in marketing facing firms and industries from both theoretical and empirical perspectives. The seminar looks at product design, positioning, and strategy, distribution, sales force, design of the marketing organization, competition, market structure, problems of information, signaling and pricing, corporate reputation and branding, advertising and promotion, and recent advances in product and service development. *Prerequisite: doctoral standing or instructor's permission. Co-Req-uisite: none.*

MG 9273 Doctoral Seminar in Technology Adoption and Diffusion 3:0:0:3

The objectives of this seminar are to familiarize you with the key viewpoints in the literature technology adoption and diffusion. The readings are selected to highlight the most important contributions to the literature by past and current academics. A critical analysis and review of this body of literature will set the stage for future research work in this important area of management. *Prerequisite: doctoral standing or instructor's permission. Co-Req-uisite: none.*

MG 9283 Doctoral Seminar on Entrepreneurship 3:0:0:3

The objectives of this seminar are to familiarize you with the key viewpoints in the literature on entrepreneurship. The readings are selected to highlight the most important contributions to the literature by past and current academics. A critical analysis and review of this body of literature will set the stage for future research work in this important area of management. *Prerequisite: doctoral standing or instructor's permission. Co-Requisite: none.*

MG 9293 Seminar on Content Innovation 3:0:0:3

Because of the development of the Internet, which has provided a robust technology platform on which content can be created, the notion of what comprises content has been expanded to include not only one-dimensional content, e.g. print newspapers, books, and music recordings which have been the core output of traditional media companies but also multi-dimensional, non-linear content which can reside in physical, digital, or hybrid (physical and digital) spaces. The popularization and proliferation of this new type of content has had a profound impact on the development of the creative industries, e.g., publishing, newspapers, video games, fashion, and music and thus presents significant challenges to managers in these industries. This seminar will explore the evolution of content innovation and focus on several major issues including the restructuring of the creative industries and related managerial challenges that have resulted because of developments in content innovation; the impact of the restructuring of creative industries on the development of urban centers of creativity and technoculture such as Silicon Alley in New York City, and Hollywood, California; the role of technology companies particularly hybrid telecommunications/content companies, and how they intersect with the creative industries and influence content innovation; the media and its symbiotic relationship with politics. *Prerequisite: doctoral standing or instructor's permission. Co-Requisite: none.*

MG 9303 Advanced Topics – Organizational Behavior and Organizational Theory 3:0:0:3

The goal of the course is to familiarize students with a broad range of theoretical perspectives in contemporary organization theory and organizational behavior. The course spans levels of analysis. It adopts mostly a practice perspective and focuses on meso-levels of analysis (inter-group collaboration and competition) and micro-levels of interpersonal and social psychological processes within organizations. *Prerequisite: doctoral standing or instructor's permission. Co-Requisite: none.*

MG 9313 Introduction to Behavioral Sciences 3:0:0:3

This is an interdisciplinary seminar for doctoral students only. The seminar focuses on behavioral sciences, i.e. on the areas of inquiry that relate to the human condition or human behavior. This definition encompasses a wide variety of disciplines from the social sciences and humanities to a corner of the biological sciences. The fields of study are as diverse as comparative literature, geography, psychiatry, and mathematics (to name just a few). In our course we will focus on sociology, anthropology, history, and political science – with an emphasis on sociology. The course explores a number of topics (social order, social solidarity, conflict, social classes, status) that have generated strong interest among social scientists. The course and the final paper pay special attention to the process of developing original theoretical arguments, suitable for empirical exploration. *Prerequisite: doctoral standing or instructor's permission. Co-Requisite: none.*

MG 9321 Special Topics 3:0:0:3

Individualized readings on special topics. *Prerequisite: doctoral standing or instructor's permission. Co-Requisite: none.*

RESEARCH METHODS SEMINARS**MG 9403 Business Research Methods** 3:0:0:3

This course serves as an introduction to the theory and techniques of research methods in business. The course includes an introduction to philosophy of science and to the principles of investigation in the social sciences. Students learn to design a study, sample, and choose a research design. Also discussed are basic data preparation, measurement and analysis procedures, focusing on univariate and multivariate statistics. *Prerequisite: doctoral standing or instructor's permission. Co-Requisite: none.*

MG 9413 Quantitative Methods Seminar I 3:0:0:3

An introductory PhD-level course in quantitative analysis. Topics include specification, estimation, and inference in the context of models that start with the standard linear regression framework. After reviewing the classical linear model, the asymptotic distribution theory necessary for analysis of generalized linear and nonlinear models is developed. The course then analyzes estimation methods such as instrumental variables, maximum likelihood, generalized method of moments (GMM), and others. Inference techniques used in the linear regression framework (such as t and F tests) is extended to Wald, Lagrange multiplier, likelihood ratio, and other tests. Finally, the linear regression framework is extended to models for panel data, multiple equation models, and models for discrete choice. *Prerequisite: doctoral standing or instructor's permission. Co-Requisite: none.*

MG 9423 Quantitative Methods Seminar II 3:0:0:3

In this seminar we attempt to gain understanding of the theories that underpin economic and quantitative analysis in business. We examine three different but interrelated academic disciplines to achieve this end: the axiomatic foundations of economics, the assumptions and methods that create the basis for game-theoretic analysis, and the deviations from the economic rationality required by these methodologies that have been identified by the behavioral decision-making literature. *Prerequisite: doctoral standing or instructor's permission. Co-Requisite: none.*

MG 9433 Qualitative Research

Methods

3:0:0:3

The course covers methods that allow you to enter natural social settings to capture data about human behavior in the actual contexts in which people pursue their daily lives. These methods include especially observation and interviewing. The emphasis is on studying first-hand and close-up the ongoing worlds of other people. The course will help participants learn how to make sense of data inductively, i.e., from the bottom up. This course is not about hypothesis testing. It is about building grounded theory. Our focus will be on the coding and categorization of qualitative data (observational notes and interview transcripts). You will learn to go beyond the journalistic description of data to the analysis that characterizes good inductive social science. *Prerequisite: doctoral standing or instructor's permission. Co-Requirement: none.*

INDEPENDENT RESEARCH

MG 9913 Independent Research 3:0:0:3

Directed individual study or supervised readings in advanced areas of the thematic electives advised by the doctoral adviser. Three credits required. *Prerequisite: doctoral standing or instructor's permission. Co-Requirement: none.*

DOCTORAL DISSERTATION

MG 9993 Doctoral Dissertation

Research

3:0:0:3

Twenty-four credits of doctoral dissertation research are required. *Prerequisite: doctoral standing or instructor's permission. Co-Requirement: none.*

TELECOMMUNICATIONS NETWORKS PROGRAM

Program Director: Shivendra S. Panwar

Telecommunications is a rapidly growing field. From the military communications networks of the early 1950s, telecommunication technology has evolved to find applications in almost all areas of modern society including banking, reservation systems, office information systems, corporate networks, and the Internet and World Wide Web. Recent challenges include gigabit optical networks, multimedia communications, and wireless network access.

The rapid evolution of telecommunication technology demands a broad educational background including today's technological breakthroughs. Polytechnic's masters program in telecommunication networks contains a wide variety of courses ranging from fundamental topics to recent technological advances.

GOALS AND OBJECTIVES

The objective of the Master of Science in Telecommunication Networks is to prepare students for a profession in telecommunication networks. The program trains students to understand, design, manage, and operate telecommunication networks. The unique features of the program are:

- An exceptionally wide range of course offerings in telecommunications
- Graduate laboratory courses in networking offering hands-on experience
- Professors with extensive experience in research, industry and teaching
- Interaction with Polytechnic's New York State Center for Advanced Technology in Telecommunications, where students have access to research and development projects

REQUIREMENTS FOR THE MASTER OF SCIENCE

Admission to a Master of Science in Telecommunication Networks requires an undergraduate degree in computer science, computer engineering or electrical engineering, with a superior undergraduate record from an accredited institution. The Graduate Record Exam (GRE) is recommended. Applicants having comparable degrees in other fields will be considered for admission on an individual basis. Generally, entering students are expected to have a basic knowledge of computer fundamentals, such as programming in C++, data structures, and computer architecture. Students having superior aca-

demical credentials but lacking sufficient background are admitted with conditional status pending satisfactory completion of several individually specified preparatory courses. These preparatory courses include CS 5303 Introduction to Programming, CS 5403 Data Structures and Algorithms. However, no credit will be allowed for any of the preparatory courses toward this degree. Other preparatory courses may be required. In some cases students will be invited to an interview to determine the necessary preparatory courses they need to complete. Successful completion of the preparatory courses with a B GPA or better is a necessary condition for transfer to regular status. Admission with advanced standing is accepted in accordance with Polytechnic regulations published in this catalog. A maximum of 9 credits may be applied to the MS in Telecommunications Networks from previous graduate work at an acceptable institution. To satisfy the requirements for a master's degree, students must complete a total of 30 credits as described below, with an overall average of B. In addition, a B average is required in the core courses described in Group 1 and Group 2 below.

Students who have satisfactorily completed equivalent courses, as determined by the MSTN advisor, may be allowed to replace required courses in Group 1 and Group 2 with other courses, starting with the remaining Group 2 courses. For example, a student who has previously taken a course equivalent to EL 5373 will be required to take all the remaining four courses in Group 2. If a student has previously taken two or more equivalent courses from Group 1 and 2, these additional courses can be replaced by advanced courses. Permission of the program director is required for all course substitutions.

GROUP 1: Required Core Course (3 Credits)

EL 5363 Principles of Communication Networks

Students who have satisfactorily taken a course equivalent to EL 5363, e.g., EE 136, or otherwise as determined by the MSTN advisor, can replace this course by a course from Group 2.

GROUP 2: Additional Core Courses (12 Credits)

Students are required to take 4 out of the 5 course choices listed below.

1. EL 5373 Internet Architecture and Protocols or CS 6843 Computer Network Protocols and Applications
2. EL 6373 Local and Metropolitan Area Networks or EL 6383 High Speed Networks
3. CS 6133 Computer Architecture I or CS 6233 Operating Systems I
4. CS 6273 Performance Evaluation of Computer Systems or EL 7353 Communications Networks I (the later requires EL 5363 and EL 6303 as prerequisites)
5. CS 6823 Network Security

In certain rare circumstances, and with approval of the program's director, other computer science and electrical engineering courses may be used to fulfill the core requirement. Students may not take both CS 6843 and EL 5373.

GROUP 3: Project Requirement (3 Credits)

All students in the Telecommunication Networks Program are required to take a project course, either CS 6873 Project in Telecommunication Networks or EL 9953 Advanced Project I, depending on whether the project advisor is from the CS or ECE departments, respectively. Students must obtain a project adviser and have a project plan approved before registering. The project should be completed in one semester. After obtaining the program director's approval, students may substitute the required 3-credit project with a 6-credit MS thesis. The extra 3 credits for the thesis will be counted towards the program elective in Group 4.

GROUP 4: Program Elective Courses (12 Credits)

Students are required to take four courses (not already counted towards the core requirement) from the following partial list of courses. Other courses are possible with the approval of the program director.

- EL 5013 Wireless Personal Communication Systems
- CS 5023 Introduction to Java Programming
- EL 5143 Multimedia Laboratory
- EL 6013 Principles of Digital Communication: Modulation and Coding
- EL 6023 Wireless Communications: Channel Modeling and Receiver Design
- EL 6033 Modern Wireless Communication Techniques & Systems
- EL 6063 Information Theory
- EL 6303 Probability Theory
- EL 6313 Stochastic Processes
- EL 6383 High-Speed Networks
- EL 6393 Advanced Network Security

TELECOMMUNICATIONS NETWORKS PROGRAM

- EL 7353 Communications Networks I:
Analysis Modeling and Performance
- EL 7363 Communications Networks II:
Design and Algorithm
- EL 7373 High-Performance Routers and
Switches
- EL 9303 Wireless Information Systems Lab
- CS 6033/6043 Design & Analysis Algorithms I/II
- CS 6133/6143 Computer Architecture I/II
- CS 6233/6243 Operating Systems I/II
- CS 6063 Software Engineering I
- CS 6083 Principles of Database Systems

MG graduate courses: Relevant graduate courses in the management department can be taken with the approval of the MS Telecommunication Networks advisor. No more than two MG courses can be counted towards the MSTN degree.

Total: 30 Credits

Descriptions of electrical engineering, computer science, and graduate management courses are located, respectively, in the Electrical Engineering, Computer Science, and Management program sections of this catalog.

TELECOMMUNICATIONS AND INFORMATION MANAGEMENT EXECUTIVE PROGRAM

Academic Program Co-Directors:
Mel Horwitch and Nina D. Ziv

GOALS AND OBJECTIVES

The objective of the Telecommunications and Information Management Executive Program is to deliver a high level learning experience focusing on the intersection of broadly defined information technology and management, which is at the heart of the modern economy. The Telecommunications and Information Management [TIM] Executive Master's degree program focuses on the crucial challenges facing managers in telecommunications and information management sectors which have been radically transformed as a result of digital-based and mobile innovations, changes in telecommunications regulations, and the globalization of firms and industries. IT managers must learn how to innovate in a world in which the use of wireless and Internet-based technologies has:

- Changed traditional organizational structures into a seamless, 24/7 global entities
- Created a knowledgeable and demanding customer base
- Become the impetus for the convergence of technology, content and devices, which has resulted in the rise of competitors that are hybrid content/technology firms
- Led to the emergence of users of technology in diverse firms as an important source of technology innovation
- Led to the creation of new organizational forms and managerial imperatives

The TIM Program serves a wide variety of executives faced with new challenges and opportunities in the broad arena where telecommunications, information technology, and management intersect. The perspective of TIM is high-level, yet grounded. The orientation of TIM is pragmatic and managerial. TIM is a rigorous 16-month, four-semester state-of-the-art program. The TIM Program is based on a cohort system in that all participants enter at the same time and take the same sequence of courses throughout the program except where choices may be offered such as in electives. The cohort system is an intrinsic part of the philosophy of the TIM Program and is essential for developing a cohesive group of participants. It enables participants to establish relationships with one another, easily develop project teams, and promotes a sense of camaraderie among the participants. The entire curriculum is 30 credits.

TIM is an executive program with the following general features:

- Close interaction and teamwork
- A professional, modern, and informal learning environment
- Participants viewed as real partners in the learning process (in class and in the joint generation of intellectual capital as presentations, reports or cases—in paper and digital formats)
- A curriculum that is continually up-dated
- Close collaboration with respected partners in industry and the relevant scholarly community
- Full courses and new half-semester courses to make the most of the limited time available
- Carefully selected elective courses to maintain flexibility in meeting diverse professional needs
- Blend of live class experience with use of modern, web-based technology
- Effective remote-collaboration learning and teamwork that are also enabled by technology
- Learning materials that are often in digital web-based format to take advantage of Internet-based technologies and methods
- The incorporation of technology is undertaken with ease of use and access as key watchwords

TIM is geared for the growing set of professionals who must use information and networking technology and the Internet for carrying out critical tasks and in developing and delivering value within their organizations and for customers.

TIM classes are held every other week on Wednesday or Thursday evening and all day Saturday at the New York Information Technology Center, 55 Broad Street, in Manhattan. An all-inclusive fee covers tuition and fees, textbooks and other educational material, special tutorials and lectures and meals on class days. Visit the program's website at www.mot-tim.poly.edu for the most current information.

ADMISSIONS INFORMATION

Admission to the TIM Program is based on an in-depth evaluation of a candidate's academic record, work experience, and overall intellectual and professional qualifications and potential. Applicants must demonstrate strong commitment, an ability to benefit professionally from a rigorous 16 month executive programs. Because of the heavy demands of these programs, it is important that

employers also explicitly support such professional education.

In general, GRE and GMAT tests are not required for applying to the TIM Programs. But the TIM Executive Master's Management Degree Programs office may ask an applicant to submit scores later in the admissions process.

HOW TO APPLY:

The Executive Master's Degree Program uses an admission process called the Self-Managed Application (SMA). Applicants must gather the materials required by the program and forward them in a single envelope to:

Administrative Director
MOT-TIM Executive Master's Degree Programs
Polytechnic University
55 Broad Street, Suite 13B
New York, NY 10004

TO APPLY

1. Complete the application and attach a copy of your professional resume and the application fee.
2. Please ask the registrar at all colleges and universities you attended to send official transcripts directly to you. In order for them to remain official, they must be sealed in the original envelope. Opened transcripts are not considered official.
3. Please arrange for two (2) letters of recommendation to be sent directly to you. These letters are generally from a supervisor or high-level colleague who is familiar with your professional work. As with transcripts, to be considered official, recommendations must be sent directly from the recommender to the applicant unopened. Use the enclosed forms for this purpose. Write your name at the top, sign the waiver if you wish and give one form and one of the enclosed envelopes to each person writing in support of your application.
4. After we have received all necessary materials:
 - Application form
 - Application fee
 - Professional resume
 - Transcripts from all schools
 - Two letters of recommendation
5. The final step for admission is a personal interview with one of the Academic Co-Directors to discuss career objectives and to make sure the Program fits your goals.

For more information, contact the TIM program administrative director:
Tel: 718-260-4014
Fax: 212-547-7029
E-mail: mot-tim@poly.edu
Web: www.mot-tim.poly.edu

PROGRAM CURRICULUM

The courses that constitute the TIM program curriculum (the order in which courses are given may vary):

First Semester

MG 6093 Managerial Accounting & Finance
MG 6903 Managerial Decision Making in Information-Intensive Businesses
MG 7903 Foundations of Telecommunications & Networking Technology

Second Semester

MG 6083 Managerial Economics
MG 6933 Information, Technology, Systems & Management in Organizations
MG 7913 Principles of Modern Networking

Third Semester

MG 6073 Marketing
MG 7933 Global Management in the Networking, Telecommunications & Information Industries**
MG 9603 TIM Capstone Project**
MG 7923 Modern Network Environment Management

Fourth Semester

MG 8203 Project Management & Assessment for Technology Managers
MG 9603 TIM Capstone Project**
MG 7743 Advanced Trends in Technology Management and Innovation**
MG XX Elective**
(select one from the list below)

Elective Course Portfolio

MG 7813 Selected Topics in Networking & Information Technologies**
MG 7843 Negotiation in Technology-Intensive Sectors**
MG 7853 High-Technology Leadership**
MG 7863 High-Technology Entrepreneurship**
MG 7873 Intellectual Property for Technology & Information Managers**
MG 7883 Modern Supply Chain Management: Integration Through Technology**
MG 7893 Special Elective Topics for MOT & TIM**
MG 7973 Financing for Value Creation**

** half-semester courses

SPECIAL TIM TRACK:

The e-Business Track

For many professionals in the TIM environment e-business constitutes an important arena for value creation. e-Business can enhance market performance and can make or-

ganizations more efficient and effective. Those TIM participants wishing to be formally recognized as knowledgeable in e-Business focus may choose to enter the TIM e-Business Track. Choosing this track requires the completion of a final project dealing specifically with an important topic in the e-Business world as part of the Capstone Course in the final semester. The e-Business track is open to all TIM students.

COURSES

The following courses are unique to the TIM Executive Program. For other course descriptions, refer to the Management Program or Financial Engineering Program sections of this catalog.

MG 6073 Marketing 2½:0:0:3

Emphasizes the imperative to be customer-focused in the information sectors. Market definition and redefinition due to technological change. Analysis of customer decisions. Strategic choices of markets and products. Positioning for competitive success. Product pricing, distribution and communications decisions. New product development. Market system dynamics and the value chain.

MG 6083 Managerial Economics and the Economic Environment 2½:0:0:3

The fundamentals of microeconomics needed by managers. Demand theory (theory of the consumer) including models of demand, demand elasticities, and demand forecasting. Supply theory (theory of the firm) including diminishing returns, profit maximizing production levels, labor/capital tradeoffs and long-run vs. short-run issues. Market structures and how they affect optimal production and profit levels. Positive and negative externalities and government intervention including regulation, tariffs and subsidies. Selected applied topics. All topics are presented with emphasis on managerial application.

MG 6093 Managerial Accounting and Finance 2½:0:0:3

Principles and practices of the modern finance function including accounting and corporate finance, and their relevance for all information business managers. Strategic perspectives—balancing long-term development and short-term returns. Financing of ventures and innovative activities. Project selection, capital budgeting, and risk analysis. Special emphasis is placed on financial decision-making in the information-business sectors and the financial assessment of in-

creasingly important knowledge-intensive assets.

MG 6903 Managerial Decision Making for Information-Intensive Businesses 2½:0:0:3

An introductory course in managerial decision making and strategies with an emphasis on information-intensive businesses and the fast-changing environment in which they compete. This course explores such issues as competing in both the digital and physical spaces, technology as an enabler of change, the role of the professional manager, and managing in an increasingly globalized environment.

MG 6933 Information Technologies, Systems and Management in Organizations 2½:0:0:3

Designed for managers who need to understand the role and potential contribution of information technology (IT) within organizations. The focus of the course is on information technology and its business applications. The course concentrates on the current state of IT in organizations, challenges and strategic use of IT, IT infrastructure and architecture, the technical foundation of IT, building and implementing organization information systems, emerging issues in IT such as intelligent systems, business process re-engineering, knowledge management, and group support systems. The course format is interactive with concept presentation followed by open discussion on real-world applications of IT and business cases.

MG 7743 Advanced Trends in Technology Management and Innovation (variable 2½ / 1¼)

This course explores several trends that have emerged in the technology management and innovation arena in the past decade. These include the advent of digital-based innovation in the late 1990s which has had a profound affect on how many firms conduct business; the effect of the crash of the NASDAQ in March 2000 and the September 11 event which had a major effect on corporations which now had to operate within major economic and creative constraints; the development of the concept of networks as it relates to the organization and strategy of the firm; the development of the wireless technology platform and its effect on technology innovation; and the development of a new innovation paradigm which suggests a relationship between information technology, creativity, and business practices. The course

emphasizes classroom discussions as well as team based and individual projects.

MG 7813 Selected Topics in Networking and Information Technologies
(half-semester course) *1¼:0:0:1½*

An in-depth exploration of selected modern networking and information technologies. The specific topics studied vary from year to year. Examples are mobile communications, IP telephony, enterprise data systems, etc. The course builds on previous TIM courses and provides a solid technology grounding in a learning context, which also emphasizes how these selected technologies affect markets, industries, providers, integrators, and users. The technical content of this course is supplemented with actual case examples and relevant guest speakers.

MG 7823 Competitive Information Strategy
(half-semester course) *1¼:0:0:1½*

Course in applied competitive strategy, which draws upon recent experiences associated with the impact of information technology upon diverse industries, ranging from securities trading to consumer-packaged goods retailing. Students master a basic understanding of the competitive implications of information technology and the strategies for using information technology in business. This competence in analysis is arrived at through understanding how availability of information (through technology or otherwise) affects the basic strategic options available and how firms and industries are likely to be affected. In addition, students are introduced to the often poorly structured process of evaluating potential systems innovations. They are then able to participate in strategic planning and systems planning from a managerial point of view.

MG 7843 Negotiation in Technology-Intensive Sectors
(half-semester course) *1¼:0:0:1½*

Negotiation is the art and science of creating good agreements. This course covers the science of negotiation by discussing and applying theories of negotiation. Students develop the art of negotiation by negotiating with each other in realistic cases. A wide variety of negotiation applications is covered in this class, including one-time and repeated negotiation, single and multi-issue negotiations, and two-party and multi-party bargaining. Special emphasis is placed on negotiations in technology-intensive environments. Course is taught using the case method. Many of the

examples used in this course are cases that the students actually negotiate with each other. Students' grades are based on their performance in these negotiations and on their class participation.

MG 7853 Leadership
(half-semester course) *1¼:0:0:1½*

Leaders set a vision, communicate it well, influence and inspire others to achieve their vision. However, there are many ways to achieve these things and many challenges and ineffective ways. The purpose of this course is to develop the student's leadership style by analyzing individual styles, understanding their impact, and then enabling each student to create the right leadership style. This course addresses fundamental leadership issues and frameworks, drawing on current organizational research, but most of all it provides students with ways of getting insights on their own leadership style. The course emphasizes hands-on experience and focuses on experiential learning. Course objectives include assessment of leadership styles; developing leadership skills; and understanding the role of leadership coaching in the management of teams.

MG 7863 High-Technology Entrepreneurship
(variable 2½ / 1¼)

Focuses on entrepreneurship as a critical engine for wealth creation in the high-technology and innovation-intensive economy. Deals with such key issues as: (1) assessing attractiveness of opportunities; (2) launching a new venture; (3) obtaining the necessary financial, human, and technology resources; (4) managing the transition from a small entrepreneurial firm to a large, sustainable professionally managed but still entrepreneurial corporation; and (5) being an entrepreneur and promoting entrepreneurship in a large corporation.

MG 7873 Intellectual Property for Technology and Information Managers
(half-semester course) *1¼:0:0:1½*

Focuses on the role of intellectual property (e.g., patents, trade secrets, copyrights, trademarks) as a major element in modern technology and information strategy. Relevant concepts and case studies are used, with examples representing both classical and digital innovations.

MG 7883 Modern Supply Chain Management: Integration Through Technology
(half-semester course) *1¼:0:0:1½*

An introduction to the role of information technology in supply chain management. It builds on some of the concepts covered by MG 7833 New Frontiers in Electronic Business. Both qualitative and quantitative aspects of supply chain management are covered. Articles pertaining to leading-edge research and management thought are discussed and analyzed by students. The underlying objective is to prepare participants to develop skills that are useful in analyzing technology, marketing, logistics, operations and broader channel-management issues. Classes are conducted using the case method, and a high level of class interaction is expected.

MG 7893 Special Elective Topics for TIM
(half-semester course) *1¼:0:0:1½*

Covers selected key emerging trends and issues in the MOT and TIM domains. Discussion with industry leaders and specialists from business, government, and academia. Topical treatment of technologies, markets, business practices, government regulations, and the relationships among them.

MG 7903 Foundations of Telecommunications and Networking Technology
2½:0:0:3

Introduction of the basic concepts of telecommunications and networking technologies. Course examines on a macro-level how data communications and networking have become integral, vital parts of an organization. It discusses business information requirements and applications of data communications and networking, such as e-mail, Groupware, document sharing, and the Internet and World Wide Web. It reviews the following technical concepts and discusses their managerial implications: components of network architecture; data communications hardware; data transmission concepts; data communications models, such as OSI, TCP/IP and IPX/SPX; detailed study of data link layer and network layer; components of Local Area Networks (LANs); and types of LANs. It further reviews the importance of networking standards and standards-making organizations.

MG 7913 Principles of Modern Networking *2½:0:0:3*

Focuses on advanced concepts and issues in enterprise networking. Course reviews technical concepts and managerial implications of: client/server architecture; components of Wide Area Networks (WANs); dedicated and switched circuit services, such as T-1 lines, ISDN, SMDS, and DSL; high speed/broadband/backbone networks; network components, such as hubs, bridges, switches, routers, brouters and gateways; fiber distributed data interface (FDDI); internet-working; IP addressing and routing; wireless/mobile networks; electronic data interchange (EDI); multimedia networking. It focuses on high-level managerial issues, such as network design and implementation, network management tools, WAN performance and fault management, cost management, network security, and regulatory issues. It also introduces other aspects of the networking environment, including software and appliances.

MG 7923 Modern Network Management *2½:0:0:3*

Explores emerging issues and trends in modern enterprise networking. It examines implications of such developments in the business environment and infrastructural needs of organizations and clusters of organizations. It reviews ramifications of the TCP/IP revolution leading to commercialization of the Internet/World Wide Web. Course discusses the network infrastructure required to implement Intranets/Extranets, electronic commerce and interorganizational business communication and collaboration generally. It evaluates electronic business and emerging technologies (such as data warehouses, electronic payment systems, corporate digital libraries, multicasting, firewalls, and digital signatures). It also deals with the implications of internetworking, such as digital cities, smart buildings, distance learning, telecommuting and teleconferencing, and appliances that are merging.

MG 7933 Global Management in the Networking, Telecommunications and Information Industries *(variable 2½ / 1½)*

In viewing the modern telecommunications, managerial and IT value chaining, this course assumes a global perspective. Focuses on key aspects of the modern telecommunications and information sectors, e.g., changing strategies related to infrastructure/equipment; re-configured role of operators and providers; the role of IT outsourcing and professional-services firms; the emergence of wireless on a global scale (including the wireless Internet). Also discusses implications of changing technologies and regulation policies.

MG 7973 Financing for Value Creation (half-semester course) *1¼:0:0:1½*

Covers the key-creating strategies and financial skills required by managers of entrepreneurial and innovative firms at various stages of evolution: from new, stand-alone entrepreneurial ventures to innovative, technology-driven projects of established corporations.

MG 8203 Project Management and Assessment for Technology Managers *(variable 1½ / 3 units) 1¼:0:0:1½*

Managing technology-based projects ranging from individual research and development to large-scale and complex technological systems. Feasibility and risk analysis. Project selection and portfolio optimization. Alternative financing methods. Functional and administrative structures, coordination and scheduling of activities, personnel planning, negotiations, contracts and computer-based techniques. Cost estimation, capital budgeting, cost controls, and effective matrix management. Actual case studies are used in this course, as are relevant and modern project management software applications.

MG 960 TIM Capstone Project Course *2½:0:0:3*

A Capstone, integrative and state-of-the-art intellectual experience for participants at the conclusion of the program. The whole class focuses on an over-arching theme that is of broad and compelling managerial concern and that is related in important ways to the innovation, technology-intensive, and/or information business arenas. The class is initially divided into small groups to tackle various aspects of the overall subject. Individual participants are expected to submit their own analysis of a specific issue or firm associated with the general subject. Participants are encouraged to employ relevant concepts and insights that they have acquired during the course of the program.

TRANSPORTATION PROGRAM

Program Adviser: Elena S. Prassas

The Department of Civil Engineering offers graduate degree programs in transportation leading to the degrees of:

- MS in Transportation Planning and Engineering
- MS in Transportation Management
- PhD in Transportation Planning and Engineering

A number of graduate certificate programs are also available in:

- Traffic Engineering
- Transportation Planning
- Transportation Management and Economics

Graduate certificates, which entail completion of 12 focused credits of study, offer the opportunity for students to specialize in one of the areas of transportation planning and engineering. It also allows students not ready to embark on a full Master of Science degree program to receive formal recognition for more focused study.

Master of Science programs are practice-oriented with a strong foundation in underlying principles and methods. The PhD is intended for students with a strong research interest and a desire to advance the state-of-the-art as a result of that research.

REQUIREMENTS FOR MASTER OF SCIENCE PROGRAMS

ADMISSION REQUIREMENTS

To be eligible for admission as an MS candidate, applicants must hold at least a baccalaureate degree from an acceptable institution. Students pursuing degrees in transportation planning and engineering must also have a firm background in quantitative analytic skills. If admitted, students lacking such skills will be required to take remedial courses in addition to degree requirements to strengthen analytic competency.

All foreign students admitted to transportation programs must take an examination in English before registration. Based upon an evaluation of the examination, they may be required to take up to two additional courses in English as a Second Language (ESL) for which no graduate credit is given.

GRADE REQUIREMENTS

To earn master of science degrees or graduate certificates, students must have a 3.0 GPA or better in all graduate courses and in all guided studies (readings, projects, theses). Averages are separately computed for courses and guided studies. Transfer credits from other institutions are not included in this average.

In addition, transportation program students are required to have an overall 3.0 GPA in all courses required for their degree or certificate program. Students may not repeat a course toward any of the transportation degree programs more than once.

ANALYTIC BACKGROUND

All applicants for MS or graduate certificate programs in transportation must show evidence of quantitative analytic ability, generally including a minimum of two years of college mathematics and a college-level course in statistics.

ADVISING

Each student in the master of science program is assigned a faculty adviser. It is important that students maintain frequent contact with their adviser throughout the course of their studies.

Students must meet with their academic adviser prior to each registration and at any other time they need advice or consultation. Students must have a detailed program of study formally approved by the adviser prior to registration. Advisers also handle requests for waiver of certain degree requirements where warranted. Such waivers must be approved in writing and must be entered into the student's departmental file. Where specific courses are waived, the permission of the course instructor is also required. When waivers are granted, students may be required to take other specific courses in their place, otherwise additional electives will be selected.

Students registering for any guided studies (readings, projects, theses) are assigned project advisers for each such activity. The project adviser may or may not be the same as the student's academic adviser, depending upon the subject matter selected. To register for any guided study activity, students must submit written proposals for the topic(s) to be covered to an appropriate project adviser before registration. To register, students must obtain the written approval of the project adviser and the academic adviser.

In addition to academic and project ad-

visers, students studying under research or teaching fellowships are assigned fellowship advisers. Normally, these would be either the principal investigator of the research effort funding the fellowship or the director of the academic area in which the teaching fellowship is awarded.

While academic advisers consult and give advice to students, it is the student's responsibility to ensure that all degree requirements are fulfilled and to submit all proper forms and application when necessary.

TRANSFER CREDITS

The minimum number of units students must take at Polytechnic to be awarded an MS is 21 credits. All credits for a graduate certificate must be taken at Polytechnic.

Students may transfer up to 9 credits of acceptable courses toward an MS degree, subject to the approval of the academic adviser. To be transferred, the course(s) must be relevant to the transportation program and from an acceptable institution. A grade of B or better is required for granting of transfer credit. Courses graded on a pass/fail basis are not considered for transfer unless accompanied by a detailed written evaluation by the instructor of the course. All transfer requests must be accompanied by an official transcript from the transferring institution. Applications for transfer credits are accepted only after students have earned 12 credits at Polytechnic. Validation credits by examination may not be used toward any transportation degree program.

MASTER OF SCIENCE IN TRANSPORTATION PLANNING AND ENGINEERING

The MS program has a strong foundation in traffic engineering, transportation planning, transportation economics, public transportation systems, and intelligent transportation systems. Students are exposed to a learning atmosphere that provides a meaningful combination of theoretical and practical approaches. Courses include a mix of presentations, workshop and project exercises, and practical problem solutions.

The program focuses on (1) material suited to the issues and projects students will face on the job, so that they are immediately productive; (2) material packaged by course in such a way that each course provides specific skills and knowledge so that the student is immediately productive in that area; most of the students are part-time, working full-time for area consultants and agencies; (3)

projects in a number of courses, as an underlying approach to teaching the courses and the program; (4) modern tools integrated into the courses, including, but not limited to: Synchro and SIM-Traffic, VISSIM, HCS+, TransCAD, AutoCAD templates for intersection design, and data collection and processing software; (5) design problems taught through a project/case studies approach; (6) statistics integrated into courses, with moderately advanced skills in EXCEL and WORD expected in all courses (but not explicitly taught).

The program includes a strong focus on the rapidly-emerging field of intelligent transportation systems. This field applies telecommunications and information technology to the solution of a variety of transportation functions, from route guidance systems to automated toll collection systems to the automated highway.

GOALS AND OBJECTIVES

The primary goal of the MS in Transportation Planning and Engineering is to prepare transportation professionals to plan, functionally design, control and operate facilities, systems, and services that satisfy the demand for both passenger and freight transportation. Specific objectives of the program are to provide the skills necessary to:

- Fundamentally understand the nature and generation of transportation demands
- Understand the political, policy, and economic forces that affect transportation demands and the public framework in which they are addressed
- Functionally design transportation systems and components
- Control and operate traffic and other transportation facilities
- Apply information technologies to intelligent transportation systems

PROGRAM REQUIREMENTS

Course No.	Course Title	Credits
TR 6013	Fundamental Concepts in Transportation	3
TR 6023	Analytic Methods in Transportation	3
TR 6113	Forecasting Urban Travel Demand	3
TR 6313	Traffic Control and Signalization I	3
TR 6323	Traffic Control and Signalization II	3
TR 6213	Transportation Economics and Finance	3
TR 6223	Intelligent Transportation Systems and Their Applications	3
Total Required Credits:		21

All students would select 6 to 9 credits from the following list of electives:

Course No.	Course Title	Credits
TR 7123	Transportation Planning and Congestion Management	3
TR 7133	Urban Public Transportation Systems	3
TR 7323	Design of Parking and Terminal Facilities	3
TR 7333	Design and Management of Arterial and Street Networks	3
TR 7033	Transportation Safety and Security	3
TR 7233	Transportation Management	
TR 7243	Intelligent Transportation Systems: Deployments and Technologies	3
TR 7343	Urban Freeways and Intercity Highways	3
TR 8013/8023	Selected Topics in Transportation I, II	3
TR 9003	Readings in Transportation	3 each
TR 9013	Thesis in Transportation	3 each

Total Elective Credits M.S. students in the Transportation Planning and Engineering program may take 3 credits of free electives from any graduate course offering at Polytechnic, assuming that the student has the appropriate pre-requisites. Adviser approval is required for all elective selections.

MASTER OF SCIENCE IN TRANSIT MANAGEMENT

The program is intended for practicing professionals who deal with a public transit system, agency, and/or facility management. It combines basic management skills with a working knowledge of techniques and approaches to optimizing transportation system results.

GOALS AND OBJECTIVES

The primary goal of the MS in Transit Management is to prepare professionals to effectively and efficiently manage various transportation enterprises, with an emphasis on agencies, facilities and services in the public sector. Specific objectives of the program are to provide:

- A basic background in management skills and techniques, specifically as applied to public and private transportation organizations;
- A basic understanding of the economic aspects of the transportation sector;
- An understanding of the importance of national, state and local transportation policy on public and private sector organizations;
- Fundamental knowledge on some of the specific issues and problems in managing and operating public transportation facilities

PROGRAM REQUIREMENTS

The following courses are required of all students:

Course No.	Course Title	Credits
TR 6013	Fundamental Concepts in Transportation	3
TR 6213	Transportation Economics and Finance	3
TR 6223	Intelligent Transportation Systems and Their Applications	3
TR 7223	Transportation Management	3
TR 7133	Urban Public Transportation Systems	3
TR 7233	Management of Transit Maintenance and Operations	3
Total Required Credits:		18

Students will take elective courses in the following areas:

MG General management courses. (with appropriate pre-requisites)	9
TR General transportation courses (with appropriate pre-requisites)	3
Total Elective Credits:	12

DOCTOR OF PHILOSOPHY IN TRANSPORTATION PLANNING AND ENGINEERING

The PhD in Transportation is a research-oriented degree intended for those whose goal is a career in basic transportation research and/or teaching at the university level or in private research organizations.

GOALS AND OBJECTIVES

The fundamental goal of the PhD in Transportation Planning and Engineering is to develop professionals with strong research skills capable of advancing the profession of transportation planning and engineering through their work. Specific objectives of the program are to provide the skills necessary to:

- Develop strong and deep fundamental knowledge concerning the profession of transportation planning and engineering
- Develop the knowledge and skills required to perform independent fundamental research in the field of transportation planning and engineering
- Produce a piece of fundamental research that meaningfully advances the state-of-the-art of the profession of transportation planning and engineering

PROGRAM REQUIREMENTS

Students pursuing the PhD in Transportation Planning and Engineering generally specialize in one of the following subject areas:

- Transportation planning
- Traffic engineering

- Intelligent transportation systems
- Transportation safety

Other focus areas are possible, and can be developed with the assistance of faculty advisers. All subject areas must be, of course, relevant to the degree sought, and there must be a faculty member who is willing and able to guide the student's research.

PROGRAM ADMINISTRATION

All graduate applications are processed through the civil engineering departmental office, which distributes applications to the appropriate graduate coordinator. Graduate program coordinators formally implement admission decisions in accordance with departmental regulations. Coordinators consult with other departmental faculty as needed. They are also responsible for keeping records for all graduate students within their program areas, and for processing all graduation audits for students within their program areas. The current coordinator for the transportation program is Professor Elena Prassas.

The graduate coordinators form the departmental Graduate Committee. All PhD applications are reviewed by the committee, and admissions decisions are made by the committee and implemented by the appropriate graduate coordinator.

For each registration, the student's program must be approved by the academic adviser and signed by the transportation program coordinator.

ADMISSION CRITERIA

Admission to the PhD in Transportation Planning and Engineering requires an MS in Transportation Planning and Engineering or equivalent, with a GPA of 3.5 or better (on a 0-4 scale).

Admission to PhD programs does not require GRE's (Graduate Record Examination), but applicants are encouraged to take these examinations. If these examinations are taken, the student must submit the results for consideration.

Foreign applicants must take the TOEFL examination and submit the results for consideration.

The "equivalent" of the MS degree can be achieved in several ways. The candidate may have an MS degree with a different title that covers substantially the same material. In more general terms, the applicant must demonstrate that he/she has the equivalent of all undergraduate and master's level coursework to be able to pursue doctoral level work in the major area chosen. Further, "equivalence" is evaluated based on the totality of the student's undergraduate and

graduate record, not on a course-by-course basis.

Because admission to a PhD program requires an appropriate MS (or equivalent), those applicants who have not yet achieved a master's degree would normally be admitted as MS students. They are expected to earn an MS degree while completing their major and minor course requirements. In rare cases, an applicant with only a BS degree may be directly admitted into the PhD program with the written approval of the department head.

DOCTORAL COMMITTEES

Every PhD student is assigned an academic adviser, who is selected by the department head upon admission. Any member of the civil engineering faculty can be an academic adviser to a graduate student. In cases where a student is being supported on a research contract, the principal investigator of the contract would normally be appointed as the academic adviser for the student. Where a student has a particular research interest and is working with a particular faculty member, the student may request that the faculty member be appointed as his/her academic adviser. In rare cases where a PhD student enters the program without a prior selection of a major area of study, the initial academic adviser will be the Graduate Coordinator of the transportation program.

In the course of fulfilling their academic requirements, PhD candidates, will deal with two advisory committees:

Academic Advisory Committee: The student's academic adviser works out an appropriate program of courses to fulfill major and minor requirements for the PhD. The Academic Advisory Committee generally will consist of the academic adviser and one faculty member for each minor area of study. The Academic Advisory Committee guides the PhD student's work through the successful completion of a qualifying examination. A letter signed by the academic adviser and approved by the department head is placed in the student's file indicating the composition of the Academic Advisory Committee.

Dissertation Committee: The Dissertation Committee is formed immediately after the student passes the qualifying examination. It consists of a major adviser, a dissertation adviser and a minor adviser for each minor the student has pursued. Additional faculty members may also be on the Dissertation Committee. The Dissertation Committee may be the same as the Academic Advisory Committee, or may be different. The Dissertation Committee guides the student's course and research work after the student has passed the qualifying examination.

The Dissertation Committee must be formally assigned with the approval of the department head and is filed with the Office of Graduate Studies. The major adviser must be a full-time faculty member of the Department of Civil Engineering. The major and dissertation advisers may be the same individual where appropriate.

DOCTORAL DEGREE REQUIREMENTS

To earn a PhD in Transportation Planning and Engineering, the following requirements must be met:

- 51 credits of graduate work (not including the PhD dissertation) in relevant major and minor areas of study beyond the bachelor's degree, with an average grade of B or better (cumulative average of 3.0 or better on a 0-4 scale).
- Completion and successful defense of a 24-credit dissertation related to the major area of study. Dissertations must consist of original research that meaningfully advances the state-of-art in the subject area of the research, and should result in the publication of at least one paper in a strictly peer-reviewed technical journal appropriate to the subject. A grade of B or better must be achieved for the dissertation.
- Completion of two minor areas of study, each consisting of between 9 and 12 credits of graduate work. At least one minor area must be outside the transportation area.
- Residency requirements for the PhD in Transportation Planning and Engineering include the 24-credit dissertation plus a minimum of 9 credits of applicable graduate course work taken at the Polytechnic.

In satisfying the 51-credit course requirement, the student must satisfy all requirements for the major and minor areas selected, or their equivalent.

In satisfying these basic PhD requirements, students must also satisfy one of the two following conditions:

- 39 credits of appropriate graduate course work, not including individual guided studies (readings, projects, theses, etc.) beyond the bachelor's degree, with an average grade of B or better (cumulative average of 3.0 or better on a 0-4 scale).
- 21 credits of appropriate graduate course work, not including individual guided studies (readings, projects, theses, etc.) beyond the master's degree, with an average grade of B or better (cumulative average of 3.0 or better on a 0-4 scale).

Satisfying condition 2 requires that the department accept the student's MS degree in

toto without regard to its specific content. This requires a recommendation from the department's Graduate Committee and the approval of the department head.

TRANSFER CREDITS

Transfer credits for PhD students can be awarded on a course-by-course basis, or an MS degree from another institution may be accepted for transfer in toto. In the former case, a maximum of 48 credits of appropriate graduate work may be transferred. The latter requires a recommendation from the department's Graduate Committee, and the approval of the department head. Transfer units are generally awarded at the time of admission, and must be approved by the academic adviser, the transportation graduate coordinator, and the department head.

QUALIFYING EXAMINATION

Departmental qualifying examinations for the PhD in Transportation Planning and Engineering are given once per year (usually in May or June), and are coordinated with other qualifying examinations in the department. If sufficient demand exists, a second qualifying examination may be scheduled in December or January. Every PhD student must pass a qualifying examination in the major area of study, and in any in-department minor areas of study before becoming a candidate for the PhD. Further:

- No student may register for dissertation units until the Qualifying Examination is passed.
- A dissertation committee cannot be formed until the student passes the Qualifying Examination.
- A student may take the Qualifying Examination twice. A third attempt is permitted only with the written recommendation of the Academic Advisory Committee and the approval of department head. In no case may a student take the examination more than three times.
- Students normally take the Qualifying Examination (for the first time) after successfully completing most of their course requirements in the major and in-department minor areas of study.

The Qualifying Examination consists of a six-hour written portion (generally given in two three-hour blocks on the same day) and an oral portion of approximately one hour. Both written and oral portions of the examination focus on the student's major and in-department minor. The oral portion may also explore higher-level skill areas required to successfully conduct independent research. Students are deemed to have passed

the examination based upon an overall evaluation of results of both the written and oral portions. While some students may not be invited to the oral examination if they have done poorly in the written portion, invitation to the orals does not imply that the student has "passed" the written portion of the exam.

The Qualifying Examination is either "passed" or "failed." A letter indicating the result of each examination is placed in the student's graduate file. In rare cases, a student may be deemed to have "conditionally passed" the Qualifying Examination. This occurs in cases where the student does extremely well in all areas except for a single subject area in which weakness has been noted. Such a student must follow a prescribed preparation plan for strengthening their knowledge and skills in the area of weakness, and must pass a special examination on the area of weakness within one calendar year. A student who has "conditionally passed" the Qualifying Examination may register for dissertation credits, and may form a Dissertation Committee.

All transportation faculty members participate in submitting written problems for the qualifying examination, in the grading process, and in the oral examination. All departmental faculty members are welcome to observe any oral examination and to ask appropriate questions. Each student's Academic Advisory Committee will have the opportunity to review the entire exam before it is administered, and may suggest changes if it deems that the examination as presented is not an equitable test of the student's abilities. Recommendations on the results of the examination are submitted by each student's Academic Advisory Committee, augmented by any departmental faculty in the sub-disciplines tested. The departmental faculty, acting as a whole, votes to accept or reject such recommendations at a meeting scheduled for this purpose.

DISSERTATION PROPOSAL

Following passage of the Qualifying Examination and the appointment of a Dissertation Committee, the PhD candidate must submit a written dissertation proposal outlining the subject of the proposed research. This proposal should be between 15-20 pages long, and should address the following specific items:

- Description of the topic.
- Literature review sufficient to insure that the work contemplated is original.
- Methodology(ies) to be employed in the research. Data and/or laboratory needs, and their availability to the student.

ANTICIPATED OUTCOMES.

The Dissertation Proposal must be submitted within one semester of full-time study, or before 9 units of dissertation credit are completed.

The Dissertation Proposal is orally presented and defended before the Dissertation Committee and any other interested departmental faculty. The date of the oral defense and copies of the draft Dissertation Proposal must be made available to departmental faculty at least two weeks (14 calendar days) prior to the defense.

When the Dissertation Proposal is formally accepted, the Dissertation Adviser enters a letter into the student's graduate file indicating this, together with a copy of the proposal. While the Dissertation Committee has reasonable flexibility in modifying the proposal as appropriate during the course of the research, any significant change in focus area or methodology requires that an amended Dissertation Proposal be written and formally accepted following the same procedure noted herein.

DISSERTATION DEFENSE

The culmination of the student's PhD work is the oral presentation and defense of the final draft dissertation. A defense is generally scheduled after the Dissertation Committee has reviewed the draft dissertation and determined that it is complete and of sufficient quality to be presented and defended.

The defense is organized and scheduled by the Dissertation Committee. All University faculty members are invited to observe and ask appropriate questions at all Polytechnic dissertation defenses. Therefore, the date of the defense must be announced University-wide at least one month prior to the event, and copies of the draft dissertation must be made available to any faculty member who requests one in a timely fashion and in no case less than two weeks prior to the defense.

GRADUATE CERTIFICATE PROGRAMS

The Transportation Program offers graduate certificates to students completing 12 credits of study in specified areas of concentration. These are intended for students who do not wish to commit to a full advanced degree program. Applicants may be students with bachelor's degrees seeking to specialize in an aspect of transportation or those with advanced degrees wishing additional course work in a highly focused area of the profession.

Students in certificate programs may apply for transfer to degree programs without any loss of credits, assuming they are admitted to the degree program and that the

courses are appropriate to the degree. Admission to a certificate program does not guarantee admission to a full degree program.

The Department of Civil Engineering offers the following certificate programs (in transportation) with the following requirements:

CERTIFICATE IN TRAFFIC ENGINEERING:

Course No.	Course Title	Credits
TR 6013	Fundamental Concepts in Transportation	3
TR 6313	Traffic Control and Signalization I	3
TR 6323	Traffic Control and Signalization II	3
Select on One of the Following:		
TR 7323	Design of Parking and Terminal Facilities	3
TR 7333	Design and Management of Arterial and Street Networks	3
TR 7343	Urban Freeways and Intercity Highways	3

Certificate in Transportation Planning:

Course No.	Course Title	Credits
TR 6013	Fundamental Concepts in Transportation	3
TR 6113	Forecasting Urban Travel Demand	3
TR 7123	Transportation Planning and Congestion Management	3

Select One of the Following:

TR 6213	Transportation Economics and Finance	3
TR 7133	Urban Public Transportation Systems	3
TR 6223	Intelligent Transportation Systems and Their Applications	3

Certificate in Transit Management:

TR 6013	Fundamental Concepts in Transportation	3
TR 7133	Urban Public Transportation Systems	3
TR 7233	Management of Transit Maintenance and Operations	3

Select One of the Following:

TR 6213	Transportation Economics and Finance	3
TR 7233	Transportation Management	3
MG xxxx	General management course.	3

GRADUATE COURSE DESCRIPTION

GENERAL COURSES

TR 6013 Fundamental Concepts in Transportation 3:0:0:3

The purpose of this course is to provide the contextual foundations for the study of urban transportation systems, using performance criteria that reflect the perspectives of system providers/owners, users, and communities. The connection between transportation supply, travel demand, service volume, and level of service will be explored and quantified for various travel modes. The impacts of transportation system performance on travel behavior, communities, and the environment will be discussed. The roles of technology and institutions will be explored through case examples. *Prerequisite: Graduate status or permission of instructor.*

TR 6023 Analytic Methods in Transportation 3:0:0:3

This course introduces transportation students to a variety of analytic techniques as they are commonly applied to transportation issues. The course covers basic statistics and statistical analyses and their application to transportation studies, including traffic characteristics studies and survey instruments. Mathematical techniques for analysis of transportation queues are covered. Statistical tests for significance of improvement impacts are illustrated. Regression analysis applied to the development of transportation models is covered. An introduction into traffic simulation is also given. *Prerequisite: Graduate status or permission of instructor.*

TR 7033 Transportation Safety and Security 3:0:0:3

Technology, legislation, and market forces have contributed to improved transportation safety for decades. But one must consider which metrics are most relevant for which modes, the role of demographics and traffic levels, and other factors when analyzing and predicting safety trends. Attention is paid to a systems view, to metrics by mode, and to both standard field and statistical analyses. Consistent with current priorities, the course addresses security as well as safety issues. *Prerequisite: Graduate status or permission of instructor.*

TRANSPORTATION PLANNING, ANALYSIS, AND EVALUATION

TR 6113 Forecasting Urban Travel Demand 3:0:0:3

The purpose of this course is to study methods and models used in estimating and forecasting person travel in urban areas. The objective of the course is to acquire an understanding of the fundamental relationships between land use, transportation level of service, and travel demand, and to apply methods and state-of-the-practice models for predicting person travel on the transportation system. *Prerequisite/Corequisite: TR 6013*

TR 7123 Transportation Planning and Congestion Management 3:0:0:3

The purpose of this course is to provide a contextual understanding of urban transportation planning and its component activities; to understand the enabling environment necessary to sustain the planning process; to understand the causes of transportation congestion and its impacts on transportation users and communities; to set forth a vision for congestion management and to develop and evaluate strategies and policies that achieve the vision. *Prerequisite/Corequisites TR 6013*

TR 7133 Urban Public Transportation Systems 3:0:0:3

This course provides a thorough understanding of policy, planning, operational, and technical issues that affect urban public transportation. It includes the historical development of cities and the rise of urban transport. The characteristics of various urban transportation modes (their specific operating and infrastructure characteristics), as well as key elements that are critical to service provision, such as service planning, scheduling, fare collection, communication and signaling, station design, and customer service, are covered. The course offers a broad perspective on regional planning, capital programming, and policy matters. Special focus will be on emerging technologies and their practical applications. *Prerequisite: Graduate status or permission of instructor.*

TRANSPORTATION MANAGEMENT AND FACILITY OPERATIONS

TR 6213 Transportation Economics and Finance 3:0:0:3

This course provides the basic principles of engineering economic analysis and their application to transportation projects. Half of the course covers the concepts of present worth, capital recovery, sinking funds, and annual cost applied to economic comparisons and evaluations of alternatives. The second half of the course delves into financing transportation and how government policy on transportation affects the economy and environs at the local, state, and federal levels. Historical perspectives on the financing of highway systems, public transportation systems, and transportation agencies are presented. Other subjects include privatization, innovative financing methods, business plans. *Prerequisite: Graduate status or permission of instructor.*

TR 6223 Intelligent Transportation Systems and Their Applications 3:0:0:3

This course will introduce the concepts and applications of Intelligent Transportation Systems (ITS) and its growing role in the management of transportation systems. The course will stress the role of ITS as national policy, as specified in major transportation funding legislation – ISTEA, TEA21, and SAFETY-LU. A systems engineering approach to overall development of ITS technologies is stressed. Major components of ITS are discussed, and examples of their application treated. Coordination and integration of ITS components will be treated. *Prerequisite: Graduate status or permission of instructor.*

TR 7213 Transportation Management 3:0:0:3

This course presents an overview of the transportation management profession. Levels of management and unique objectives of management in the transportation sector are presented and discussed. Management structures for private and public transportation organizations are analyzed. Management practices are treated from the perspective of organizations, optimization of the use of public resources, legislative, and legal contexts and operations. *Prerequisite: Graduate status or permission of the instructor.*

TR 7223 Management of Transit Maintenance and Operations 3:0:0:3

This course is intended to provide a comprehensive understanding of modern public transportation systems, with emphasis on their technology and operational practices. Planning and management aspects are also covered. Such operational management issues as maintenance practices, scheduling, procurement, and labor relations are broadly outlined and discussed. Planning and capital programming issues are also treated. *Prerequisites: Graduate status or permission of instructor.*

TR 7243 Intelligent Transportation Systems: Deployments and Technologies 3:0:0:3

Transportation infrastructure deploys a wide range of modern technology to provide service to travelers, the general public, and private entities. This technology enables other systems to function effectively and serve societal needs. This course focuses on data communications and applications in intelligent transportation systems: communications alternatives and analyses, emerging technologies, geographic information systems (GIS), and global positioning systems (GPS). *Prerequisite: TR 6223 or equivalent, or permission of instructor.*

TRAFFIC ENGINEERING

TR 6313 Traffic Control and Signalization I 3:0:0:3

Traffic controls are imposed to provide for safe, efficient, and orderly movement of people and goods on our nation's street and highway systems. Traffic control is examined in the urban context in which both vehicles and pedestrians be accommodated. Techniques for quantifying traffic stream behavior are described. Federal, state, and local standards for the design and implementation of control devices are presented. Selection of appropriate control measures, design and timing of traffic signals at individual intersections and in arterial networks is treated in detail. Use and application of current computer tools – HCS++ and Synchro – are illustrated. *Prerequisite: Graduate status or permission of instructor.*

TR 6323 Traffic Control and Signalization II 3:0:0:3

Continuation of TR 6313. Emphasis on the arterial as a facility, and on systems concepts such as traffic calming, access management, and roundabouts as a design element. Network problems induced by traffic congestion and remedies such as critical intersection control, network metering, oversaturated control policies, and real time sensing. Traffic impacts from growth and development, including assessment and mitigation. Use of modern tools, including VISSIM, Synchro/SIMTraffic, and HCS++. The course centers on two projects done by students working in teams. *Prerequisite: TR 6313 or equivalent, or instructor's approval*

TR 7323 Design of Parking and Terminal Facilities 3:0:0:3

This course covers design techniques and approaches to a variety of pedestrian and vehicular needs in conjunction with access to land functions. Parking serves as the primary access interface to many land facilities, from shopping centers and sports facilities, to medium- and high-density residential developments. The planning and design of appropriate parking facilities, and the planning of access and egress from these facilities is a critical element to the economic success of a development. Terminals are inter-modal interface facilities involving the transfer of people and/or goods from one mode of transportation to another. This course will cover essential elements of terminal planning and design, including transit stations and terminals, major goods terminals at ports and railheads, and others. The design of pedestrian space and ways within terminal structures is also treated. *Prerequisite: Graduate status or permission of instructor.*

TR 7333 Design and Management of Arterial and Street Networks 3:0:0:3

The system of surface arterials and streets serves as the bloodstream of urban and suburban activities. The physical design and management of these critical traffic systems plays an important role in the economic and social viability of an urban or suburban area. This course focuses on the design elements of urban roadway systems, and on the management of arterial and street space. While an overview of traffic control for such systems is included, the focus is on design aspects of facilities, and on overall management strategies for optimizing the

functionality of urban/suburban networks.

Prerequisite: TR 6313 or equivalent.

TR 7343 Urban Freeways and Intercity Highways 3:0:0:3

This course focuses on the design, analysis, control, and management of urban freeways and intercity highways of all classes. The course covers geometric design standards and principals, the application of highway capacity and level of service analysis methodologies (including HCS++), marking and signing, speed control, and modern freeway management systems and approaches. *Prerequisite:* TR 6013, TR 6313, or equivalents, or permission of instructor.

GUIDED STUDIES AND PROJECTS

TR 8013, 8023 Selected Topics in Transportation I, II 3:0:0:3

These courses are given as needed to present material on current topical subjects that are not expected to be given on a regular basis. The topic(s) for each offering are indicated, and are listed on the student's transcript. These courses may be taken more than once if the listed topics are different. *Prerequisites:* As appropriate to the topic(s); to be specified for each offering.

TR 9003 Readings in Transportation
Variable

This is an individually guided effort involving research into a topic of interest, usually growing from a course the student has taken. Readings courses should not duplicate material available in a regularly scheduled course, but should involve additional research on a topic or topics of interest to the student that is related to a course or courses. A formal written report is required. The student must have a faculty advisor who agrees to work with them, and an agreed topic before registering. The student may register for 1 to 3 credits for a readings effort, as appropriate to the effort and approved by the supervising instructor. *Prerequisite:* Permission of supervising instructor.

TR 9013 Thesis in Transportation
3 Each

Students electing to take a 6-credit M.S. An M.S. Thesis involves a significant individually-guided research effort, resulting in a formally defended thesis report, and bound in accordance with University requirements. *Prerequisites:* M.S. degree status and permission of thesis advisor.

TR 999X Dissertation for the PhD (Transportation Planning and Engineering)

Variable, ½-12 24 Total

The dissertation is an original investigation embodying the results of comprehensive research in a specific area of transportation worthy of publication in a recognized, formally refereed transportation journal. Students are required to make a formal oral defense of their dissertation, and must submit a formally bound written document. Students must complete a minimum of 24 credits of dissertation registration before defending. Once the dissertation is started, the student must maintain a minimum of 3 credits of registration during each semester (not including summer) until the dissertation is complete. During the last semester of registration, the student may be permitted to register for 1/2 credit with the permission of the Graduate Office and dissertation advisor.

Prerequisite: Ph.D. degree status, passage of the Qualifying Examination in Transportation, and permission of the Dissertation Advisor.

URBAN SYSTEMS ENGINEERING AND MANAGEMENT PROGRAM

Program Director: Ilan Juran

The Department of Civil Engineering offers a graduate program in Urban Systems Engineering and Management, leading to the Master of Science. This program was developed as part of the Institute for Civil Infrastructure Systems (ICIS), supported by the National Science Foundation. Polytechnic University is a major partner institution in ICIS, a consortium effort led by New York University.

The primary objective of ICIS, and of the Urban Systems Engineering and Management Program, is to educate professionals with both engineering and non-engineering backgrounds to understand and manage major urban infrastructure systems and the problems they pose to society and government. It is not sufficient to have a technical understanding of the engineering aspects of urban infrastructure systems and their components. To manage this sector effectively, professionals must also understand the societal and political contexts that affect them. Issues of public policy, finance, monitoring, and maintenance must all be understood more clearly.

This Master of Science program attempts to provide a broader exposure to the range of knowledge and skills needed to play a leading role in infrastructure management in an urban setting. Thus, the program includes elements of engineering and technology, management, economics, finance, and public policy.

GOALS AND OBJECTIVES

The specific objectives of the Urban Systems Engineering and Management Program are to provide students with the following:

- A broad base of understanding of infrastructure management and policy issues
- Analytic and decision-making skills that account for the political, economic, and social impacts of infrastructure technologies
- A broad overview of the full range of urban infrastructure systems
- An integrated knowledge of the interactions and interdependencies of various urban infrastructure systems
- Specialized management skills and techniques to apply to unique problems of the infrastructure segment

ADMISSION REQUIREMENTS

Admission to the MS in Urban Systems Engineering and Management is open to professionals with BS or BA degrees and backgrounds in engineering, science, public policy, management, economics, and/or finance. Appropriate mathematics background, usually including undergraduate calculus, would be required, as would an undergraduate GPA of 3.0 or better.

GRADE REQUIREMENTS

To earn graduate degrees or certificates, students must have 3.0 GPA or better in all graduate courses and guided studies (readings, projects, theses, dissertations). Averages are separately computed for courses and guided studies. Transfer credits from other institutions are not included in this average.

ANALYTIC BACKGROUND

All applicants for this MS program must show evidence of quantitative analytic ability, generally including a minimum of two years of college mathematics and a college-level course in statistics.

TRANSFER CREDITS

The residency requirement for the MS degree is 24 credits. This is the minimum number of credits that must be taken at Polytechnic to be awarded a Polytechnic MS degree.

Students may transfer up to 6 credits of acceptable courses towards an MS degree, subject to the approval of the academic adviser. To be transferred, the course(s) must be relevant to the program and from an acceptable institution. A grade of B or better is required for granting of transfer credit. Courses graded on a pass-fail basis are not considered for transfer unless accompanied by a detailed written evaluation by the instructor of the course. All transfer requests must be accompanied by an official transcript from the transferring institution. Applications for transfer credits are accepted only after the student has earned 12 credits at Polytechnic.

ADVISING

Each student in the graduate program is assigned a faculty adviser. It is important that students maintain frequent contact with the adviser throughout the course of their studies. Students must meet with their academic adviser prior to each registration and at any other time they need advice or consultation.

Students must have a detailed program of study formally approved by their adviser prior to registration. Advisers also handle requests for waiver of certain degree requirements where warranted. Such waivers must be approved in writing and must be entered into the student's departmental file. Where specific courses are waived, the approval of the course instructor is also required. When waivers are granted, students may be required take other specific courses in their place, or to select additional electives.

Students registering for any guided studies (readings, projects, theses) are assigned project advisers for each such activity. The project adviser may or may not be the same as the student's academic adviser, depending upon the subject matter selected. To register for any guided study activity, students must submit written proposals for the topic(s) to be covered to an appropriate project adviser before registration. To register, the written approval of the project adviser is required in addition to the approval of the academic adviser.

While academic advisers consult and give advice to students, it is the student's responsibility to ensure that all degree requirements are fulfilled and to submit all proper forms and application when necessary.

REQUIREMENTS FOR THE MASTER OF SCIENCE

Program Core:

All students must complete the following five courses:

Course No.	Course Title	Credits
CE 7813	Infrastructure Planning, Engineering & Economics	3
CE 7843	Introduction to Urban Systems Engineering	3
CE 7853	Concepts & Implementation of Infrastructure Management Systems	3
CE 7673	Environmental Impact Evaluation	3
CE 8733	Infrastructure Financing: Structuring a Deal*	3
Total credits		15

*Course is part of the Exec21 program; special requirements (see Civil Engineering Program) or permission of adviser required.

Minor, Technical and Free Electives:

Each minor area of study includes: (1) three minor courses, required for the minor; and (2) two to three technical electives, available to all program students.

Students may elect not to take a specified minor area. They may, instead take five or six technical electives from the approved list in any of the specified areas. The number of technical electives is influenced by whether the student elects to do a 3-credit case-study report or a 6-credit MS thesis, as described in a later section.

Minor areas of concentration are available in:

- Transportation Systems Management (TSM)
- Construction Management (CM)
- Environmental Systems Management (ESM)
- Civil Infrastructure Systems Management (CISM)

Because of course content, students selecting the CISM minor should hold a BS in Civil Engineering or the equivalent.

Minor in Transportation Systems Management

Credits required in the minor:

Course No.	Course Title	Credits
TR 7223	Transportation Management	3
TR 6223	Introduction to Intelligent Transportation Systems	3
TR 7133	Urban Public Transportation Systems	3

Approved Technical Electives in Transportation

Course No.	Course Title	Credits
TR 6133	Travel Demand Forecasting	3
TR 7123	Transportation Planning & Congestion Management	3
TR 6213	Transportation Economics & Finance	3

Additional electives may be approved by the adviser.

Minor in Construction Management

Course No.	Course Title	Credits
Required in Minor:		
CE 8253	Project Management for Construction	3
CE 8713*	Construction & the Law	3
CE 8723*	How to Succeed in Construction: Business Management Essentials & Risk Assessment	3

Approved Technical Electives in Construction:

Course No.	Course Title	Credits
CE 8273	Contracts & Specifications	3
CE 8783	Construction Management and Planning	3
CE 8703*	Managing & Leading in the 21st Century	3

Additional electives may be approved by the adviser.

** Course is part of the Exec21 program; special requirements (see Civil Engineering Program) or permission of adviser required.*

Minor in Environmental Systems Management

Credits required in the minor:

Course No.	Course Title	Credits
CE 7753	Environmental Systems Management	3
CE 7533	Hazardous/Toxic Waste Management	3
CE 7563	Environmental Law	3

Approved Technical Electives in Environmental Studies:

Course No.	Course Title	Credits
CE 7473	Stream and Estuary Analysis	3
CE 7523	Air Pollution	3
CE 7543	Hazardous/Toxic Site Management	3

Additional electives may be approved by the adviser.

Minor in Civil Infrastructure Systems Management

Credits required in the minor:

Course No.	Course Title	Credits
CE 7863	Infrastructure Monitoring & Performance Assessment	3
CE 6063	Bridge Engineering	3
CE 8433	Urban Geotechnology	3

Approved Technical Electives in Infrastructure Systems:

Course No.	Course Title	Credits
CE 6143	Steel Structures	3
CE 8433	Instrumentation, Monitoring and Condition Assessment	3
CE 8493	Environmental Geotechnics	3

Additional electives may be approved by the adviser.

CAPSTONE EXPERIENCE

Students fulfill the requirement for a meaningful Capstone experience by completing an independent case study in urban systems management and engineering (3 credits) or a master's thesis on a topic of independent study (6 credits).

GRADUATE COURSES

CE 7753 Environmental Systems Management 2½:0:0:3

An overview of information technologies as applied to the remote sensing of environmental infrastructure systems. Development of infrastructure system databases to assist in complex decision-making on environmental infrastructures.

CE 7813 Infrastructure Planning, Engineering and Economics 2½:0:0:3

Methods for the identification, formulation, preliminary appraisal and detailed analysis of individual projects and systems of civil engineering projects. Different approaches appropriate for government agencies, public utilities, industrial firms, and private entrepreneurs. Planning considers projects that satisfy single and multiple purposes and objectives, meets local and regional needs and takes advantage of opportunities for development. Financial and economic analyses, including sensitivity and risk analysis. Mathematical models for evaluation of alternatives and optimization. Impacts of projects: environmental, social, regional economic growth, legal and institutional and public involvement.

CE 7843 Introduction to Urban Systems Engineering 2½:0:0:3

A descriptive overview of the key infrastructure systems and technologies that must be managed, operated and maintained. Systems treated include buildings and structures, water supply, solid and liquid waste handling and disposal, transportation, power communications and information systems, health and hospitals, police and fire protection. Course treats the financial, political, administrative, legal, and institutional settings of these systems and technologies. Apportion of the course features distinguished guest lecturers who are experts in some of the systems and technologies included.

**CE 7853 Concepts and Implementation
of Infrastructure Management Systems**

2½:0:0:3

Review of state-of-the-art performance monitoring and system condition assessment methodologies as part of infrastructure management systems. Emphasis is placed on information technologies as applied to remote sensing and database development for urban systems management. Infrastructure tools, such as GIS and dedicated databases for condition assessment represented in a laboratory environment. Invited experts participate in such areas as transportation, water distribution, and utilities.

**CE 7863 Infrastructure Monitoring and
Performance Assessment**

2½:0:0:3

Introduction to the physical nature of infrastructure materials and systems. Concept of performance is introduced from the point of view of strength and durability. Lectures and laboratory demonstrations identify the mechanism of degradation and cover techniques for condition assessment and quality assurance.

**CE 9903 Case Study in Urban Systems
Engineering and Management**

3 credits

A comprehensive independent case study involving a specific urban infrastructure engineering and management project under the guidance of a faculty adviser and generally in coordination with a participating infrastructure agency. Case studies are submitted as formal reports and must be formally presented and defended.

**CE 9913 MS Thesis in Urban Systems
Engineering and Management**

3 credits each

A 6-unit thesis focusing on a topic of current importance in infrastructure engineering and management. Thesis generally involves the development of a system approach to some aspect of infrastructure and may include elements of case studies. Thesis is under the guidance of a faculty adviser and thesis committee and may involve cooperative elements with an infrastructure agency. All theses are formally submitted as bound reports (see University requirements for bound theses and dissertations.)

PART 4

SPECIAL PROGRAMS



GENERAL STUDIES PROGRAM

The General Studies (GS) Program was created to provide students who do not meet the traditional admissions requirements an opportunity to obtain a science, engineering, humanities, and management based education in a supportive environment. To ensure student success, the General Studies students are provided with a broad variety of services beginning with a mandatory summer program prior to the start of their freshman year and continuing throughout the academic year with mandatory weekly tutoring and advisement sessions. Once admitted into Polytechnic, students must successfully participate in the program for one year before they are allowed to officially declare their major.

For further information, visit www.poly.edu, or call 718-260-3391.

ADMISSION AND APPLICATION PROCEDURES

Consideration for the General Studies program involves a multi-step process, beginning with the completion of the general Poly admissions application. The admissions committee determines the applicants' eligibility for the GS program. Qualified candidates are invited in for an interview with the program director to determine the congruence of the applicant's goals with the program's objectives and services. Students who are accepted and plan on attending the program must come in to take a math and writing skills assessment test before the start of the summer program.

ACADEMIC SUPPORT SERVICES

GS students are provided an array of services to help them adjust to the rigorous curriculum at Polytechnic. The services include, but are not limited to the following:

- A six-week summer program prior to the start of their freshman year. Students take computer skills for engineers class, along with pre-college math and writing courses.
- College survival skills course
- Individualized tutoring and group review sessions
- Individual and group advisement sessions

ADVISEMENT

Weekly advisement meetings are held to provide an opportunity for students to discuss any questions and/or concerns related to the academic curriculum and general college adjustment issues. The individual advisement sessions act as a more personal continuation of the group meetings. Students meet with the General Studies director each week to discuss a broad range of topic such as academic, financial, and personal concerns, to name a few.

FINANCIAL AID

General Studies student's financial aid packages are based on the information entered on the Free Application for Federal Student Aid (FAFSA) form. It is recommended that students complete the FAFSA forms as early as possible in order to get the best financial aid package available.

COURSES

GS 101 Computer Skills for Engineers

Course focuses on the basic functions and intricacies of AutoCAD, Microsoft Word, Excel, Project, and PowerPoint. Course requirements consist of weekly lab assignments, a midterm and final exam, and an individual project synthesizing the course content.

GS 102 Pre-college Writing

Course is designed to prepare students for writing at the collegiate level. Class time is composed of reading and writing exercises, grammar quizzes and lessons, and a close examination of student writing (workshops).

GS 103 Pre-college Math

Course focuses on preparing students for the Introduction to Pre-calculus course. Course requirements consist of daily participation, weekly quizzes, daily homework assignments, and a midterm and final exam.

STAFF

Melinda Parham, Director

CENTER FOR YOUTH IN ENGINEERING AND SCIENCE (YES CENTER)

The Center for Youth in Engineering and Science (YES Center) promotes activities to nurture and develop high school students' scientific curiosity and encourage them to study and pursue careers in engineering and science. Special attention is paid to attracting students from populations underrepresented in engineering and science, specifically women and minorities. The center directs many programs such as: Summer Research Institute, the Mathematics and SAT Prep Program, Ace Mentor Program, College Preview Programs, Inner Force Outreach Program, Venture Scholars Program and Trendsetters, Johns Hopkins CTY and Next Generation Program, Girl and Boy Scouts Information Programs, SECME Workshops, and Information Sessions. In addition, the center sponsors seminars, tutorial programs in math and science, science fairs, competitions (JETS Team Competitions, Botball Competition, First Robotics), University tours, and seminars for high school teachers.

SUMMER RESEARCH INSTITUTE

The Summer Research Institute (SRI) gives talented high school students educational opportunities in science, engineering, and mathematics beyond what is usually taught in high schools. Students learn to conduct independent research in the University's laboratories under the guidance of Polytechnic faculty members in a one-to-one relationship. For information contact YES Center at 718-637-5944 or www.poly.edu/yes.

SRI has three components:

Preparation Pre-Program: Depending upon the research area selected by the student, pre-summer preparation may be necessary to develop specific skills needed to successfully complete a project. This may take the form of one-to-one contact with a faculty mentor, attending special seminars and programs or taking a college preview course before enrolling in the Summer Research Institute.

Research: The Summer Research Institute, a six week program where high school students work full-time on a self-proposed research project, either individually or as part of a group, and are overseen by a faculty member.

Seminars: Seminars supplement students' research experiences. Sessions are devoted to drafting preliminary essays, learning appropriate formats for science papers, compiling data profiles and presenting research results. Several seminars feature speakers from Polytechnic and industry. Students also attend preparatory seminars to learn how to maximize their progress during the program.

Students are encouraged to submit their research results to regional and national competitions, including the Intel Westinghouse Talent Search, the Siemens Westinghouse Science and Technology Competition, and the New York City Mathematics, Science, and Technology Fair as well as other prestigious competitions.

Qualifications: Admissions to the SRI is selective and competitive, and determined by the student's scholastic record, evidence of successful completion of science and/or technology courses, expressed interest in the program, and recommendations from high school teachers, principals and/or counselors. Eligible applicants are current high school sophomores or juniors.

THE MATHEMATICS INSTITUTE AND SAT PREP PROGRAM

The Mathematics Institute at Polytechnic is a six-week summer program that focuses on giving high school students real-world, problem-solving experience with an emphasis on pure and applied mathematics. Students build their skills within areas such as number theory, geometry, combinatorics, and elementary analysis. Pre-calculus and calculus are taught in small classes and are designed to prepare students for the rigor of college study. Polytechnic faculty members teach these essential courses using state-of-the-art equipment and software such as IBM ThinkPad and Matlab software. Through Matlab, students learn how to combine their knowledge of mathematics and computer programming to use this powerful tool used by engineers and others who use computational mathematics in their work. Successful participants are invited to become a part of the multi-year program. Additionally, students receive a voucher from Polytechnic to apply the tuition-paid portion for these courses to the tuition costs of their Polytechnic freshman year.

ACE MENTOR PROGRAM

The ACE Mentor mission is to enlighten and increase the awareness of high school students to career opportunities in architecture, construction and engineering and related areas of the design and construction industry through mentoring; and to provide scholarship opportunities for students in an inclusive manner reflective of the diverse school population.

ACE is a unique partnership among industry professionals — architects, interior designers, engineers, construction managers, college and university representatives, and other professionals from related corporations and professional organizations — who work together to attract young people to their professions. Industry professionals volunteer as mentors to high school students and introduce them to the professions in these fields.

COLLEGE PREVIEW PROGRAM

On-Site: Polytechnic offers introductory college courses to outstanding high school students. Interested students must complete an application and submit a recommendation from their guidance counselor or principal. Polytechnic waives regular tuition, but charges a non-refundable registration fee per course. Students earn college credits for satisfactorily completed course work, and a transcript is provided. Introductory college courses offered include mathematics, computer science, physics, chemistry and selected courses in the humanities and social sciences. Students must submit an application in the first week of September to enroll in fall courses and in mid-January for spring courses. Applications are available at area high schools and the YES Center.

INNER FORCE OUTREACH PROGRAM

Inner Force prepares middle-school students for future careers by developing their ability to problem solve using mathematics and to communicate effectively while working on teams. Through various workshops, students learn about the interrelationship of physical health, mental health, and the impact of technology and economics on their lives. The Inner Force program offers a six-week, full-day summer program for middle-school and junior high school students that covers math, science, economics, dance, music, writing, critical thinking, and leadership training. Students also participate in one educational trip per week. Inner Force also offers an academic program during the school year.

VENTURES SCHOLARS PROGRAM

The Ventures Scholars Program is a national membership program designed to help underrepresented and first-generation college-bound students interested in pursuing math- and science-based careers link to information, resources, and opportunities that will help them successfully pursue their career goals.

The Program collaborates with colleges, universities, professional associations, and organizations nationwide (VSP Partners) and offers a variety of tools to link students to the partners' information, resources, and opportunities. The Program also invites parents/guardians and guidance counselors to receive these resources, too!

PROGRAMS FOR HIGH SCHOOL STAFF MEMBERS

Polytechnic offers high school teachers various staff development and training workshops, led by professional workshop facilitators and specialists. Polytechnic also offers a 50 percent tuition discount to full-time teachers taking non-matriculated courses at Polytechnic. Documentation from the home school is required.

SPECIAL SEMINAR PROGRAMS

High school students and faculty are invited to attend the various seminars, conferences and lectures that Polytechnic sponsors throughout the year in science, technology, engineering, social science, mathematics, and computer science. Several yearly programs are specifically designed for high school students and faculty, and program information is distributed to area high schools. High schools interested in seminars on particular topics should contact the YES Center.

YES CENTER COMPETITIONS

- **JETS TEAMS COMPETITION** - JETS sponsors the TEAM (Tests for Engineering Aptitude, Mathematics and Science) competition which challenges high school students to prepare for tomorrow's world. The competition is a one-day, two-part exam that encourages higher-order thinking, application of knowledge, team cooperation and management skills. Each student is a significant player on his school's team and strategy is a key element in team selection. All teams participate in both Part 1 and Part 2 of the exam and the results determine local, state, and national rankings.
- **BOTBALL COMPETITION** - Botball is a hands-on learning experience in robotics designed to engage students in learning the practical applications of science, technology, engineering, and mathematics. The Botball Program begins with a 2-day professional development workshop where educators and team leaders learn about current robotics technology and how to implement it into their classroom or community. Through the course of the workshop, participants receive all the information about the current Botball game and the reusable robotics kit and components. Following the workshop, students are given about seven weeks to design, build, and program a team of mobile, autonomous robots as well as document their process on a weblog. Participants compete against each other on a 4' x 8' playing field in a fast paced, non-destructive regional tournament.
- **FIRST ROBOTICS** - FIRST Robotics Competition (FRC) is a unique varsity sport of the mind designed to help high-school-aged young people discover how interesting and rewarding the life of engineers and researchers can be. The FIRST Robotics Competition challenges teams of young people and their mentors to solve a common problem in a six-week timeframe using a standard "kit of parts" and a common set of rules. Teams build robots from the parts and enter them in competitions designed by Dean Kamen and Dr. Woodie Flowers, and a committee of engineers and other professionals. FIRST redefines winning for these students because they are rewarded for excellence in design, demonstrated team spirit, gracious professionalism and maturity, and the ability to overcome obstacles.

Scoring the most points is a secondary goal. Winning means building partnerships that last.

TUTORIALS

The Polytechnic University Tutoring Program is a peer-based tutoring program designed to provide one-on-one assistance and small group support to all students. The service is FREE of cost. Students having difficulty with course work are encouraged to stop by the YES Center, located in the Wunsch Building.

Students interested in being tutored by a Polytechnic student should contact the YES Center. Tutors can help with homework problems, paper-writing, and exam preparation for courses in different subject areas. Tutors are also trained to provide assistance with study skills, time management, and note taking.

UNIVERSITY TOURS

In order to introduce prospective students and familiarize new incoming students with the University, we offer tours in which students are able to not only view the campus, but to have many of their questions answered as well. Polytechnic regularly gives tours of its laboratories and facilities. The tours include demonstrations, lectures on careers in engineering and science, and presentations on college planning and financial aid. High schools interested in a University tour should call the YES Center.

STAFF

Beverly Johnson, Executive Director of the Center for Youth in Engineering & Science and Associate Dean of Undergraduate Admissions

Albert Sanchez, Program Assistant

THE DAVID PACKARD CENTER FOR TECHNOLOGY AND EDUCATIONAL ALLIANCES

Created in 1996, the David Packard Center for Technology and Educational Alliances develops opportunities connecting Polytechnic with educational, business, and community organizations to enhance and disseminate information on electronically mediated learning, and to encourage advanced studies in mathematics, science and technology.

The Packard Center seeks to:

- Ensure equity of availability, opportunity and access for women and underrepresented minorities in the use of computers and information-age technology and in the study of mathematics and science.
- Build alliances of stakeholders, enabling information-age technology to impact the learning process and social, economic, and educational institutions.
- Serve as a resource for the professional development of teachers to enhance learning in science, mathematics, and technology.
- Utilize technology as a tool to assist learning, and disseminate findings through publications, multimedia communications, symposia, and lectures.

COLLEGE AND UNIVERSITY ALLIANCES

Through the Knowledge Workers Educational Alliance (KWEA), a consortium of six colleges and universities, students at participating liberal arts institutions prepare to become knowledge workers, well versed in technology and well rounded by a traditional liberal arts education. As upperclassmen, undergraduate students study in “bridge courses” in technical areas and then continue as graduate students at Polytechnic. At the end of five years, these students are armed with two degrees: a bachelor’s degree from their original college and a master’s from Polytechnic. They are qualified for specialized jobs that require sophisticated technical knowledge. Programs currently offered for a master’s degree include computer science, integrated digital media, organization behavior/human resources information management, transportation engineering and planning, bioinformatics, and construction planning and management.

SECONDARY SCHOOL ALLIANCES

The Packard Center serves to extend the University’s commitment to pre-college students by providing a contact point for learning initiatives, particularly those which promote engineering careers. Polytechnic students and staff serve as mentors, interns, and instructors. In addition, high school teachers form alliances with Polytechnic faculty, and professional development programs yield long-term advantages for high school and college learners.

The Packard Center hosts a variety of activities on campus that allow middle and high school students to participate in scientific research, competitions and exhibitions, meet noted scientists and engineers, and attend academic symposia. Among these programs and events are the Principal’s Scholars Dinner–Symposia; the Future City Regional Competition; the New York City FIRST! Competition (FRC), a national robotics and design competition for high school students; and the FIRST LEGO League Competition (FLL), which is similar to FRC but is designed for middle school students.

High school teachers attend specially designed workshops, courses, and conferences at Polytechnic to learn to use information-age technology, robotics, and sensors in their classrooms. A companion program seeks to develop varied teaching strategies in science and mathematics that emphasize hands-on learning experiences. In Summer 2007, Poly offered teachers two professional development institutes under the NY State Education Department’s “Engineers of the Future” program.

COMMUNITY ALLIANCES

Polytechnic University has worked closely with schools to support their efforts to align engineering curricula with those found at a university. Additional programs have brought Polytechnic faculty and students directly into high schools, where they serve as resources for science study, as is the case with a National Science Foundation-supported program in which Polytechnic undergraduate and graduate students are posted at local high schools where they teach classroom units, assist teachers with their understanding of instrumentation and robotics, and provide students with opportunities for active learning experiences.

Launched in 2007, the Central Brooklyn Robotics Initiative (CBRI) assists a cohort of middle and high schools to offer opportunities in mechatronics to students by developing teachers’ skills and knowledge. Polytechnic students work with teachers and students to prepare robotics teams for learning applications. Moreover, Poly is an active partner in the development of the Urban Assembly Institute, a 6-12 grade public school for girls, which emphasizes math and science study.

STAFF

Noel N. Kriftcher, Executive Director
EdD, Hofstra University

Susan Hermon, Administrative Coordinator

HIGHER EDUCATION OPPORTUNITY PROGRAM (HEOP)

The Higher Education Opportunity Program (HEOP) is a New York State-funded program designed to provide broad and varied educational instruction to capable students who, due to limited academic and financial resources, might otherwise not have the opportunity to attend Polytechnic. Once admitted to the HEOP program, students are provided with financial assistance, counseling, tutoring, advisement, and other support services throughout their college career. HEOP's goal is to retain and graduate students who are traditionally under-represented in the fields of engineering and science.

ADMISSION AND APPLICATION PROCEDURES

To qualify for the program, applicants must be residents of New York State and demonstrate both academic and economic need. Applicants are either referred by an admissions counselor, or may indicate on their application that they are interested in being considered for HEOP. Economic eligibility is determined by income guidelines issued by the New York State Education Department.

Since SAT scores may not thoroughly reflect a student's potential for success at Polytechnic, an intake interview with each applicant is an essential part of the HEOP admissions process. During the interview the counselor will discuss the applicant's academic strengths and weaknesses, and give a basic overview of what to expect at Polytechnic.

TRANSFER STUDENTS

Students wishing to transfer into HEOP at Polytechnic must have been in an opportunity program (HEOP, EOP, SEEK, etc.) at their previous institution. Each applicant must also complete an admissions transfer application. Transfer applicants are considered based on their academics and their individual circumstances. The HEOP director reviews college transcript(s) and recommendations from counselors or professors, and a decision is sent to the Office of Admissions.

ACADEMIC SUPPORT SERVICES

To help students reach their full academic potential and succeed at Polytechnic, HEOP provides freshmen and continuing students with academic support services. These services include:

- A mandatory pre-freshmen summer program, which includes courses in Pre-Calculus, Chemistry, and Computer Science
- A Study Skills course offered during the fall semester. Topics include time management, test-taking, note-taking, and concentration techniques
- Individual and group tutoring sessions
- Monthly group meetings and seminars

COUNSELING

HEOP offers students one-on-one academic, financial, personal, and career counseling. Group and individual counseling sessions are scheduled to assist students in making the transition to college, as well as maintaining and managing their academic career throughout their stay at Polytechnic.

FINANCIAL AID

HEOP students receive a financial aid package, which includes funding from HEOP, Tuition Assistance Program (TAP), PELL, Supplemental Educational Opportunity Grant (SEOG), Polytechnic grants, College Work Study Program, Stafford Loans, and other educational loans. It is important that students complete the Free Application for Student Aid (FAFSA) and the Tuition Assistant Program (TAP) applications as early as possible.

For further information, please visit the HEOP website at www.poly.edu/heop, or call 718-260-3370.

COURSES

CM 000 Pre-college Chemistry

6:0:NC

Covers Mole concept and stoichiometry, gaseous molecular behavior and gas law equilibrium and Le Chatelier's principle.

HE 000 Study Skills

2:0:NC

A workshop which prepares students for the academic and social challenges of college. Workshop topics include self-exploration and development of skills, such as note-taking, exam preparation, time management, and evaluation of academic goals.

MA 000 Pre-college Math

6:0:NC

Review of trigonometry, quadratic and absolute value questions and inequalities, limits and differentiation of both algebraic and trigonometric functions.

CS 000 Pre-college Computer Science

6:0:NC

General topics covered include the fundamentals of programming, software development practices, and problem solving using the C++ programming language. Other topics include compiling, running and debugging a program, program testing, documentation, variables and data types, assignments, arithmetic expressions, input and output, top-down design and functions, and conditionals and loops.

STAFF

Teresina Tam, Director

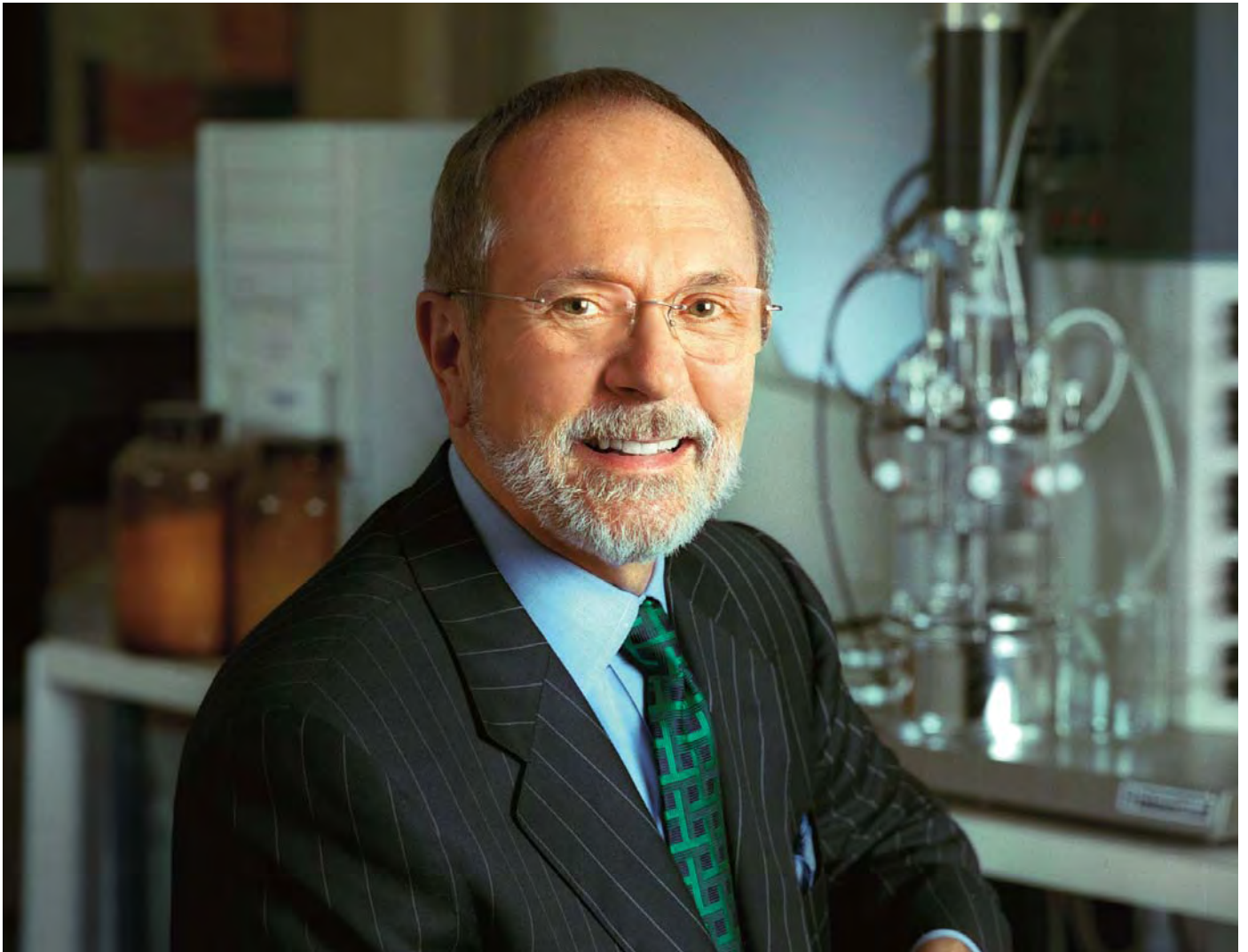
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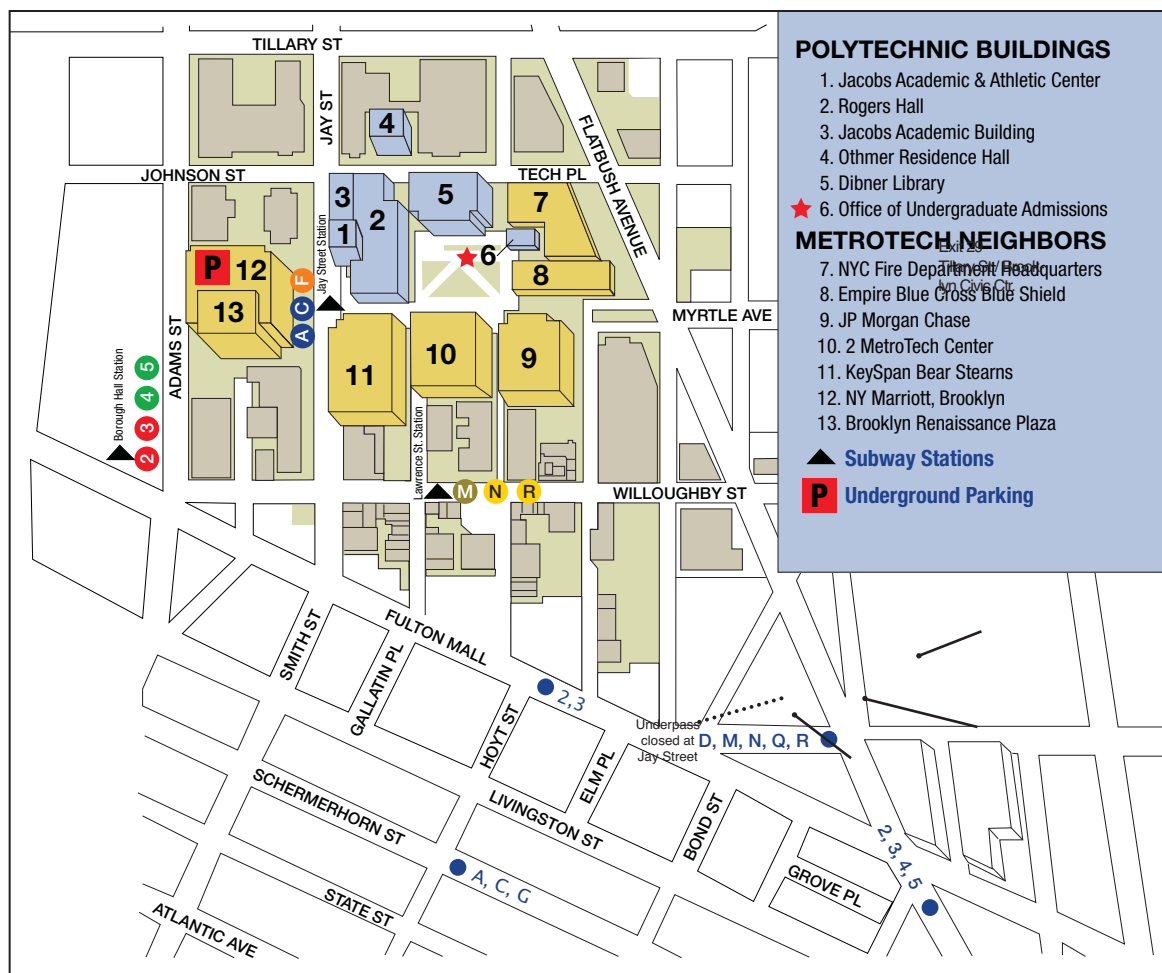
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PhD, University of Illinois

BROOKLYN CAMPUS



By Subway from all Boroughs:

A, C or F train to Jay St.-Borough Hall; or the 1, 2, 4 or 5 subway to Borough Hall (walk to Fulton and make a left onto Jay); or the R or M to Lawrence St.

By Car from Manhattan:

Take the FDR Drive to the Brooklyn Bridge, make the first left after the bridge onto Tillary, and a right onto Jay St.

By Car from Queens or the Bronx:

Take the Brooklyn-Queens Expwy. to Tillary St. and then left onto Jay St.

By Car from Staten Island:

Take the Verrazano Narrows Bridge to the Brooklyn-Queens Expwy. to the Tillary St. exit. Make a left onto Jay St.

By Car from New Jersey:

From the George Washington Bridge take the Harlem River Drive to the FDR Drive or Holland Tunnel to Brooklyn Bridge. (Continue as from Manhattan.)

By Train from Brooklyn or Long Island:

Take the Long Island Railroad to Flatbush Ave. Then take a taxi or bus #B67 to MetroTech on Jay St., or the R or M subway to Lawrence St. It's about a one-mile walk from the LIRR station: go to the Fulton Mall and make a left, then a right onto Jay St.

By Car from Brooklyn or Long Island:

Take Brooklyn-Queens Expwy. to the Tillary St. exit. Go left onto Jay St.

By Car from Westchester:

Take the Major Deegan or Cross Bronx Expwy. to FDR Drive to Brooklyn Bridge or the Triborough, Whitestone or Throgs Neck Bridge to Brooklyn-Queens Expwy. to Tillary St. From there take a left onto Jay St.

PUBLIC PARKING is available at the Marriott Hotel on Jay St., across from Polytechnic.

LONG ISLAND GRADUATE CENTER



From New York City & Long Island:

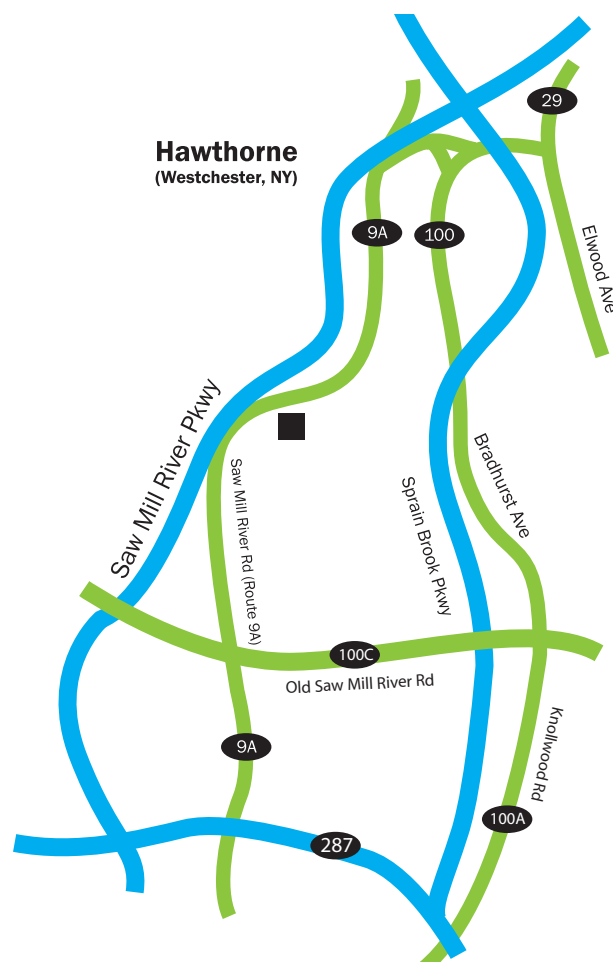
Take the Long Island Expressway (I-495) East to exit 49S (Rt. 110 S/Amityville). Merge onto the S. Service Rd. and turn right onto NY-110 S. (approximately half a mile). Turn left onto Baylis Rd. (approximately half a mile). Turn left onto Maxess Rd. (The Long Island Graduate Center is on the right within 150 yards. Enter through North entrance of 105 Maxess Road).

From Westchester:

Take the Hutchison River Parkway South to the I-95 S/Stillwell Ave exit. Keep right at the fork in the ramp. Merge onto New England Thwy. New England Thwy becomes Bruckner Exwy. Take

the I-695 exit- exit number 7A- on the left towards I-295/Throgs Neck Bridge/Long Island. Merge onto Throgs Neck Exwy. Take I-695 S. I-695 S becomes Throgs Neck Exwy. Throgs Neck Exwy becomes I-295 S. Take the Cross Island Pkwy exit towards Eastern L I. Merge onto Cross Island Pkwy S. Take the I-495/Long Island Expressway exit- exit number 30- towards Eastern L I. Merge onto LI Expressway. Take the exit- exit number 49S- towards RT-110 S/Amityville. Merge onto S. Service Rd. Turn right onto NY-110 S. Turn left onto Baylis Rd. Turn left onto Maxess Rd. (The Long Island Graduate Center is on the right within 150 yards. Enter through North entrance of 105 Maxess Road).

WESTCHESTER GRADUATE CENTER



BY CAR

From New York City: Take NY-9A West Side Highway to Saw Mill River Parkway North. Or I-278 to Triboro Bridge to I-87 North, exit at I-287 East to Saw Mill River Parkway North (Exit 1). Travel North on Saw Mill River Parkway for 3 miles after interchange for I-287 to Exit 25 for Hawthorne (Route 9A). Turn left at light onto Route 9A northbound. Polytechnic is on the right side of road.

From New Jersey and Downstate New York: Take I-87 South (New York State Thruway) to Tappan Zee Bridge. After bridge, take I-287 East to Saw Mill River Parkway North (Exit 1). Travel north 3 miles to Exit 25 for Hawthorne (Route 9A). Turn left at light on to Route 9A northbound. Polytechnic is on the right side of road.

From Northern Westchester and the Hudson Valley: Take the Taconic State Parkway South or Saw Mill River Parkway South to the Sprain Brook Parkway. Exit at Route 100C. Make a right on to Route 100C westbound and travel 3/4 mile to Route 9A North, entrance on right. Travel north on Route 9A for 2 miles; Polytechnic is on the right.

From Connecticut and Southern Westchester: Take I-95 to I-287 West (Cross Westchester Expressway) to Route 9A (Exit 2) North. Travel north 3 miles; Polytechnic is on the right.



It is the policy of Polytechnic University to comply with the laws, regulations and orders that provide for and impose obligations on employers with respect to the management of their equal employment opportunity and affirmative action programs.

Accordingly, Polytechnic University will conduct its business and practices in a manner that fully complies with and supports Presidential Executive Order 11246, as amended. Our compliance with Executive Order 11246 is calculated to eliminate discrimination against employees or applicants for employment on account of race, color, religion, sex, age, national origin, sexual orientation, liability for service in the Armed forces of the United States, veteran status or disability.

Inquiries about the above policies may be directed to the Office of Affirmative Action, Polytechnic University, Six MetroTech Center, Brooklyn, New York 11201.

The University is authorized under federal law to enroll non-immigrant alien students.

This catalog is not intended to be, and should not be regarded as, a contract between Polytechnic University and any student or other person.

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