R·I·T

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- Choices
- Results

Graduate Bulletin 2007–08

Rochester Institute of Technology
2007–08 Institute Calendar

Fall Quarter (20071)

April 24–September 3, 2007
Fall registration. Use Student Information System, walk-in, fax, or mail-in options. Students will be billed.*

September 3–10
Add/Drop Period

September 3
Day and evening classes begin

September 8
Saturday classes begin

September 10
Last date to add/drop courses

October 12
Last date to withdraw with a "W" grade

November 9
Last day class

November 12, 13, 14, 15, 16
Final exams—day classes

November 16
Last evening class

November 17
Last Saturday class

November 22–23
Thanksgiving
University closed

November 19–November 30
Fall/Winter break

Winter Quarter (20072)

October 16–December 3, 2007
Winter registration. Use Student Information System, walk-in, fax, or mail-in options. Students will be billed.*

December 3–December 11
Add/Drop Period

December 3
Day and evening classes begin

December 8
Saturday classes begin

December 10
Last date to add/drop courses

December 21
Last day of classes before break

December 22
Last Saturday class before break

January 7, 2008
Day and evening classes resume

January 25
Last date to withdraw with a "W" grade

February 22
Last day class

February 25, 26, 27, 28, 29
Final exams—day classes

February 29
Last evening class

March 1
Last Saturday class

March 3–March 7
Winter/Spring break

Spring Quarter (20073)

January 29–March 10, 2008
Spring registration. Use Student Information System, walk-in, fax, or mail-in options. Students will be billed.*

March 10–17
Add/Drop Period

March 10
Day and evening classes begin

March 15
Saturday classes begin

March 17
Last date to add/drop courses

April 18
Last date to withdraw with a "W" grade

May 16
Last day class

May 17
Last Saturday class

May 17, 19, 20, 21, 22
Final exams—day classes

May 23
Last evening class

May 23
Academic Convocation/
Commencement Ceremonies

May 24
Commencement Ceremonies

May 26
Memorial Day
University closed

May 28–June 1
Spring/Summer break

Summer Quarter (20074)

April 15–June 2, 2008
Summer quarter registration.
Use Student Information System, walk-in, fax, or mail-in options. Students will be billed.*

June 2–9
Add/Drop Period

June 2
Day and evening quarter classes begin

June 7
Saturday classes begin

June 9
Last date to add/drop summer quarter courses

July 4
Independence Day
University closed

July 11
Last date to withdraw with a "W" grade

August 8
Last day class

August 11, 12, 13, 14
Final exams—day classes

August 15
Last evening class

August 16
Last Saturday class

** Refer to the 2007-08 Registration Guide for specific registration dates and times, or the Student Information System (SIS) at http://infocenter.rit.edu.*

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RIT is chartered by the legislature of the State of New York and accredited by The Commission on Higher Education, Middle States Association of Colleges and Schools, 3624 Market Street, Philadelphia, Pa. 19104-2680, (215) 662-5606, and New York State Education Department, Office of College and University Evaluation, 5 North Mezzanine, Albany, N.Y. 12234, (518) 474-2593.

In addition to institutional accreditation, curricula in the colleges are accredited by appropriate professional accreditation bodies. Where applicable, specific mention of these is included in the college descriptions. Students wishing to review documents describing accreditation should contact the Office of the Associate Provost for Academic Programs.

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Rochester Institute of Technology

About This Bulletin

This Graduate Bulletin does not constitute a contract between the university and its students on either a collective or individual basis. It represents RIT's best academic, social and financial planning at the time the Graduate Bulletin was published. Course and curriculum changes, modifications of tuition, fee, dormitory, meal and other charges, plus unforeseen changes in other aspects of RIT life, sometimes occur after the Graduate Bulletin has been printed but before the changes can be incorporated in a later edition of the same publication. Because of this, Rochester Institute of Technology does not assume a contractual obligation with its students for the contents of this Graduate Bulletin.

RIT will admit and hire men and women; veterans; people with disabilities; and individuals of any race, creed, religion, color, national or ethnic origin, sexual orientation, age or marital status in compliance with all appropriate legislation, including the Age Discrimination Act and Title VI of the Civil Rights Act of 1964 (P.L. 88–352).

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Why Get Your Graduate Degree from Rochester Institute of Technology?

Choices

RIT is one of the nation's top comprehensive universities and sets the national standard for career-oriented education in many technological, scientific and professional areas of study. With more than 70 graduate programs in high-growth and high-tech career fields including business, computer science and information technology, engineering, science and art, RIT offers the choices you want in graduate education.

Graduate study options include master's and doctoral degrees, as well as advanced graduate certificates. RIT offers several ways to obtain your graduate degree, including part-time study, evening programs, online learning, accelerated executive education programs and one-year master's degree options.

Quality

RIT is chartered by the legislature of the state of New York, and is accredited by the well-recognized Middle States Association of Colleges and Schools. In addition, many of our individual programs and departments have professional accreditation from business and industry organizations.

At RIT, you'll interact with faculty members who have extensive teaching experience and are internationally respected for their contributions in their professional fields. RIT enrolls more than 15,000 students from across the United States and in 95 foreign countries.

Selected faculty and student awards, honors and partnerships

- Ford Foundation Grants
- Fulbright Scholars
- Edmund S. Muskie Fellows
- Ronald McNair Scholars
- Pulitzer Prizes
- Student Academy Awards
- National Science Foundation Awards
- Alfred P. Sloan Foundation Grants
- Excellence in Engineering Education Award
- New York Foundation for the Arts Fellowship

Reputation

Fueled by significant support from government, industry and private donors, RIT offers a unique, career-oriented graduate education tailored to meet your individual needs.

RIT is the 20th-largest private university in the United States, and has been consistently recognized by leading college guides, industry publications and the media. RIT has been cited by *U.S. News & World Report* as the most comprehensive university in the North for academic reputation.

More than 100,000 alumni worldwide include business, industry and government leaders. Hundreds of top companies and government agencies—from global giants to startup companies—rely on RIT as a source for filling full-time positions and providing ongoing employee development.

Results

RIT graduates are highly sought after by companies of all sizes in virtually every industry in the U.S. and abroad. More than 600 companies visit RIT annually to recruit students, and employment and advancement opportunities for our graduate students remain strong.

Graduate students take advantage of government and industry-sponsored programs and research projects to broaden their experience and increase their visibility with potential employers. Research projects and experiential education often result in permanent employment offers and opportunities for our graduates. Our graduate students currently work for such companies as Amazon.com, IBM, Bausch & Lomb, NASA, Xerox, Boeing and Johnson & Johnson.

You want a degree that will be recognized and valued in today's competitive marketplace, and RIT delivers.

Graduate Education at RIT

RIT, founded in 1829, is a privately endowed university in suburban Rochester, N.Y. Its eight colleges are:

College of Applied Science and Technology

E. Philip Saunders College of Business

B. Thomas Golisano College of Computing and Information Sciences

College of Imaging Arts and Sciences

Kate Gleason College of Engineering

College of Liberal Arts

College of Science

National Technical Institute for the Deaf

For additional information, write, phone or e-mail:
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Office of Graduate Enrollment Services
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Rochester, NY 14623-5604
(585) 475-2229
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www.rit.edu/grad

Andrew Moore
Dean of
Graduate Studies

Message from the Dean

The graduate learning experience at RIT is focused. RIT graduate programs focus on the conceptual structure and organization of knowledge in the chosen subject—an understanding that is essential to accept and lead technological change in the professions. They also build an educational base for additional learning and for generating new knowledge and insights through research.

The programs themselves are centered in fields that combine both theoretical knowledge and practical applications, especially those with a proven need in the marketplace. Thesis topics often relate directly to situational concerns, rather than theoretical discourse. Many programs require a thesis or project, and encourage other avenues for professional experience, such as optional or required cooperative education or an internship.

Students often use employers as primary sources for research and special projects. This application approach attracts faculty who value problem-solving skills in students. Whether a thesis, project or professional portfolio is required of them, our students are encouraged to incorporate both independent study and experiential learning into their programs. Graduate students also may assist in undergraduate education, such as in laboratories.

A philosophy supported by campus resources

RIT's international reputation as an applied technological university gives graduate students the advantage of working with sophisticated technology and in laboratories found on and off campus. Students in microelectronic engineering have access to clean-room facilities that meet industry standards. Computer graphics design students access digital media using a variety of systems and software, including Macintosh, IBM, Silicon Graphics and Media 100 digital video editing. Our telecommunications technology workstations were donated by an industry eager to hire students experienced with equipment used in their own laboratories. Students in the clinical chemistry MS program may take a research course at a laboratory outside of RIT.

Technology also has brought together students in design, photography and printing. In RIT's Electronic Still Photography Laboratory, the three disciplines have merged through electronics.

Regardless of the program, RIT encourages and promotes technological innovation in all areas.

Specialized and diverse programs

While technology is integral to all graduate programs, the essence of RIT graduate education is found in the diversity of programs, course offerings and learning options. Our reputation as a technologically advanced university is matched by our commitment to offering programs designed to meet the specialized needs of employers. A dozen international corporations—including Eastman Kodak Co., Konica, Agfa Gevaert, Xerox Corp. and Fuji Photo Film Co.—have sponsored the building of laboratories in the Chester F. Carlson Center for Imaging Science, which houses the nation's most comprehensive imaging science programs. Enriched by the perspective provided by the National Technical Institute for the Deaf, one of RIT's colleges, we offer full access to deaf and hard-of-hearing students seeking graduate-level academic programs.

Across campus, graduate students engage in exciting research and stimulating dialogues with faculty and such distinguished visitors as George Bush, Bill Clinton, Joe Torre, Jesse Jackson, John Hockenberry, Maya Angelou, Annie Leibovitz, Jerry Uelsmann and Greg Heisler. The E. Philip Saunders College of Business draws prominent figures from the business world—including U.S. Steel CEO Thomas Usher and Robert Bartley, editor and vice president of The Wall Street Journal—through the William D. Gasser Distinguished Lectureship in Business.

The university continues to receive international recognition for the quality of its academic programs. In a recent ranking of national photography programs, *U.S. News & World Report* named RIT's School of Photographic Arts and Sciences in the top five. This publication has also consistently ranked RIT in the top 20 in its master of fine arts category.

Convenient and flexible programs

RIT's diversity also extends to the manner in which courses and programs are scheduled. Many of our graduate programs are available on a part-time, online or evening basis and are designed for working professionals. Examples of programs offered through online learning include software development and management; information technology; environmental, health and safety management; telecommunications engineering technology; imaging science; print media; microelectronics manufacturing engineering; and health systems administration. These programs allow students access to an RIT education without attending classes on campus.

In addition, RIT's executive MBA offers professionals an opportunity to earn a master's degree by studying on campus Friday and Saturday, every other week. Professionals from California to England visit RIT every year for executive leader master's degree programs in service management, hospitality and tourism management, health systems administration, and packaging science, which combine on-campus residencies with classes using distance-learning technology.

The RIT philosophy and mission

RIT's mission is the education of men and women for work and life in a democratic, technological and global society. It is integral to the university's mission to be a dynamic center of higher education—one in which technology, the arts and sciences and other dimensions of human knowledge and civilization are valued, cultivated and applied.

Throughout its history, the university has been at the forefront in preparing students for technological and professional careers. RIT structures itself as an educational resource for all who seek to be competent and enthusiastic lifelong learners, whether they are young adults or professionals seeking to upgrade their skills by studying for an advanced degree. Our goal is that all graduates will understand the ethical, technological, humanitarian and aesthetic challenges of a diverse workplace and an international community.

The university's educational philosophy emphasizes not only theory—the natural foundation of knowledge—but also the practical workplace application of theories. This dual emphasis is prized by employers, and offers graduates upward career mobility and the flexibility for changes in career direction.

Another asset of an RIT education is cooperative education, offering students in selected programs the opportunity for paid, professional work experience while completing their degrees.

History of graduate education

Starting in 1955 with the master of fine arts degree, RIT continually has created new graduate programs to meet employers' and students' requests for education in particular functional areas. When surveys in the 1960s indicated the need for sophisticated statistical knowledge, a master of science degree in applied and mathematical statistics was created. More recently, RIT's Center for Microelectronic and Computer Engineering began a master's degree in microelectronic engineering. Other graduate programs have taken similar routes, and all eight RIT colleges exhibit continuous concern for the emerging needs of the business, industrial and scholarly communities.

To support RIT's continuing endeavor to provide education in emerging career fields, the university has added three new doctoral programs, in microsystems engineering, computing and information sciences, and in color science, in addition to its longstanding doctoral program in imaging science. These degrees are four of more than 70 graduate degrees now offered by the university.

Accreditation

RIT is chartered by the New York state legislature and accredited by:

The Commission on Higher Education
Middle States Association of Colleges and Schools
3624 Market Street
Philadelphia, PA 19104-2680
(215) 662-5606

and

New York State Education Department
Office of College and University Evaluation
5 North Mezzanine
Albany, NY 12234
(518) 474-2593

In addition to institutional accreditation, curricula in the colleges are accredited by appropriate professional accreditation bodies. Where applicable, specific mention of these is included in the college descriptions. Students wishing to review documents describing accreditation should contact the Office of the Vice President for Academic Affairs.

Sponsored research projects

Externally sponsored projects are a vital and integral component of RIT's educational and research activity. Faculty and students undertake sponsored projects for a variety of important reasons: to add to the body of knowledge, for professional development and to strengthen academic programs. Sponsored projects enhance the university's academic programs, broaden its research resources, provide opportunities for student participation in research, strengthen university-industrial partnerships and serve the wider community.

Moreover, grants and contracts enhance existing resources and provide new opportunities for faculty, staff and students. External funding comes from federal and state agencies, private foundations and corporations. RIT's major sponsors include the National Science Foundation, the National Institutes of Health, the U.S. Department of Education, the Department of Defense, the National Aeronautics and Space Administration, and New York state.

Additional information is available through the Office of Sponsored Research Services at (585) 475-7985, research@rit.edu, or on their website at www.research.rit.edu.

RIT Research Centers and Organizations

- Analog Devices Integrated Microsystems Laboratory
- Astrophysics Science and Technology
- Biomedical Imaging/MRI
- Biomedical Imaging/Ultrasound
- Center for Advanced Device Research
- Center for Advancing the Study of Cyberinfrastructure
- Center for Applied and Computational Math
- Center for Biosciences Education and Technology
- Center for Computational Relativity and Gravitation
- Center for Education Research Partnerships
- Center for Electronic Manufacturing and Assembly
- Center for Excellence in Lean Enterprise
- Center for Innovation and Entrepreneurship
- Center for Integrated Manufacturing Studies
- Center for Nanolithography Research
- Center for Quality and Applied Statistics
- Center on Access Technology
- Chester F. Carlson Center for Imaging Science
- Digital Imaging and Remote Sensing Laboratory
- Image Permanence Institute
- Imaging Products Laboratory
- International Center for Hearing and Speech Research
- IT Collaboratory
- Laboratory for Advanced Communication Technology
- Laboratory for Computer-Human Interaction
- Laboratory for Digital Image Restoration
- Laboratory for Environmental Computing and Decision Making
- Laboratory for Graphical Simulation, Visualization and Virtual Worlds
- Laboratory for Imaging Algorithms and Systems
- Laboratory for Intelligent Systems
- Laboratory for Printing Materials and Process
- Laboratory for Social Computing
- Laboratory for Wireless Networks and Security
- Manufacturing Technologies Program
- Munsell Color Science Laboratory
- NanoPower Research Laboratory
- National Center for Remanufacturing and Resource Recovery
- Print Research and Imaging Systems Modeling Laboratory
- Printing Applications Laboratory
- Printing Industry Education Program
- Research and Teacher Education Center
- RF/Analog Mixed Signal Laboratory
- RIT Venture Creations Incubator
- Semiconductor and Microsystems Fabrication Laboratory
- Sloan Printing Industry Center
- Sustainable Systems Research Center
- Systems Modernization and Sustainment Center
- Thermal Analysis and Microfluidics Laboratory
- Visual Perception Laboratory

The Graduate Bulletin provides comprehensive information on all graduate programs at RIT. I encourage you to explore its contents to find the educational and research opportunities you seek. I look forward to welcoming you to our campus, and wish you success in your chosen program of study.

Graduate Programs of Study

	College	Degree and HEGIS Code						
		Advanced Certificate	Ph.D.	MBA	ME	MFA	MS	MST
Business and Management								
Business Administration †	Business			0506				
Elements of Health Care Leadership*	Applied Science and Technology	1202						
Facility Management*	Applied Science and Technology						0599	
Finance	Business						0504	
Health Information Resources*	Applied Science and Technology	1202						
Health Systems Administration*	Applied Science and Technology						1202	
Health Systems Finance*	Applied Science and Technology	1202*						
Hospitality-Tourism Management †	Applied Science and Technology						0510.1	
Human Resource Development †	Applied Science and Technology	0515					0515.00	
Innovation Management	Business						0506	
Management	Business						0513	
Manufacturing Leadership	Engineering						0599	
Project Management*	Applied Science and Technology	0506						
Senior Living Management*	Applied Science and Technology	0599						
Service Leadership and Innovation	Applied Science and Technology	0510						
Service Management †	Applied Science and Technology						0599	
Computer and Information Sciences								
Computer Engineering	Engineering						0999	
Computer Science	Computing and Information Sciences						0701	
Computing Security and Information Assurance	Computing and Information Sciences						0799	
Computing and Information Sciences	Computing and Information Sciences		1701					
Game Design and Development	Computing and Information Sciences						0799	
Information Assurance*	Computing and Information Sciences	0799						
Information Technology*	Computing and Information Sciences						0699	
Interactive Multimedia Development	Computing and Information Sciences	0699						
Learning and Knowledge Management Systems*	Computing and Information Sciences	0799					0799	
Networking and System Administration*	Computing and Information Sciences						0702	
Software Development and Management*	Computing and Information Sciences						0799	
Software Engineering	Computing and Information Sciences						0999	
Technical Information Design*	Applied Science and Technology	0605						
Professional Studies (Individualized Program)								
Professional Studies*	Applied Science and Technology						4999	
Education and Liberal Arts								
Applied Experimental and Engineering Psychology	Liberal Arts						2099	
Art Education	Imaging Arts and Sciences							0831
Communication and Media Technologies	Liberal Arts						0605.00	
Human Resource Development †	Applied Science and Technology	0515					0515	
School Psychology	Liberal Arts	0826.02					0826.02	
Science, Technology and Public Policy	Liberal Arts						2102	
Secondary Education of Students Who Are Deaf or Hard-of-Hearing	NTID						0803	

Graduate Programs of Study

	College	Degree and HEGIS Code						
		Advanced Certificate	Ph.D.	MBA	ME	MFA	MS	MST
Engineering and Technology								
Applied Statistics*	Engineering						1702	
Computer Engineering	Engineering						0999	
Electrical Engineering	Engineering						0909	
Engineering Management	Engineering				0913			
Environmental, Health and Safety Management*	Applied Science and Technology						0420	
Industrial Engineering	Engineering				0913		0913	
Manufacturing and Mechanical Systems Integration	Applied Science and Technology						0913	
Manufacturing Engineering	Engineering				0913			
Manufacturing Leadership	Engineering						0599	
Materials Science and Engineering	Engineering/Science	0915					0915	
Mechanical Engineering	Engineering				0910		0910	
Microelectronic Engineering*	Engineering						0999	
Microelectronics Manufacturing Engineering*	Engineering				0999			
Microsystems Engineering	Engineering		0999					
Packaging Science †	Applied Science and Technology						4999	
Product Development	Engineering						0599	
Statistical Quality*	Engineering	1702						
Systems Engineering	Engineering				0913			
Telecommunications Engineering Technology*	Applied Science and Technology						0925	
Photography, Fine Art and Graphic Communication								
Art Education	Imaging Arts and Sciences							0831
Ceramics	Imaging Arts and Sciences					1009		
Computer Graphics Design	Imaging Arts and Sciences					1009		
Digital Print and Publishing*	Imaging Arts and Sciences	0605						
Fine Arts Studio	Imaging Arts and Sciences					1002		0831
Glass	Imaging Arts and Sciences					1009		
Graphic Design	Imaging Arts and Sciences					1009		
Imaging Arts/Computer Animation	Imaging Arts and Sciences					1011		
Imaging Arts/Film	Imaging Arts and Sciences					1011		
Imaging Arts/Photography	Imaging Arts and Sciences					1011		
Industrial Design	Imaging Arts and Sciences					1009		
Medical Illustration	Imaging Arts and Sciences					1299		
Metals	Imaging Arts and Sciences					1009		
Nontoxic Intaglio Printmaking	Imaging Arts and Sciences	1009						
Print Media*	Imaging Arts and Sciences						0699	
Wood	Imaging Arts and Sciences					1009		
Science, Mathematics and Imaging Science								
Applied Mathematics	Science						1799	
Applied Statistics*	Engineering						1702	
Bioinformatics	Science						0499	
Chemistry	Science						1905	
Clinical Chemistry	Science						1223	
Color Science	Science		1999.20				1099	
Environmental Science	Science						0420	
Imaging Science*	Science		1999.20				1999.20	
Materials Science and Engineering	Engineering/Science	0915					0915	
Statistical Quality*	Engineering	1702						
Statistical Methods for Product and Process Improvement*	Engineering	1702						

* These programs include opportunities for degree completion through online learning.

† These programs include degree completion through Executive Education option.

College of Applied Science and Technology

www.rit.edu/~700www/

Programs

Master of Science degrees in:

⇆	Environmental, Health, and Safety Management	p. 7
⇆	Facility Management	p. 8
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	Hospitality-Tourism Management*	p. 12
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Advanced Certificates in:

⇆	Elements of Health Care Leadership	p. 18
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⇆	Health Systems Finance	p. 18
⇆	Health Systems Leadership	p. 19
⇆	Project Management	p. 20
⇆	Senior Living	p. 19
	Service Leadership and Innovation	p. 16
⇆	Technical Information Design	p. 20

**These programs are available in an executive leader format, a nontraditional delivery for graduate education.*

Executive Leader:
This program is an accelerated delivery of graduate education for degrees in hospitality-tourism management, service management, human resource development, health systems administration, and packaging science.

⇆ *Online learning option available*

Carol A. Richardson,
Interim Dean

Graduate education in any discipline requires commitment of both the student and the institution involved. The diverse, graduate-level academic areas within the College of Applied Science and Technology represent RIT's commitment to curricular innovation, program flexibility and academic rigor. We also are committed to advancing the state the education we provide through the latest technology, management theories and educational philosophies.

Faculty

The faculty is experienced at preparing individuals for current career opportunities. They are accessible to students for individual guidance, and their ongoing participation as professional consultants and researchers allows them to integrate the latest technical innovations into their classes.

Resources

The college's facilities include state-of-the-art laboratories in support of courses that address current and future applications in the areas of electrical, computer and telecommunications engineering technology; manufacturing and mechanical engineering technology; and packaging science. In addition to laboratories in computer networking and telecommunications, a circuits "studio" and mechanics and materials labs, our facilities include student study space and administrative offices.

RIT's Center for Integrated Manufacturing Studies gives graduate students the opportunity to test new technologies for actual companies seeking solutions to real problems. Continual

computer laboratory upgrades mean we have technology that is considered the industry standard.

Most importantly, the academic leadership of our programs is world renowned. In addition, our close ties to business and industry mean that our course content is relevant and practical for tomorrow's managers, whether they oversee computer-integrated manufacturing or a resort hotel. Graduates are eagerly sought out by employers. We have a high placement rate that assures graduates can pick the best positions for their personal and professional development.

Department of Civil Engineering Technology, Environmental Management and Safety

Master of Science in Environmental, Health and Safety Management

Maureen Valentine, Department Chair
(585) 475-7398, msvite@rit.edu
Joseph Rosenbeck, Graduate Program Coordinator
(585) 475-6469, lmrcem@rit.edu
www.rit.edu/~704www

The last decade has seen significant changes in how organizations view and manage environmental, health and safety issues. Increasingly, companies are capitalizing on the synergies among these three areas by managing them together—necessitating that professionals be cross-trained in all three functions. The emergence of voluntary standards and codes of conduct, including international standards, coupled with the need to manage costs, has resulted in a trend to go beyond regulatory compliance through the use of environmental, health and safety management systems, as well as integration of these systems into key business processes.

RIT's master of science degree in environmental, health and safety management was developed by experienced professionals and designed to provide students with a solid foundation in both the technical and managerial aspects of developing, designing and implementing environmental, health and safety programs. The program utilizes an integrated systems focus to ensure that students can:

- identify and leverage the regulatory, voluntary and business drivers for environmental, health and safety programs;
- design and implement effective management systems and programs;
- design and implement performance measurement processes to verify effectiveness; and
- demonstrate how an effective environmental, health and safety program adds value to the organization.

Distance learning option

The program is designed to be completed on campus or through distance learning in 15 months by full-time students, or in two years of part-time study while working full time. Students can tailor an individual program of study by complementing core and foundation courses with professional electives that match their academic and career interests.

Admission requirements

Unconditional admission to the MS degree program in environmental, health and safety management requires:

- a bachelor's degree from an accredited university or college;
- a minimum undergraduate grade-point average of 3.0 (B) over the junior- and senior-level years;
- at least 20 quarter credit hours (or 15 semester credit hours) of college-level science course work, with at least 4 credit hours (or 3 semester credit hours) in each of the following categories: general or organic chemistry; biology, microbiology, ecology or biochemistry; and physics, geology, hydrology or geochemistry;
- at least one college-level course in statistics; and
- at least one college-level course (or equivalent experience) in computer science.

Graduate Record Examination scores are not required. Applicants who do not meet the above requirements, however, may be required to submit test scores to support their candidacy.

International students are required to submit scores from the Test of English as Foreign Language. Applicants should have minimum scores of 570 (paper-based), 230 (computer-based) or 88 (Internet-based). In addition to the RIT graduate application, applicants must submit two writing samples to demonstrate written communication skills and a current résumé or CV with sufficient detail to identify specific tasks and level of responsibilities.

Generally, applicants are expected to have formal academic training or documented experience in the areas of environmental management (air, water, solid and hazardous waste), occupational health and occupational safety. Academic and experiential gaps in these areas may be addressed through the program's foundation courses/electives.

The program is designed for professionals in the environmental, health and safety industry that have some work experience. Applicants with less than one year of relevant work experience may be expected to complete one or more quarters of graduate-level cooperative education experience during their program of study. Applicants are strongly encouraged to contact the graduate program coordinator at (585) 475-6469 for additional information about the program.

Transfer credit

Up to 12 quarter credit hours of graduate course work may be accepted and applied toward the program if the course work is appropriate. The student's major professor or the admissions committee must review all courses.

Curriculum

The MS program in environmental, health and safety manage-

ment consists of 48 quarter credit hours of graduate study. The program is available in both classroom and distance-learning formats, with some courses only available as online courses. The curriculum consists of a sequence of core courses (24 credits), professional electives chosen from the program or other departments (18 credits) and a graduate thesis or project (6 credits).

Core courses include:

0630-720	Environmental, Health and Safety Management
0102-740	Organizational Behavior and Leadership
0630-725	EHS Accounting and Finance
0630-740	EHS Management System Design
0630-760	Integrating EHS Into Business Management
0630-790	EHS Internal Auditing

For applicants who have limited academic or work experience in the environmental, health and safety field but wish to pursue the MS degree to broaden their knowledge, foundation courses may be necessary to bridge any gaps and prepare the student for success in the program. Foundation courses are intensive survey courses designed to provide an overview of the field and establish a strong groundwork for additional study. Any necessary foundation course work will be determined at the time of admission to the program. Up to 18 credits of foundation course work may be counted toward the degree as professional electives.

Master of Science in Facility Management

Maureen Valentine, Department Chair
(585) 475-7398, msvite@rit.edu
www.rit.edu/~704www

The physical assets of an organization are typically one of its largest financial holdings, and the strategic planning, development and maintenance of these assets are critical to an organization's financial health and stability.

Facility managers need to be knowledgeable about business management, strategic planning, interior and architectural design, construction management, information technology, real estate, engineering, labor relations and quality of life aspects in the work environment. It's a broad-based field that requires individuals to have breadth and depth in their education and, eventually, their work experience.

The facility management program prepares graduates to work in a management capacity, where they will oversee the operations, planning and maintenance of facilities. Graduates will be able to intelligently communicate facility issues with corporate officers, customers, contractors, vendors and employees.

RIT's master of science degree in facility management was developed by a panel of experienced facility management professionals and designed to provide students with a solid foundation in both the technical and managerial aspects of the field. The curriculum was developed using educational standards established by the International Facility Management Association.

Distance Learning

The program can be completed on campus or through distance learning in 20 months by full-time students, or in two years of part-time study if students elect to work full time. Students can tailor an individual program of study by complementing core courses with professional electives that match their academic and career interest.

Admission Requirements

Admission to the MS degree in facility management requires:

- a bachelor's degree from an accredited university or college. Generally, applicants are expected to have formal academic training or documented experience in the areas common to facility management (i.e., engineering technology, engineering, construction management, interior design, architecture, technology and business). Academic and experiential gaps in these areas may be addressed through program electives.
- a minimum undergraduate GPA of 3.0 overall, or a minimum GPA of 3.0 for course work completed in the junior and senior years.
- two writing samples to demonstrate written communication skills.
- current resume or CV with sufficient detail to identify specific work experience, tasks and level of responsibility.

Graduate Record Exam scores normally are not required. Applicants who do not meet the above requirements, however, may be required to submit GRE scores to support their candidacy.

A minimum score of 570 (paper-based) or 230 (computer-based) on the Test of English as a Foreign Language (TOEFL), a GRE score of 1,200 (V&Q) and an analytical writing score of 3.5 or higher are required for international applicants seeking admission from non-English speaking countries. Applicants with low GRE scores may be admitted conditionally; they will take a prescribed English language test and, if required, English language courses along with a reduced MS program course load.

Students who do not meet the academic admission requirements may be asked to complete certain undergraduate courses as a bridge for the required content knowledge. The graduate program coordinator will design a bridge program specific to each individual student's needs based on the evaluation of academic records and documented work experience.

Some students' work experience may exempt them from one or more of the core courses. In these cases, students may substitute other course work, with the permission of the graduate program coordinator and in accordance with RIT policy.

The admission requirements for the facility management program ensure that students entering the program will have a reasonable chance for success. The requirements also establish areas of prerequisite knowledge that students will need to integrate into graduate-level courses.

Applicants without any documented, relevant work experience in the facility management profession may be expected to

complete a graduate cooperative education requirement during their program of study. This co-op requirement may be up to two quarters in length. Potential applicants are strongly encouraged to contact the graduate program coordinator at (585) 475-2183 for additional information about the program.

Transfer Credit

Up to 12 quarter credit hours of graduate course work may be accepted and applied toward the program if the course work is appropriate. The student's major professor or the admissions committee must review all courses.

Curriculum

The MS in facility management consists of 52 quarter credit hours of graduate study. The program is available predominately in the distance learning format, although some courses and electives are available as on-campus classes. The curriculum consists of a sequence of core courses (40 credits), professional electives chosen from the program or other departments (8 credits) and a graduate project (4 credits). Project topics should complement the student's interests and professional position, and are generally considered applied in nature.

Core courses include:

0632-700	Principles and Practice in Facility Management
0632-720	Environmental, Health and Safety Management for Facility Management
0681-710	Introduction to Project Management
0632-760	Space Planning in Facility Management
0101-703	Accounting for Decision Makers
0632-800	Operation and Maintenance of Facilities I
0632-810	Operation and Maintenance of Facilities II
0632-830	Real Estate of Facilities
0102-740	Organizational Behavior and Leadership
0632-850	Digital Communication and Analytical Tools in Facility Management

Department of Manufacturing and Mechanical Engineering Technology/Packaging Science

Master of Science in Manufacturing and Mechanical Systems Integration

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www.rit.edu/~719www/PROGRAMS/MS/MAIN.HTM

The master of science program in manufacturing and mechanical systems integration is a multidisciplinary degree offered by the department of manufacturing and mechanical engineering technology and packaging science, in collaboration with the E. Philip Saunders College of Business, the Kate Gleason College of Engineering and the B. Thomas Golisano College of Computing and Information Sciences. This program is designed for individuals who wish to achieve competence in the effective integration of the computing, manufacturing, design, quality and management functions found in many manufacturing enterprises. Students take a set of common core courses and then elect a concentration in automated manufacturing, electronics packaging, management, product design, quality or software development.

Admission requirements

Applicants should have a baccalaureate degree (or equivalent) from an accredited academic institution in the field of engineering, engineering technology, computing, or business. A minimum grade point average of 3.0 is required. Students with degrees in other disciplines will be considered on an individual basis. Calculus, computer programming and probability and statistics are required backgrounds. Students with a grade point average below 3.0 will be evaluated on a case-by-case basis and may be admitted on a probationary basis. These students will have to secure a B or better average in the first three graduate courses to be considered for full admission.

Applicants should submit two professional recommendations, transcripts from previous college attendance and a clearly written one-page statement of purpose in addition to the graduate application form.

International applicants are required to submit scores from the Test of English as a Foreign Language and the Graduate Record Exam. A minimum score of 550 (paper-based), 213 (computer-based) or 88 (Internet-based) on the TOEFL is required. A score of 1,200 (V&Q) and an analytical writing score of 3.5 or higher are required on the GRE. Applicants with low GRE scores may be admitted conditionally; they may be required to take additional English language tests and, if required, English language courses along with a reduced MS program course load.

Curriculum

The graduate program consists of 52 quarter credit hours and is comprised of the core, concentration, electives and a capstone project or thesis. Students may be required to take additional prerequisite courses, depending on their background and elected concentration. The program adviser may approve the waiver of courses in the prerequisite group from graduation requirements, depending on students' academic and employment background. Full-time students are eligible for two co-op blocks (three months for each block) after completing three quarters (nine months) of study at RIT.

Core courses (20 credits)

0617-850	Flexible Manufacturing and Assembly Systems
0617-730	Data Management and Communication
0617-631	Computer Aided Engineering
0101-794	Cost Accounting in the Manufacturing Environment
0106-744	Project Management

Concentration options (20 credits)

Automated Manufacturing

0617-833	Robotics in CIM
0617-870	Manufacturing Automation Controls
0610-830	Instrumentation and Computer Aided Data Acquisition
0303-710	Systems Simulation
0303-729	Advanced Systems Integration

Electronics Packaging

0617-855	Electronics Packaging Fundamentals
0617-856	Advanced Concepts in Electronics Packaging
0307-721	Statistical Process Control
0307-770	Design of Experiments for Engineers and Scientists
0307-862	Reliability Statistics I

Management

0101-703	Financial Accounting Systems
0102-742	Introduction to Technology Management
0106-743	Operations Management and Process Improvement
0106-749	Manufacturing Strategy and Tactics
0307-781	Quality Management

Product Design

0610-630	Tolerance Design
0610-710	Product Development and Integration
0610-820	Concept Design and Critical Parameter Management
0610-830	Instrumentation and Computer Aided Data Acquisition
0610-870	Robust Design

Quality Improvement

0307-721	Statistical Process Control
0307-731	Statistical Acceptance Control
0307-781	Quality Management
0307-801	Design of Experiments I
0307-802	Design of Experiments II

Software Development

0610-830	Instrumentation and Computer Aided Data Acquisition
4002-710	Object Technologies
4002-720	Data Object Development
4002-733	Fundamentals of Computer Communication
4002-750	Distributed Systems

Capstone project/thesis (4 credits)

Electives

Each student must take two graduate-level elective courses (8 credits) according to his or her concentration. Courses selected must be:

- any course from another concentration.
- any course from another graduate program, if approved by the program adviser and faculty member teaching the course.
- any independent study course if approved by the student's academic adviser.

Master of Science in Packaging Science

Deanna Jacobs, Program Coordinator
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www.rit.edu/packaging

The MS program in packaging science is designed to meet the needs of professionals who have been working in the field for a number of years. The program also is suitable for students who wish to pursue a graduate program immediately upon earning a BS degree.

Although an undergraduate curriculum in packaging science is preferred as preparation for the MS program, graduates from certain other disciplines can successfully pursue the program if certain introductory packaging science courses are coupled with appropriate work experience.

Admission requirements

Students entering the program will have a graduate thesis academic adviser appointed and develop their programs of study in consultation with their adviser. They may utilize an outlined curriculum to complete their degree requirements, or students may propose alternative course work. All programs must be consistent with the general outline of the model curriculum and be approved by an adviser. Students who have insufficient academic or practical preparation to study packaging at the graduate level will complete an appropriate program to correct such deficiencies. The following undergraduate courses are generally suggested: Packaging Materials (0607-502), Container Systems (0607-503) and Concepts to Consumer (0607-504). These courses may not be used for credit toward the MS degree.

A basic competence in statistics and computer literacy will be assumed. Applicants for graduate study may satisfy these requirements by having completed Fundamentals of Statistics I (0307-711) or its equivalent, and completing a course in computer applications. Applicants lacking this background will be required to take Fundamentals of Statistics I (0307-711) and/or Computer Applications (0607-341), or equivalent course work, to establish a foundation of competency.

Applications for admission to the MS program in packaging science are made through the Office of Graduate Enrollment Services. The department of packaging science will determine final acceptance of candidates. All applicants must have earned a 3.0 (B) average grade in their final two years of undergraduate degree work. Submit transcripts of undergraduate work to RIT's Office of Graduate Enrollment Services, and two letters of recommendation to the department of packaging science. In cases where there may be some question of the capability of an applicant to complete this program, the applicant may be required to submit scores from the Graduate Record Examination to support their application.

Curriculum

The curriculum is comprised of three components: packaging core courses, research and electives. The MS program requires the completion of 48 quarter credit hours of graduate-level course work.

Packaging core courses

Students must complete a minimum of 20 credits in graduate-level packaging courses by completing one required core course and selecting the remainder of the core courses.

Required core course:

0607-701	Research Methods

Choose any four of the following:

0607-721	Packaging Administration
0607-730	Packaging and the Environment
0607-731	Advanced Packaging Economics
0607-742	Distribution Systems
0607-750	Graduate Seminar
0607-752	The Legal Environment
0607-763	Packaging for End-Use
0607-770	Advanced Computer Applications

0607-783	Packaging Dynamics
0607-798	Advanced Food Packaging
0607-799	Advanced Packaging Design

The selection of core courses must be approved by the student's adviser. Courses selected for elective credit can be combined to create specialties in areas such as packaging science, print media or service management.

Research

Students are required to prepare and defend a 12-credit graduate thesis, completed under the supervision of their thesis adviser. The student and adviser will agree upon the area of study and type of research to be completed before the student enrolls for graduate thesis credits. Students also may elect to take up to eight credits of Independent Study (0607-798). However; these courses may not be used toward the 20 credits of required packaging core course work.

Elective credit

In addition to the packaging core and thesis, each student will complete a minimum of 16 elective credits to complete the degree requirements. All elective courses must be approved by the student's adviser.

Students may elect to take up to 8 credits of Independent Study (0607-978) as part of their electives credits. However, independent study may not be used toward the 20 credits of packaging core course work required by the program.

In general, graduate-level course work will be selected to meet degree requirements. In certain circumstances, where individual need indicates appropriateness, a limited number of 500-level undergraduate courses may be used to fulfill elective credit. Undergraduate courses used as electives may not to exceed 12 credits in total.

Executive leader option

The executive leader option is an intensive program for packaging science professionals with at least five years of work experience beyond the baccalaureate degree. The program concentrates on the application of packaging technology in the supply chain.

The executive leader option consists of one or two summer sessions that each last two weeks, online learning and a research project, conducted over two consecutive summers. Admission to the executive leader option requires endorsements from senior management/administrative personnel with the applicant's employer.

The structure of the program provides individuals with an opportunity to obtain an MS degree without interrupting their employment. Graduate credit may be granted for life and professional experiences and is determined by an assessment of an executive leader portfolio. Candidates are encouraged to align the program's research project goals with current job responsibilities.

Electrical, Computer, and Telecommunications Engineering Technology Department

www.rit.edu/~706www/

Master of Science in Telecommunications Engineering Technology

Michael Eastman, Department Chair
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Throughout its existence, the telecommunications industry has driven technological innovation and provided outstanding career opportunities for people with the right technical and leadership skills. New services offered through the Internet, mobility offered by wireless technology and extreme capacity offered by fiber optics, as well as the evolution of policy and regulation, are shaping the telecommunication network of the future. RIT offers a unique program focused on telecommunications that develops the advanced level of skill and knowledge needed by future leaders in the industry

The master of science degree in telecommunications engineering technology is for individuals who seek graduate education to advance into managerial and leadership roles in a dynamic telecommunications environment.

Admission requirements

Applicants should have a baccalaureate degree in engineering technology, engineering or a related degree from an accredited institution, and a minimum cumulative grade point average of 3.0 (B). Applicants with a related degree must submit two professional recommendations that address how the applicant has obtained the competencies required for the engineering technology or engineering baccalaureate degrees. Bridge programs are available for applicants without experience in the telecommunications industry or those who do not have engineering technology or engineering degrees. Applicants from universities outside the United States should submit Graduate Record Examination scores. The GRE score is recommended for those whose undergraduate grade point average is below 3.0.

Applicants whose native language is other than English must take the Test of English as a Foreign Language. A minimum score of at least 570 (paper-based) or 230 (computer-based) is required. Applicants with a lower TOEFL score may be admitted conditionally, and may be required to take a prescribed program in English and a reduced program course load.

Transfer credit

A maximum of 12 credit hours can be transferred from an accredited institution to this program.

Curriculum

The MS in telecommunications engineering technology requires 48 quarter credit hours of study. The program includes six core courses (24 quarter credit hours) that introduce essential fundamental concepts and skills. Four additional courses (16 credit hours) must be chosen from the technical electives or other approved courses. One of these four courses must be a technical elective. Each student is required to complete a capstone project (4 to 8 quarter credit hours), which is either a graduate project or a graduate thesis. Students who choose to complete a graduate project must complete an additional elective course. The management courses are offered by the E. Philip Saunders College of Business.

Research and cooperative education

Graduate students in the telecommunications engineering technology program have the opportunity to apply for research projects or a cooperative education experience. While not a requirement of the program, these opportunities increase the value of the program and the marketability of its graduates.

Core courses

0614-720	Telecommunications Concepts
0614-722	Principles of Telecommunications Networks
4002-746	Telecommunications Network Protocols
0614-780	Telecommunications Policy and Regulation
0614-726	Telecommunications Project Management
0614-774	WAN/LAN and Design

Technical electives

Network Design

0614-761	Telecommunications Network Engineering
0614-728	Operating Systems for Telecommunications
0614-836	Next Generation Networks

Fiber Optic Telecommunications

0614-732	Fiber Optic Telecommunications Technology
0614-832	Fiber Optic Telecommunications Networks

Wireless Telecommunications

0614-764	Telecommunications Systems
0614-783	Telecommunications Transmission Systems
0614-864	Wireless RF Telecommunications Systems

Other approved electives

Students may take up to three nontechnical electives, subject to the approval of the program chair. Many students choose to include management courses from the E. Philip Saunders College of Business.

Master's project/thesis

Each student is required to take the thesis/project planning seminar and complete either a graduate project or thesis as the capstone project. Students who elect the graduate project must take an additional course from the technical electives or management courses.

Hospitality and Service Management Department

www.rit.edu/schoolhsm

Master of Science in Hospitality-Tourism Management

Linda Underhill, Graduate Program Chair
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James W. Jacobs Jr., Lecturer and
Executive Leader Option Director
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www.rit.edu/~702www/grad-tourmanag.html

Graduates of the MS program in hospitality-tourism management are well prepared to step into numerous midlevel service management and training director positions. The program is focused on service and innovation, as well as leadership functions within many service and corporate settings and at post-secondary academic institutions.

The hospitality-tourism management program may be taken on a full- or part-time basis. The length of time required to earn a degree varies according to the student's undergraduate preparation and the number of graduate courses taken per quarter. To earn the MS degree, all students must take a minimum of 48 quarter credit hours, 36 of which must be registered through RIT. For full-time students, the program will require a minimum of four quarters of study at the graduate level. Part-time students generally will require seven or eight quarters of study at the graduate level.

Admission requirements

Prior to admission to the MS program, applicants must illustrate that their previous training, ability, practical experience and education indicate a reasonable chance of success. The admission requirements are as follows:

- Graduate application
- Baccalaureate degree from an accredited institution
- Official undergraduate transcript(s)
- Two professional recommendations
- An on-campus interview (when possible)
- A resume
- Undergraduate GPA of 3.0 or higher (a GPA of 2.75 will be considered if applicant has superior recommendations; length of time since the candidate's college graduation also will be considered)
- Foundation course work with grades of 3.0 or higher (if required).

International applicants must submit scores from the Test of English as a Foreign Language. A minimum score of 550 (paper-based), 213 (computer-based) or 89 (Internet-based) is required. All international students will take the Michigan Test of English Proficiency upon arrival, unless otherwise approved.

Students who are already qualified for one or more required courses may substitute other course work, with permission of the program chair. After a review of their work by the program chair, students whose prior undergraduate work has been in areas other than hospitality-tourism may be required to complete additional courses. Students may choose elective courses with the approval of the program chair.

Curriculum

The curriculum is a combination of a required core in service management plus concentration courses. It also contains elective courses appropriate for the candidate's background and interests, and either a research thesis or a graduate project. Course offerings generally are scheduled on evenings or weekends, and also are offered during the summer and online to facilitate part-time students.

Program requirements

The curriculum for the MS in hospitality-tourism management introduces the major concepts associated with all aspects of service management, whether they are applied specifically to the hospitality-tourism industry or the wider service industry. This commonality becomes even more evident when the nature of the concepts is depicted. Among the general concepts investigated are service strategy formulation and delivery alignment (understanding and co-creating customer value, innovation and creativity, service leadership, service design implementation and metrics development), customer-focused research (understanding what customers value, building service environments and change in service organizations) and human resource issues (human capital strategies and metrics for evaluation).

Core courses

The core courses facilitate the paradigm shift from manufacturing to service and move the focus from traditional organizational structures to an organization where employees must provide several functions, sometimes simultaneously. This multifunctional approach provides a new avenue to examine service organizations and explore such issues as teamwork, learning organizations, organizational change, performance metrics and customer relationship management.

Each course not only introduces the service philosophy, but also examines the real differences in hospitality-service management outcomes necessitated by the adoption of the new paradigm. In so doing, these courses set the stage for the professional "cluster" courses.

0625-750	Elements of Service Management: A Systems Approach
0624-825	Strategic Process of Service Firms
0625-849	Service Performance Metrics
0626-734	Human Capital Strategies
0624 770	Service Leadership: Examining and Implementing Change
0624-826	Tourism Policy Analysis
0625-844	Breakthrough Thinking
0624-846	Travel Marketing Systems
0624-867	Tourism Planning and Development
0625-842	Customer Relationship Management
0625-846	Service Leadership Futures

Electives

Elective courses provide students with an opportunity to individualize their graduate programs in line with their career and professional interests. With the approval of the department chair, students are allowed to take a selection of elective courses from outside the hospitality-tourism management program. Courses may be taken from the hospitality and service management program, the human resource development program, the E. Philip Saunders College of Business and the Kate Gleason College of Engineering. Students are cautioned to observe course prerequisites in their selections.

Of the 8 to 12 quarter credit hours of electives, students are relatively free to select courses that they feel best meet their needs. All elective courses must be graduate-level. If previous course work exists, a student may transfer a maximum of 12 graduate quarter credit hours from another university. A maximum of 8 graduate quarter credit hours may be taken as independent study or practicum courses.

Master's thesis/project

A thesis or project is required of all candidates. Thesis topics should complement the candidate's undergraduate training, career experiences and graduate interests. The thesis is a formal document that reflects the candidate's professional preparation and may be of an applied research genre, a reflection of the student's ability to utilize professional modeling and other techniques to explain decision-making within the hospitality-tourism industry and/or to transform an organization or department.

The graduate faculty, in addition to the chair of the program, can aid the candidate in selecting a relevant thesis/project topic.

Master of Science in Service Management

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www.rit.edu/~702www/grad-servmanag.html

The MS in service management program fills an emerging need in the many service businesses and industries that focus on understanding various customer relationships. Such businesses will find this program in tune with their educational and training investments. Attention is focused on the management interface between the customer and the service provider, innovation of products and services, and building customer relationships. This program gives individual students access to the interdisciplinary expertise of a technological university.

The program is flexible. Five core courses (20 credit hours) are required. The choice of professional electives—from a wide array of disciplines, including information technology, quality and applied statistics, business, project management and human resources—responds to individual student needs.

Both full- and part-time study are allowed. Courses are offered in the evening and on weekends. Full-time students may complete the MS program within one calendar year (four academic quarters). The program also is offered in the executive leader format and may be completed in 14 to 16 months by taking one course every two months.

This is a broad-based, cross-disciplinary program. Careful selection of courses can provide unique educational preparation for individuals in varying service industries. An individualized professional concentration might include courses from instructional technology, human resource development, computer science, information technology and the MBA program in the E. Philip Saunders College of Business. The student may choose to earn a graduate certificate in statistical quality through the Center for Quality and Applied Statistics in the Kate Gleason College of Engineering.

The research paper or project that provides a capstone to the program may be guided under the mentorship of faculty in the various disciplines represented in the professional concentration.

Most individuals working in service-based industries will find no need to take bridge courses to fill any course work they are lacking from their undergraduate preparation.

Admission requirements

Prior to being admitted to the MS program, applicants must illustrate to the program chair that their previous training, ability, practical experience and education indicate a reasonable chance of success. The complete list of admission requirements includes the following:

- Graduate application
- Baccalaureate degree or equivalent from an accredited institution
- Official undergraduate transcript(s)
- Two professional recommendations
- An on-campus interview (when possible)
- A resume
- Undergraduate GPA of 3.0 or higher (a GPA of 2.75 will be considered, given superior recommendations and length of time since the candidate's college graduation)
- Foundation course work with grades of 3.0 or higher (if required)

The Test of English as a Foreign Language is required for international students. Applicants must achieve a minimum score of at least 550 (paper-based), 213 (computer-based) or 89 (Internet-based) to be considered for admission. All international students will take the Michigan Test of English Language Proficiency upon entry to the program, unless approved otherwise. Students should prepare to complete the Michigan Test before starting their graduate course work.

Curriculum

The program includes a minimum of 48 quarter credit hours, 36 of which must be registered through RIT. The program may be completed in four quarters of full-time study or in seven to eight quarters of part-time study. The basic curriculum is a combination of a required core, a professional concentration and a series of elective courses that will satisfy the student's individual needs. Students who are already qualified for one or more required courses may substitute other course work with the permission of the program chair. Students whose prior undergraduate work has not been in the service industry field may be required to complete additional courses and/or a cooperative education experience. This will be determined after a review of their work by the program chair. A thesis or final project is a requirement for all students.

Students may choose elective courses with the approval of the program chair. Elective courses may be selected from the hospitality and service management program, the human resource development program, the project management program, the E. Philip Saunders College of Business or the B. Thomas Golisano College of Computing and Information Technology. Of the possible 8 to 12 hours of electives, students are relatively free to select courses they feel best meet their needs. All courses must be graduate-level and all course prerequisites must be met. A maximum of 12 graduate quarter credit hours may be transferred from outside RIT, and a maximum of 8 graduate quarter credit hours may be taken as independent study or practicum courses.

Note: Students matriculated in the MBA program in the E. Philip Saunders College of Business may use service management courses, offered through the hospitality-tourism management and service management programs, as a concentration within their degree program.

Required core courses (20 credits)		Qtr. Cr. Hrs.
0625-750	Elements of Service Management: A Systems Approach	4
0624-770	Service Leadership: Examining and Implementing Change	4
0624-825	Strategic Process of Service Firms	4
0626-725	Human Capital Strategies	4
0625-849	Service Performance Metrics	4

Professional concentration 16-18 quarter credit hours

Hospitality and Service Management		Qtr. Cr. Hrs.
0625-841	Benchmarking and the Process of Continuous Improvement*	4
0625-842	Customer Relationship Management	4
0625-844	Breakthrough Thinking	4
0625-845	Relationship Management in Service Firms*	4
0625-846	Service Leadership Futures	4
0625-847	Re-engineering Service Environments*	4
0625-849	Service Performance Metrics	4
0697-798	Introduction to Project Management	4

** This course is only available in the executive leader option.*

Concentrations:

Human Resource Management		Qtr. Cr. Hrs.
0626-710	Theories of Organizational Development	4
0626-720	Human Resource Management II	4
0626-730	Strategic Employee Development	4
0626-735	Human Capital Strategies	4

Information Technology		Qtr. Cr. Hrs.
4002-718	Current Themes in Information Technology	4
4002-745	Foundations of Human Computer Interaction	4
4002-741	Fundamentals of Web-based Multimedia	4
4002-746	Telecom Network Protocol	4

Project Management		Qtr. Cr. Hrs.
0681-710	Introduction to Project Management	4
0681-711	International Project Management	4
0681-712	Advanced Project Management	4

E. Philip Saunders College of Business		Qtr. Cr. Hrs.
0102-763	Behavioral Skills in Total Quality	4
0106-745	Quality Control and Improvement	4

(Prerequisites or approval of the associate dean of graduate studies in the E. Philip Saunders College of Business may be required.)

Kate Gleason College of Engineering—Center for Quality and Applied Statistics

Graduate Certificate in Statistical Quality		Qtr. Cr. Hrs.
0307-721	Statistical Quality Control I	3
0307-731	Statistical Quality Control II	3
0307-781	Quality Management	3
0307-782	Quality Engineering	3
0307-801	Design of Experiments I	3
0307-802	Design of Experiments II	3

Facilities and equipment

The university maintains a broad array of computer software and equipment for student use. Additional computer laboratories are available across campus and, in particular, at Wallace Library. However, students are encouraged to have their own personal computer. Students taking online classes are required to have a computer.

Within the School of Hospitality and Service Management, there are 15 dedicated Dell computers connected to RIT's high-speed Ethernet, a high-volume black-and-white printer and a high-quality Xerox Color Laser printer. This computer lab, located in the hospitality and service management department, is for use by students within this program. Applied software packages include: business application software such as MS Office; document publishing software such as Adobe Acrobat Professional and Adobe InDesign; the graphics design programs Adobe Photoshop, Corel Draw, Corel Photo-Paint, Adobe Illustrator and Macromedia Freehand; the Web development tools Macromedia Dreamweaver, Fireworks, Flash and Adobe GoLive; nutritional analysis programs Diet Analysis Plus, The Food Processor and Nutrition Life Cycle; and statistical programs Minitab and SPSS.

Executive leader option

The MS program in service management is also available in an executive leader format, which is highly sought after by working professionals. The program is very intensive, with participants completing a new course every two months. The program consists of eight courses and a project, and is typically completed in 14 to 16 months. (Please note: the executive leader program was formerly available as a two-summer program. This option is no longer available.)

The executive leader option is specifically designed to enhance the continued, lifelong learning and career development of executive, midlevel service organization professionals without significant disruption to employment. The program's major emphasis is the understanding and ability to create, implement, manage and assess ongoing transformation in service organizations. While considering the strategic direction, performance outcomes, relationship-building, process improvement, innovative or creative approaches to service, or the future potential of service systems, students in the executive leader program will gain valuable insight into the thoughts of current service organizations and embark upon new direction, service organization alignment and service leadership.

Currently, the executive leader program is taught in three international locations and on the RIT campus in Rochester, N.Y. Participants may choose to interact with students from other countries by taking several courses in any of the four locations where the program is offered. Graduate credit is granted for life and management experience.

Executive leader courses

0625-750	Elements of Service Management
0625-844	Breakthrough Thinking, Innovation, and Creativity
0626-735	Human Capital Strategies
0624-825	Strategy Process of Service Firms
0625-849	Service Performance Metrics
0625-842	Customer Relationship Management
0625-846	Service Leadership Futures
0624-770	Service Leadership: Examining and Implementing Change

The executive leader option is offered to service management practitioners who have a minimum of five years experience beyond the baccalaureate degree. Certification through various professional associations—Certified Financial Planner, Certified Case Manager, Certified Corporate Travel Executive, Certified Travel Counselor, Certified Meeting Planner—are accepted as documentation of professional commitment. Endorsements from senior management and administrators are preferred. Graduate credit granted for life and professional experiences is determined by a portfolio assessment.

The complete list of admission requirements includes the following:

- Graduate application
- Baccalaureate degree (or equivalent) from an accredited institution
- Official undergraduate transcript(s)
- Two professional recommendations
- An on-campus interview (when possible)
- A resume
- Undergraduate GPA of 3.0 or higher (a GPA of 2.75 will be considered, given superior recommendations and length of time since the candidate's college graduation)
- Foundation course work with grades of 3.0 or higher (if required)

The Test of English as a Foreign Language is required for international students. A minimum score of at least 550

(paper-based), 213 (computer-based) or 89 (Internet-based) is required. All international students will take the Michigan Test of English Language Proficiency, unless approved otherwise. Students should prepare to complete the Michigan Test before starting their graduate course work.

Advanced Certificate in Service Leadership and Innovation

The advanced certificate in service leadership and innovation has been developed to offer service professionals cutting edge skills, abilities and applied service knowledge. More specifically, the certificate is for those seeking to achieve service leadership and change, build service performance packages and delivery systems, use multiple service metrics from feedback systems, employ creativity to achieve innovation and construct and implement strategic direction. The certificate will heighten the student's capacity to function in today's highly competitive and quickly evolving service environment.

The certificate combines five courses from the existing MS program in service management. Concepts mastered during the program include:

- understanding service performance system design and implementation parameters,
- understanding and using service value delivery system structures and processes,
- comprehending the evolving strategic environment of service-sector businesses,
- establishing and using service-system elements/dimensions,
- building service metrics from feedback processes,
- understanding and implementing customer relationship management, and
- constructing innovative approaches to service and managing those changes.

		Qtr. Cr. Hrs.
0625-750	Elements of Service Management	4
0625-825	Strategic Processes of Service Firms	4
0625-842	Customer Relationship Management	4
0625-844	Breakthrough Thinking	4
0625-849	Service Performance Metrics	4
Total		20

Admission requirements

The certificate is open to qualified students who meet the requirements for graduate study. Certificate courses are introductory to graduate courses in each area and thus require no prerequisite course work. The certificate may be completed as a stand-alone credential, serve as an entry point for the MS program or be used to fulfill the requirements for a professional concentration in RIT's MS program in professional studies. Qualified students may use individual courses or the certificate in other RIT graduate programs with the appropriate approvals.

Master of Science in Human Resource Development

Linda Underhill, Graduate, Program Chair
lmulsm@rit.edu, (585)475-7359
Donna Dickson, Visiting Professor
(585) 475-5036, dadism@rit.edu
www.rit.edu/~702www/grad-humanrsrc.html

A master of science degree in human resource development prepares students to influence the human assets of an organization to positively impact business results. Students in this program explore the effective workforce management and employee development practices used by high-performance organizations. These range from excellence in recruiting and performance rewards to building a flexible workplace that is ready to adapt to change.

The program is designed to provide students with the practical experience, tools and techniques needed to successfully execute business strategies related to human capital manage and develop talent to realize a higher return on investment, increase workforce productivity, improve customer and employee retention and form strategic alliances.

Applicants interested in this degree are experienced human resource practitioners eager to build new competencies in training, instructional design, performance management and employee development; managers who want to encourage employees to reach their potential; and individuals interested in starting a career in the human resource field. Courses are offered in the evening and online.

Admission requirements

Admission requirements for the MS degree include:

- the successful completion of the baccalaureate degree at an accredited college or university,
- a cumulative grade point average of 3.0 or above, or evidence of relevant professional performance,
- two letters of reference,
- a writing sample designated by the department and
- an interview with a faculty member.

International applicants are required to submit their scores from the Test of English as a Foreign Language. A minimum score of 570 (paper-based), 230 (computer-based) or 89 (Internet-based) is required.

All required admission materials must be submitted and reviewed by faculty prior to the completion of 12 quarter credit hours of graduate work in the program. Application forms are available from the Office of Graduate Enrollment Services, (585) 475-2229, www.rit.edu/~625www/.

Curriculum

The degree requires completion of a minimum of 48 quarter credit hours at the graduate level, and can usually be completed in four consecutive quarters. However, the majority of students attend part time and take three years to complete the program.

Students must maintain a B average and complete the degree within seven years of the first course counted toward the degree.

Students choose electives that best meet their career interests. All elective courses must be graduate-level or approved for graduate credit. Courses may be taken in other graduate-level programs at RIT and other institutions with permission of the adviser. A maximum of 12 quarter credit hours (not counted toward another degree) may be transferred from another college or university and counted toward the program's requirements, or may be granted toward human resource experience.

Upon matriculation, each student is assigned an adviser. Together, the student and adviser develop a plan of study. For specific questions about courses and a plan of study, the adviser or program chair should be consulted.

Required core courses:

0626-707	Applied Data Analysis in Human Resource Development
0626-780	Human Resource Management I
0626-877	Internship

Choose three of the following four courses:

0626-710	Theories of Organizational Development
0626-720	Theories of Career Development
0626-730	Theories of Human Resource Development
0626-781	Human Resource Management II

Electives/technique courses

0626-891	Facilitation Skills
0626-735	Human Capital Strategies
0626-734	Global Aspects of Human Resources
0626-427	Employment Law
0626-390	Compensation and Benefits

Master of Science in Health Systems Administration

Linda Underhill, Graduate Program Chair
585-475-7359, lmuism@rit.edu
www.rit.edu/healthsystems

The MS program health systems administration is designed to provide strategic skills to today's health care management. Now, as never before, we are realizing the rapid transformation of health care. The pace of technology and innovation are changing how, when and where health care is provided, and who is providing it. Concurrently, health care customers have high expectations for quality and responsiveness to their needs—delivered in a cost-effective manner.

To provide these strategic skills to health care management, the MS program builds on a foundation of courses in policy and law formation, health care economics, innovation and leadership. Additional options are provided through course selections, building an integrated program that meets the individual challenges of participating students.

One advantage of this program is the online format. Students can pursue their degree while maintaining full-time employment in locations around the world. Another distinct advantage is the diversity of our student population, which allows for creative discussion and comprehension of global health care issues, and how these relate to the standards and practices of the American health care system. The ability to share information and ideas, and to contrast and compare strategies, allows our students a level of creativity and scope of practice not found in the traditional classroom.

RIT provides excellent online learning support that leads the student through registration and use of distance learning tools. In addition, for select subject areas, the health systems administration program plans special learning sessions that blend presentation styles. This could be through attendance at seminars in locations throughout the country or at RIT. These formats provide a combination of both distance learning and interaction with presenters who provide a strategic view of health care delivery models.

Admission requirements

Admission requirements for the MS degree include:

- completion of a baccalaureate degree at a regionally accredited college or university,
- a cumulative grade point average of 3.0 or above (or superior endorsement),
- two letters of reference from individuals who have the opportunity to observe the applicant's work output,
- official undergraduate and, if applicable, graduate transcripts and
- participation in a telephone interview with the program chair.

Applicants also must have three or more years of experience in a health care or health-related organization as either a practitioner or manager. Applicants who do not meet this requirement may be asked to complete certain undergraduate health systems administration courses as a bridge for the content knowledge required for the graduate program and/or complete a graduate level internship in health care prior to graduation.

All credentials must be submitted and reviewed by faculty prior to the completion of 12 credit hours of graduate work in the program.

Degree requirements

The MS degree in health systems administration currently requires 48 quarter credit hours at the graduate level. The program can be completed in approximately two years by taking two courses per quarter. Students may take longer to complete the course work by reducing their workload to one course per quarter. However, students must complete their degree requirements within seven years of the date of the oldest course identified on their RIT course records. Students must maintain a 3.0 (B) average throughout their academic career. Toward the end of their program of study, students will complete a business plan for an innovative topic related to their work environment. The paper is developed and written within a course that is taken during the last year of study for the degree. Upon matriculation, each student works with the program chair for advice and direction to develop a plan of study.

In addition, an executive leader option is available for those with more health care experience. Please contact the Office of Graduate Enrollment Services for more information about this option.

Curriculum

Required courses

0626-707	Data Analysis/Metrics
0625-842	Breakthrough Thinking, Creativity and Innovation
0635-840	Health Systems Policy and Law
0635-820	Health Systems Economics and Finance
0624-770	Service Leadershpi

Concentrations/Electives

Health Information Resources

0635-715	Information Systems for Health Administrators
0635-754	E-Health
0635-752	Clinical Information Systems
0635-753	Health Administration Application

Elements of Health Care Leadership

0635-830	Health Systems Planning
0635-882	Bioethics
0625-750	Elements of Service
0625-842	Customer Relationship Management

Senior Living

0635-716	Law and Policy in Senior Living
0625-750	Elements of Service
0626-891	Human Capital Strategies
0625-842	Customer Relations Management

Health Systems Finance

0635-815	Finance for Operations
0635-881	Strategies for Health Care Accountability
0635-715	Information Systems for Health Administrators
0635-798	Risk Management

Students may fulfill electives from other concentrations or from other graduate courses offered in the School of Hospitality and Service Management with permission of their adviser and program chairs.

Executive leader option

The Executive leader MS program in health systems administration is designed for professionals with three to five years of managerial experience within their industry and who have earned a bachelor's degree in health care, information technology, business or education. The program's interdisciplinary focus makes it attractive to those with bachelor's degrees in related subjects who also have extensive experience in various sectors of health care such as senior living, pharmacy, food service, development, fundraising, marketing and communications. Executive leader course work focuses on all aspects of strategic skill development in the areas of leadership and planning. Courses are offered in a distance format or on site at Physician Regional Hospital in Naples, Fla. A focal point of the interaction with the Physician Regional Hospital is the healing hospitality leadership practices found in the hospital for the business of caring.

The program consists of nine unique courses that provide a total of 36 quarter credit hours. Up to 12 quarter credit hours are earned for health-care industry experience. An application-oriented approach is found in classroom projects and discussions.

0635-820	Health Systems Economics and Finance
0635-830	Health Systems Planning
0635-840	Health Systems Policy and Law
0635-882	Bioethics
0624-770	Service Leadership: Examining and Implementing Change
0625-750	Elements of Service Management
0625-842	Customer Relationship Management
0625-844	Breakthrough Thinking
0626-735	Human Capital Strategies

The Executive leader option is offered on site at RIT or via distance learning. Course delivery and scheduling are designed to alleviate significant disruptions to career, family and other commitments. Students in the program will bring their personal computers to class and be able to use the RIT MyCourses Online System to access support services, as well as the library, for research. On-site classes will run from Thursday afternoon through Monday morning. Although rigorous, the focused nature of the program provides constant motivation and assistance to help students succeed.

The program may be completed in an accelerated format, with students completing their studies in five academic quarters or over the course of two years. This format is designed to accommodate the working professional.

For more information on this highly focused, strategic program, visit the program website at www.rit.edu/healthsystems.

Advanced Certificates in Health Administration

The health systems administration program strives to meet the needs of health care professionals. The four concentrations offered within the program can be taken as stand-alone courses, and a certificate will be awarded at their completion. The certificates can be used to update skills or change career paths of health care professionals. If, at a later date, a student decides to pursue the MS degree in health systems administration, these courses can be applied toward the program's requirements. To meet the needs of working professionals, all the certificate courses are taught online. The certificates are as follows:

Certificate in Elements of Health Care Leadership		Qtr. Cr. Hrs.
0635-882	Bioethics	4
0635-830	Health Systems Planning	4
0625-842	Customer Relationship Management	4
0625-750	Elements of Service	4
Certificate Total		16

Certificate in Health Information Resources		Qtr. Cr. Hrs.
0635-752	Clinical Information Systems	4
0635-715	Information Systems for Health Administrators	4
0635-753	Health Administration Application	4
0635-754	E-Health	4
Certificate Total		16

Certificate in Health Systems Finance		Qtr. Cr. Hrs.
0635-815	Finance for Operations	4
0635-797	Strategies for Health Care Accountability	4
0635-881	Health Insurance and Reimbursement	4
0635-798	Risk Management	4
Certificate Total		16

Certificate in Senior Living	Qtr. Cr. Hrs.
0635-716 Law and Policy in Senior Living	4
0625-750 Elements of Service	4
0625-842 Customer Relationship Management	4
0626-735 Human Capital Strategies	4
Certificate Total	16

Center for Multidisciplinary Studies

www.rit.edu/cms

Master of Science in Professional Studies

James Myers, Director
(585) 475-4772, jamisr@rit.edu
Samuel McQuade III, Program Coordinator
(585) 475-5230, scmcms@rit.edu
www.rit.edu/cms/grad/masters.html

The professional studies program is specifically designed to enable the mature learner to fashion a customized plan of graduate study tailored to his or her personal and professional goals. This degree offers an opportunity to draw on more than 50 of RIT's graduate programs in order to gain the advanced knowledge and skills necessary to respond successfully to new and emerging career opportunities. The degree is completed with the capstone project, a practical, hands-on project directly related to the student's individualized plan of study. With certain concentrations, the MS degree in professional studies may be pursued through online learning.

The program requires the completion of 48 quarter credit hours. Students begin their program of study with Contexts and Trends (0688-705), a course where they propose a pan of study for their customized graduate program. Within Context and Trends, they are encouraged to explore RIT's graduate programs and select courses that will comprise their concentrations. Two or three professional concentrations may be chosen, based on the skills each student seeks to obtain. Each concentration is a selection of courses, drawn from an existing RIT graduate program, that constitutes 12 to 24 quarter credit hours. Graduate credits earned in other programs may be used in completing a concentration, upon approval. A number of concentrations may be completed online. These include:

Print Media
General Management
Telecommunications Engineering Technology
Microelectronics Manufacturing Engineering
Software Development and Management
Materials Science
Learning and Knowledge Management Systems
Applied Statistics
Environmental Management
Health Systems Administration
Human Resource Development
Imaging Science
Information Technology
Project Management
Product and Production Systems Design
Strategic Training
Technical Information Design

Credit hours not required in a student's concentration areas can be used for electives. All elective and transferred courses need to be integrated into the proposed plan of study. For further information or advising, call the Center for Multidisciplinary Studies at (585) 475-2234.

Admission requirements

The program is especially suitable for individuals with career experience who can define the skills and knowledge they wish to obtain through graduate study. Admission requirements include:

- successful completion of a baccalaureate degree at a regionally accredited college or university,
- a minimum undergraduate cumulative grade point average of 3.0, or superior endorsements,
- three to five years full-time work experience,
- letters of reference from two individuals who have served recently as either the applicant's supervisor or instructor,
- a statement of career objectives and description of the skills and knowledge sought through graduate study, and
- a proposed plan of study, to be developed with the program adviser.

International students must submit the results of the Test of English as a Foreign Language. A minimum score of 550 (paper-based) is required. The TOEFL requirement is waived for native speakers of English or those submitting educational transcripts and diplomas from American colleges and universities.

All applicants are urged to discuss their plans with the professional studies program adviser before submitting a formal application.

Required courses

0699-705 Context and Trends (4 credits)

This course introduces students to interdisciplinary thinking, personal self-assessment, problem solving, goal setting and research techniques using electronic information resources. Students work toward selecting concentrations and finalizing a plan of study for their graduate program.

0699-775 The Capstone Project (4 credits)

This course is a supervised, hands-on experience in which students apply the skills and knowledge developed through their individualized plans of study, concluding with oral and written presentations.

The following are examples of course sequences in the professional studies format. Many combinations are possible.

1. Cross-Disciplinary Professional Studies with Two Professional Concentrations **Qtr. Cr. Hrs.**

0699-705	Context and Trends	4

Concentration A: Marketing

0105-761	Marketing Concepts	4
0105-762	Advanced Marketing Management	4
0105-772	Marketing on the Internet	4
	Marketing Elective	4

Concentration B: Communication and Media

0535-705	Electronic Communication	4
0535-710	Visual Communication	4
0535-704	Communication Law and Ethics	4
0535-709	Public Relations and Advertising	4

Electives

0626-740	Group Leadership	4
0626-730	Theories in Human Resource Development	4

0699-775	Capstone Project	4
Total		**48**

2. Professional Studies with Three Professional Concentrations **Qtr. Cr. Hrs.**

0699-725	Context and Trends	4

Concentration A: Project Management

0681-710	Introduction to Project Management	4
0681-711	Advanced Project Management	4
0681-712	International Project Management	4
0688-732	Managing Scientific and Technical Communication	4

Concentration B: Manufacturing and Mechanical Engineering Technology

0304-618	Computer-Aided Engineering	4
0304-801	Design for Manufacture	4
0304-964	Production Tool Design	4
0610-710	Product Development and Integration	4

Concentration C: General Management

0102-740	Organizational Behavior and Leadership	4
0102-741	Managing Organizational Change	4
0102-763	Behavioral Skills for Managers	4

0699-775	The Capstone Project	4
Total		**48**

Financial aid

Applicants seeking graduate scholarships or assistantships should indicate this on the graduate application. A limited number of scholarships and assistantships are available on a competitive basis. Applicants seeking financial aid should apply by April 1. Information about student loans may be obtained from the Office of Financial Aid and Scholarships, (585) 475-2186.

Advanced Certificate in Technical Information Design

Technical information design is a growing multidisciplinary communication field that requires understanding and skills in the development and use of text, graphic design, multimedia and other techniques to enhance contemporary technical communication. Success in this field demands that the practitioner have superior writing skills, adeptness at selecting and using available and emerging media, and the ability to recognize excellence in the visual aspects of communication design.

This program focuses on the information designer's use of technology to create documentation and deliver information to the intended audience.

Admission requirements

Certificate applicants should have a baccalaureate or equivalent degree from an accredited institution and a minimum cumulative grade point average of 3.0 (B). Students with lower grade point averages may take courses on a nonmatriculated basis and be admitted after successful completion of two or more courses and permission of the program chair. Two professional recommendations must be submitted.

International applicants whose native language is other than English must submit scores from the Test of English as a Foreign Language. A minimum score of 550 (paper-based) is required. Students with a lower score may be admitted conditionally, and may be required to take a prescribed program in English, along with a reduced program course load.

Students entering this program also are expected to have basic skills in technical writing and editing, and technical document design.

Curriculum

Required courses **Qtr. Cr. Hrs.**

0688-711	Technical Information Design	4
0688-731	Technical Procedures	4
0688-741	Usability Design and Testing	4

These core courses are available through distance education. In addition, students are required to complete a minimum of 11 elective credits, chosen with the approval of their program adviser.

Elective courses

4004-730	Interactive Media Implementation	4
4004-741	Fundamentals of Web-based Multimedia	4
4004-745	Theories in Interactive Computing	4
0688-721	Creating Technical Proposals	4
0688-732	Managing Technical and Scientific Communication	4
2081-723	Contemporary Publishing	4
0688-714	Science Writing	4

Many of these electives are available through distance education. Other electives, human-computer interface, computer graphics, project management and other relevant fields may be used with an adviser's approval. For more information or advising, please call Thomas Moran at (585) 475-4936.

Advanced Certificate in Project Management

In today's business-oriented society, project-based organizations and project management have become much more than just a way of conducting business. New growth within these organizations has changed the shape of project management to reveal what is becoming an exciting new career path for many individuals. Project managers have quickly become a necessary asset for many businesses.

The goal of a project manager is to successfully plan, organize and accomplish a specific project or one-time effort. Encountering the challenges of cultural and social differences, along with an assortment of industrial focuses, the project manager must be aware of a project's goals on a daily and, sometimes, hourly basis. Completion of any project is achieved via a well thought-out project plan. RIT's new graduate certificate in project management teaches students how to plan, develop and implement successful projects from initiation to completion.

Curriculum

Required courses **Qtr. Cr. Hrs.**

0681-710	Introduction to Project Management	4
0681-711	Advanced Project Management	4
0681-712	International Project Management	4

These core courses are available both on campus and through distance learning. In addition, students are required to complete 8 elective credits, chosen with the approval of their program adviser.

Sample elective courses

0688-732	Managing Technical and Scientific Communications
0688-721	Creating Technical Proposals
0626-710	Theory of Organizational Development
0626-740	Group Leadership Skills
0626-780	Human Resource Management I
0625-841	Benchmarking and Continuous Process Improvement
0625-843	Empowered Teams
0625-844	Breakthrough Thinking: Creativity and Innovation
0102-740	Organizational Behavior and Leadership
0625-849	Service Performance Metrics

Many of these electives are available through distance learning. Other electives may be used with an adviser's approval. For more information or advising, please call Mary Boyd at (585) 475-2296.

Financial aid

Applicants seeking graduate scholarships or assistantships should indicate this on the graduate application. A limited number of scholarships and assistantships are available on a competitive basis. Applicants seeking financial aid should apply by April 1. Information about student loans may be obtained from the Office of Financial Aid and Scholarships, (585) 475-2186.

Graduate Faculty

Wiley R. McKinzie, BA University of Wichita; MS, State University of New York at Buffalo—Professor

Linda A. Tolan, BS, State University of New York at Geneseo; MS, Rochester Institute of Technology—Associate Dean; Professor

Department of Civil Engineering Technology, Environmental Management and Safety

Abi Aghayere, BS, University of Lagos; MS, Massachusetts Institute of Technology; Ph.D., University of Alberta; PE—Professor

Harry G. Cooke, BS, Northwestern University; MS, University of Texas; Ph.D., Virginia Polytechnic Institute; PE—Associate Professor

G. Todd Dunn, BS, Dartmouth College; MS, University of California; PE—Associate Professor

Robert H. Easton, BS, United States Military Academy; MS, Iowa State University; PE—Professor Emeritus

Joshua Goldowitz, BS, State University of New York at Binghamton; MS, University of Arizona—Associate Professor

William C. Larsen, BS, MS, Dartmouth College; PE—Associate Professor

Robert E. McGrath Jr., BCE, Rensselaer Polytechnic Institute; MS, Syracuse University; PE—Professor Emeritus

John Morelli, BS, Syracuse University; MS, Ph.D., State University of New York College of Environmental Science and Forestry—Professor

Mark Piterman, MCE, Odessa Marine Engineers Institute—Professor Emeritus

Joseph M. Rosenbeck, BS, MS, Central Missouri State University; CSP—Graduate Program Coordinator; Associate Professor

Jennifer Schneider, BS, Roberts Wesleyan College; MS, University of Rochester; Ph.D., University of Massachusetts at Lowell—Professor

Maureen S. Valentine, BSCE, Tufts University; MECE, Virginia Polytechnic Institute; PE—Chair, Civil Engineering Technology, Environmental Management and Safety; Professor

Scott B. Wolcott, AAS, State University of New York at Canton; BS, MS, State University of New York at Buffalo; PE—Associate Professor

Adjunct Faculty

Environmental Management and Technology

Joseph Deeb, BS, MS, Ph.D., State University of New York at Buffalo

Wayne Loomis, MS, University of Rochester

Edward Mullen, BS, Clarkson University; MS, Johns Hopkins University

Ravi Nabar, BS, Birla Institute of Technology; MS, University of Michigan; MBA, University of Saskatchewan; Ph.D., University of Michigan

Michael Pilla, MS, Rochester Institute of Technology

George Thomas, MS, Johns Hopkins University

Tom Wickerham, BA, Theil College

Faculty

Department of Manufacturing and Mechanical Engineering Technology/Packaging Science

Ronald F. Amberger, BME, Rensselaer Polytechnic Institute; ME, Pennsylvania State University; PE—Professor

Scott Anson, BS, MS, State University of New York at Binghamton; PE—Assistant Professor

Philip J. Batchelor, BS, Marquette University; MS, University of Illinois—Visiting Lecturer

Mario H. Castro-Cedeno, BS, MS, Universidad de Puerto Rico-Mayaquez; MEMS, University of California at Berkeley—Assistant Professor

Louis B. Gennaro, BS, United States Military Academy; MS, Northeastern University—Professor Emeritus

Daniel L. Goodwin, BS, MS, Ph.D., Michigan State University—Professor

Martin Gordon, BS, MS, MBA, State University of New York at Buffalo—Associate Professor

Deanna M. Jacobs, BS, State University of New York at Plattsburgh; MA, State University of New York at Geneseo; MS, Rochester Institute of Technology—Packaging Science Graduate Program Adviser; Professor

Daniel Johnson, BS, MS, Rochester Institute of Technology—Assistant Professor

Seung Kim, BS, Hanyang University; MS, Ph.D., University of Illinois—Associate Professor

Ti-Lin Liu, BS, MS, Tsinghua University—Associate Professor

Carl A. Lundgren, BS, Rensselaer Polytechnic Institute; MBA, University of Rochester—Professor

Robert A. Merrill, BS, Clarkson College; MS, Northeastern University; PE—Professor

Karen L. Proctor, BS, Michigan State University; MBA, Rochester Institute of Technology—Professor

S. Manian Ramkumar, BE, PSG, College of Technology-Bharathiar; ME, Rochester Institute of Technology—Professor; Graduate Program Adviser

Beth Carle, BSE, University of Pittsburgh; MS, Ph.D., University of Illinois; EIT Professional Certification—Associate Professor

John A. Stratton, BS, Rochester Institute of Technology; MS, Rensselaer Polytechnic Institute, PE—Professor

George Sutherland, BS, University of Alberta; MEng, McMaster University; Ph.D., Stanford University— Professor

Thomas Voss, BS, MS, Michigan State University—Associate Professor

Fritz J. Yambrach, BS, Michigan State University; BS, MBA, Utah State University; Ph.D., State University of New York at Buffalo—Associate Professor

Adjunct Faculty

Packaging Science

Dennis Young, BS, Michigan State University—Dennis Young and Associates, Inc.

Beth Aubry, BS, Rochester Institute of Technology

Lesley Bates, BFA, Rochester Institute of Technology

Craig E. Densmore, BS, MS, Rochester Institute of Technology

Lisa Talty, BS, MBA, Rochester Institute of Technology

Faculty

Electrical Computer and Telecommunications Engineering Technology

Ronald Fulle, BA, State University of New York at Oswego; MS, University of Colorado at Boulder—Associate Professor

Chance M. Glenn, Sr., BS, University of Maryland at College Park; MSEE, EE, Ph.D., Johns Hopkins University—Associate Professor

Mark J. Indelicato, BEEE, Manhattan College; MS, Polytechnic University—Associate Professor

William P. Johnson, BA, Kings College; BSEE, MSEE, Syracuse University; JD, State University of New York at Buffalo Law School—Professor

Warren L. G. Koontz, BSEE, University of Maryland; MSEE, Massachusetts Institute of Technology; Ph.D., Purdue University—Professor

Anthony P. Trippe, PE, BS, Rochester Institute of Technology; MS, Fairleigh Dickinson University (DBA U.S. International University)—Associate Professor

Faculty

Hospitality and Service Management Department

Francis M. Domoy, BS, MA, State University of New York at Buffalo; Ph.D., Michigan State University—Chair; Professor

Stanley Bissell, BA, Ohio Wesleyan University; MA, University of Auckland; MLS, State University of New York at Geneseo—Associate Professor

David Crumb, BS, Florida State University; MBA, Michigan State University—Assistant Professor

Barbra Cerio Iocca, RD, BS, M.Ed., State University of New York at Buffalo—Associate Professor

Jon Horne, BA, Colorado State University; MA, University of Phoenix; MS, Rochester Institute of Technology—Assistant Professor

James Jacobs, MS, Troy State University; Ph.D., State University of New York at Buffalo—Graduate Chair; Associate Professor

Elizabeth Kmiecinski, RD, BS, Ohio State University; MS, University of Kentucky—Assistant Professor

Dianne C. Mau, BS, Rochester Institute of Technology; MS, State University of New York at Brockport—Graduate Program Chair

Warren Sackler, BA, Michigan State University; MA, New York University—Associate Professor

Edward Steffens, BS, MBA, Rochester Institute of Technology—Assistant Professor

Linda Underhill, BS, MS Rochester Institute of Technology, Ph.D., RD, State University of New York at Buffalo—Associate Professor, Graduate Program Chair

Carol Whitlock, RD, BS, MS, Pennsylvania State University; Ph.D., University of Massachusetts—Professor

Adjunct Faculty

Hospitality and Service Management Department

Donna A. Dickson, BA, State University of New York at Buffalo; MS, Rochester Institute of Technology

Arnold S. Gissin, MPH—Administrator, Jewish Home of Rochester

Katherine Hiltunen, MBA, BSN—Director, QM/UM Analysis, Blue Cross and Blue Shield of Rochester

Donald Jacobs, BS, Buffalo State College; MS, Ph.D., State University of New York at Buffalo

Joan Johnson, BS, MBA, Rochester Institute of Technology; Ph.D., Syracuse University

Marcia Marriott, BS, MA, State University of New York at Brockport; Ph.D., Southwest University

Dianne C. Mau, BS, Rochester Institute of Technology; MS, State University of New York at Brockport; Ed.D., Columbia University

Todd Mittler, BA, Canisius College

James Myers, BS, MS, Rochester Institute of Technology; Ph.D., Michigan State University

Denise Pierotti, BA, Binghamton University; MS, University of Vermont; MS, University of Washington

Damon Revelas, BS, MS, Rochester Institute of Technology; Ph.D., State University of New York at Buffalo

Patricia Seischab, MS, Rochester Institute of Technology

Christine Sevilla, BA, University of Southern California at Santa Barbara; MPA, State University of New York at Brockport; MS, Rochester Institute of Technology

J. Wixson Smith, BS, State University of New York at Geneseo; MS, Rochester Institute of Technology

C. J. Wallington, BS, University of Missouri at Kansas City; Ph.D., University of Southern California—Graduate Program Chair; Professor

Karen Vignare, BS, Frostburg State University; MBA, University of Rochester

Beverly Voos, MS, President and Chief Executive Officer, Rochester Healthcare Information Group, Rochester, New York

Carl Winkelbauer, Ed.D., University of Rochester

Faculty

Center for Multidisciplinary Studies

Mary Boyd, BA, Earlham College; MS, University of Iowa—Associate Director, Assistant Professor

Samuel McQuade III, BA, Western Washington University; MPA, University of Washington; Ph.D., George Mason University—Graduate Program Coordinator

James Myers, BS, MS, Rochester Institute of Technology; Ph.D., University of Michigan—Director, Associate Professor

Richard Morales, BA, Michigan State University; MA, State University of New York at Brockport; MSW, Ph.D., Syracuse University—Faculty Emeritus

Thomas F. Moran, BSME, California Polytechnic State College; MSME, California State College at Long Beach—Associate Professor

Carol Romanowski, BA, State University of New York at Plattsburgh; BS, MS, Ph.D., University at Buffalo—Assistant Professor

Linda A. Tolan, BS, State University of New York at Geneseo; MS, Rochester Institute of Technology—Associate Dean, Professor

Packaging Science

0607-701 Research Methods in Packaging
Discussion of procedures, methods and requirements for carrying out the research project. Students pursue advanced study and research in the following areas: distribution packaging, package systems development, product and/or package damage in the physical distribution environment, materials, quality preservation, production and mechanical properties of packaging materials and systems. **Credit 4**

0607-721 Packaging Administration
Study of the role of packaging operations in the corporate enterprise. Positioning of the packaging function in the corporation, managerial practice, interpersonal relationships and control techniques are considered. Individualized instruction, case analysis and/or research papers supplement classroom instruction. **Credit 4**

0607-730 Packaging and the Environment
Considerations of packaging in a social context. Factors that enhance secondary use, recycling, recovery of resources and proper disposal are discussed. Package design in relation to solid waste disposal and materials and energy shortages are considered. Other topics of current social interest are discussed. Primarily a discussion class for graduate students. Open to graduate non-majors. (0607-321, 322 or equivalent) May not also get credit for 0607-530. **Class 4, Recitation 1, Credit 4**

0607-731 Advanced Packaging Economics
An advanced study of the firm's economic behavior in relationship to activities within the packaging function. Included are packaging costs, production theory and case studies demonstrating general trends in the packaging industry. Individual instruction, case study and/or research paper required, as appropriate to the student's level or interest. **Credit 4**

0607-742 Distribution Systems
Study of the shipping and handling environment encountered by goods in packages during distribution to the product user. Materials handling, warehousing and the impact of the distribution environment on shipping container design and development are considered. Case study or individual research appropriate to student's interest. **Credit 4, Class 3, Lab 2**

0607-750 Graduate Seminar
Course concentrates on topic of current interest, depending on instructor, quarter offered and mix of students. Content to be announced prior to registration dates. **Credit 4**

0607-752 The Legal Environment
An intensive study of federal, state and local regulation that affects packaging. Individualized study and research on an interest basis. **Credit 4**

0607-763 Packaging for End Use
An intensive study of package design requirements specific to use of a product at specified end points. Individual design and development of a package system and its specifications, appropriate to the needs of the product and the consumer/user. **Credit 4**

0607-770 Advanced Computer Application
Study of the application of computer techniques and data processing for packaging applications: specification development, test simulation, optimum sizing of package systems, process control and similar applications will be presented. Computer program development and individual research on an interest basis. **Credit 4**

0607-783 Advanced Packaging Dynamics
The study of instrumentation systems for analysis, evaluation and application of shock and vibration test methods and data to package system design and development for specific products. A research paper is required. **Credit 4 Class 3 Lab 2**

0607-798 Independent Study
Student-initiated study in an area of specialized interest, not leading to a thesis. A comprehensive written report of the investigation is required. Cannot be used to fulfill core requirements. **Variable credit (maximum of 8)**

0607-799 Advanced Packaging Design
Advanced package design projects selected in consultation with the instructor. Individual study appropriate to area of interest and background of student. (Consent of department) **Variable credit 1–4**

0607-890 Graduate Thesis
An independent research project to be completed by the student in consultation with the major professor. A written thesis and an oral defense of the thesis are required. (Consent of department) **Variable credit (maximum of 12)**

0607-899 Executive Leader Portfolio
The portfolio credit option is for the Executive Leader students only and is designed to evaluate extensive prior experience. Students must provide extensive documentation of at least 5 years of experience in the packaging industry after completion of the appropriate baccalaureate degree. The content for the portfolio and the number of credits sought are determined in conjunction with the graduate coordinator. Final review and award of credit are then completed through the graduate coordinator and the Program Chair. **Credit 1–10**

0607-999 Packaging Science Graduate Co-op
Work experience in packaging science position appropriate to selected major in graduate program. Position to be obtained through interviewing process with the assistance of Cooperative Education and Career Services Office. **Credit 0**

Manufacturing and Mechanical Engineering Technology

0610-710 Product Development and Integration
This course covers a broad set of topics, processes and best practices related to the disciplined development of products & production systems. The course takes two major views of product development: first is total quality development and second is system engineering as applied to the earliest phases of new product development. A thorough review of product and technology development processes and best practices will be covered in the context of reducing time to market. Skills will be developed to enable the student to construct and actively participate in a modern, concurrent new product development process. The student will be introduced to critical parameter management to aid in fulfilling voice of the customer requirements. System integration for total product life cycle performance is a major focus. Studies and reading in diverse product and system development topics are required. **Credit 4**

0610-820 Concept Design and Critical Management
This course focuses on gathering the voice of the customer, translating it into technical requirements, defining functions to fulfill the requirements, generating concepts to physically fulfill the functions & the evaluation and selection of superior product and subsystem concepts that are safe to take to commercialization. Team labs will be conducted in QFD, functional analysis and decomposition, concept generation and PUGH'S concept selection process. Critical parameter management techniques will be covered in detail. **Credit 4**

0610-830 Instrumentation and Computer Aided Data Acquisition
This course integrates modern methods of acquiring, processing, and analyzing data. The goal is to generate value added information to the critical parameter management process during new product development. The course focus is on the measurement of product or process critical functional responses that are direct indicators of the true physical functions that control product quality. Students will acquire a strong set of skills in hands-on development, design, construction & operation of manual & computer-aided data acquisition systems. Topics include applications for data base management & application for empirical model building, robust design, tolerance design & statistical process control. Students will be introduced into using Lab View for data acquisition and control. **Credit 4**

0610-870 Robust Design for Products and Systems
This is an advanced course in Taguchi's dynamic methods of robust design. Students learn to optimize design parameter nominal set points to promote insensitivity to sources of variation in the manufacturing & customer use environments. Development of robust & tunable systems and their manufacturing processes is a major focus. The role of engineering methods for designing for additively is used to promote rapid system integration. The role of robust design in critical parameter management will be demonstrated. Team labs in robust design projects will be required. **Credit 4**

Telecommunications Engineering Technology

0614-720 Telecommunications Concepts
Transmission, switching and signaling are each important elements of any communication network. Topics included are the architecture of the public switched telephone networks, modulation, multiplexing, data communication protocols, various types of switching, introduction to optical fiber, emerging technologies, and an introduction to traffic engineering. (BS in engineering technology, engineering, or a related degree) **Lecture 4, Credit 4**

0614-722 Principles of Telecommunications Networks
The course provides the student with a solid understanding of local access and backbone networks, topology, equipment and technology. Topics in the course are the public switched telephone network, local and wide area networks, carrier transport networks and emerging technologies in each of these areas. BS in engineering technology, engineering, or a related degree) **Lecture 4, Credit 4**

0614-726 Telecommunications Project Management
This course addresses the processes and skills needed for successful project management in the Telecommunications industry. Topics in the course are project life cycle, planning templates, project deliverables, project work breakdown structure, estimating resources and task costs, Gantt charts, PERT techniques, project team duties and responsibilities, project team management techniques and software tools for large projects. The course includes an applied project planning assignment in which students define a project related to the telecommunications industry and use Microsoft (MS) Project software and "best practices" to properly plan the project tasks, schedule and budget. (BS in engineering technology, engineering, or a related degree) **Lecture 4, Credit 4**

0614-728 Operating Systems for Telecommunications
The course starts by examining the features and operation of a typical operating system. Basic functions are to execute user commands, provide for system resource sharing, management of memory, the creation and management of files, networking and communications of distributed computer systems, and to provide security and protection functions. Students will examine typical methods and techniques which implement the key operating system functions. A sequence of commonly used operating systems will be studied to compare and contrast how each provides its services and determines the benefits and short comings that exist between them. The course includes real time and embedded operating systems along with how the operating system interfaces with telecommunications applications and hardware. (BS in engineering technology, engineering, or a closely related degree.) **Lecture 4, Credit 4**

0614-732 Fiber Optic Telecommunications Technology
This course will present the student with the basic components of fiber optic telecommunications systems including optical fiber, light sources and transmitters, photo detectors and receivers, optical amplifiers and passive optical components. Fiber optic telecommunication is one of the most dynamic and important technologies in the telecommunications field. The fundamental driving forces, notably including the growth of wideband access to the Internet, are still in place and the demand for telecommunications capacity continues to increase exponentially. (MS or PhD in physics or engineering and an academic specialty or industrial experience in optical components or optical telecommunication systems, calculus, and differential equations) **Lecture 4, Credit 4**

0614-761 Telecommunications Network Engineering
This course covers accepted network design principles and methodologies as they apply to circuit, packet, frame, cell and synchronization networks. Course topics are transmission engineering, traffic engineering models, timing and synchronization, design of voice and data networks, and electrical grounding concepts. (Telecommunications Concepts 0614-720, Principles of Telecommunications Networks 0614-722, Telecommunications Network Protocols 4055-746) **Class 4, Credit 4**

0614-764 Telecommunications Systems
The fundamental principles that govern the communication of information are introduced. At the end of this course students will understand signal spectral analysis and the principles of digital and analog modulation formats. Topics in the course are spectral analysis techniques, modulation schemes, and noise and bit error rates. (Calculus and differential equations) **Class 4, Credit 4**

0614-774 WAN/LAN Planning and Design
This course provides participants with an introduction to the art and science of wide area network (WAN) design. Topics are often illustrated with real-world examples. Various design approaches are introduced and several heuristic design algorithms are utilized. Blocking networks and delay networks are studied. A PC design tool is utilized in the course and project work is focused on complicated WAN design and local area network planning and design. (Telecommunications Concepts 0614-720, Principles of Telecommunications Networks 0614 722) (This course is not appropriate if the student has completed the RIT undergraduate course, Network Planning and Design 0614-574 course with an A or B or an equivalent course at another university in the past five years.) **Credit 4**

0614-780 Telecommunications Policy Issues
This course provides an introductory overview of domestic and international telecommunications policy and issues with special emphasis on domestic policy, regulation and law. Current issues, trends and standards are also investigated. (This course is not appropriate if the student has completed the RIT undergraduate course, Introduction to Policy and Issues 0614-480, with an A or B or an equivalent course at another university in the past five years.) **Credit 4**

0614-783 Telecommunication Transmissions Systems
The fundamental principles that govern wired and wireless transmission systems are introduced. At the end of this course students will be able to apply transmission system theory to the analysis and design of copper, fiber-optic, and wireless transmission systems. Topics in the course are Transmission Lines, link budgets, satellite communications, and an introduction to cellular engineering and mobile radio transmission. (Calculus, differential equations, and an undergraduate course in electronic communications systems that teaches the concepts of modulation and demodulation and the electronic components in transmitters and receivers) **Class 4, Credit 4**

0614-798 Special Topics in Telecommunications
Special topics in Telecommunications is an experimental graduate level course that will allow innovative topics in the rapidly changing telecommunications field to be offered and evaluated as potential permanent components of the ET curriculum. **Class 4, Credit 4**

0614-832 Fiber Optic Telecommunications Network
This course is focused on the operation of the elements of fiber optic telecommunications networks and the structure and operation of optical telecommunications networks. Students will be able to design optical networks to meet specified capacity, flexibility, and reliability requirements at the end of the course. (Fiber Optic Telecommunications Technology 0614-732) **Lecture 4, Credit 4**

0614-836 Next Generation Networks
The course provides graduate TET students the opportunity to research and report on "Next Generation Networks." The course consists of professor led discussions on one type of Next Generation Network followed by each student researching two additional Next Generation Network types. A case study approach is utilized. After completing the research and written paper regarding one's selected topic/case, each student will present to all other students in the class. As a result, every student will not only benefit from their own research of two topics/cases but also be informed of other Next Generation Network issues by other students. (Students with an engineering technology or engineering BS degree and/or graduate students who have completed ALL core MSTET requirements are welcome) **Credit 4**

0614-864 Wireless RF Telecommunications Systems
The fundamental principles that govern the application of wireless mobile and fixed radio frequency communication systems are studied in this course. At the end of this course students will understand the radio frequency mobile wireless environment, the common wireless systems, and the zoning/public policy aspects related to deployment of the wireless infrastructure. (Telecommunication Systems 0614-764, Calculus and Differential Equations) **Lecture 4, Credit 4**

0614-890 Graduate Thesis/Project Plan
This is the first of a two-course sequence in which each TET graduate student will design and conduct research and prepare a proposal for either a graduate thesis or a graduate project. **Credit 2**

0614-892 Graduate Thesis
The graduate thesis is an independent research or development project that provides new knowledge, data, processes, software or other assets that benefit the field of telecommunications. A formal written thesis and an oral defense are required. (0614-890, Thesis/Project Planning Seminar) **Credit 6**

0614-893 Graduate Project
Graduate projects are an applied research project that reflects the student's ability to utilize professional skills to design and develop a project that demonstrates the use of telecommunications technology, tools, or applications. A formal written document and demonstration are required. (0614-890, Thesis/Project Planning Seminar) **Credit 2**

0614-899 Independent Study
Study or laboratory work on a telecommunications or closely related topic. (Requires approval of the instructor and the telecommunications engineering technology program chair.) **Credit 2–4**

0614-999 Graduate Co-op
One quarter of appropriate work experience in a telecommunications related industry. It is expected that a student will normally take no more than two quarters of cooperative education in the course of the MSTET program. **Credit 0**

Manufacturing and Mechanical Systems Integration

0617-811 Design for Manufacturing and Assembly
The basics of Manufacturing Processes (I and II) are expanded and applied to the design process. Design is taken from early courses that deal with function and theories of failure and now is considered from the viewpoint of manufacturability. Part concepts will be considered for various manufacturing processes to determine which processes will yield the lowest cost part that meets all product functional requirements. Cost will consider the sum of piece part, associated tooling, and assembly costs. (0617-420 and 0610-220 or instructor permission. Students are encouraged to have 0617-436 Engineering Economics and 0617-472 Tool Engineering or equivalent courses or experience.) **Credit 4**

0617-850 Flexible Manufacturing Assembly
The course provides an in-depth knowledge of automated manufacturing and assembly systems, their design, operation and implementation. Topics include system hardware, software, controls, programming, and integration. Emphasis will be placed in providing a thorough understanding of computer controlled machines, tooling, tool management, part feeding, part orientation, part holding, material handling systems, robots, AGVS, coordinate measuring machines, sensors system controls, general purpose and special purpose assembly systems and management issues. Concepts pertaining to design of products for automated manufacturing, handling and assembly will also be discussed. **Class 4, Credit 4**

0617-855 Electronic Packaging Fundamentals
This course will provide a thorough understanding of the technology, components, equipment, design and manufacturing process for surface mount electronics manufacturing. As an introductory course, it will provide the students with a strong foundation needed for advanced work in the surface mount technology (SMT). The laboratory demonstrations will provide the students an orientation and familiarization of the manufacturing equipment and process for printed circuit board assembly. **Class 4, Credit 4**

0617-856 Advanced Concepts in Electronics Packaging
This course provides an in-depth study of thermal, mechanical, material, manufacturing and reliability aspects of SMT and advanced packaging. The lecture topics will include design and manufacturing standards, thermal modeling and management, mechanical properties of materials, failure mechanisms, materials processing, high-density interconnection, advanced component packaging, technology trends, reliability testing, inspection. **Class 3, Lab 2, Credit 4**

0617-870 Manufacturing Automation Control
This course deals with the principles and application of programmable logic controllers (PLC). Topics include PLC hardware, programming and application of PLC's in a computer integrated manufacturing (CIM) environment. Students will also be exposed to man machine interface (MMI) and PLC networks. (Manufacturing Processes) **Class 3, Lab 2, Credit 4**

0617-896 Project Management in CIM
Interdisciplinary course covering project management in CIM. Students will study real-world problems that are related to manufacturing hardware or manufacturing processes and propose solutions to problems requiring an integrated approach. Topics include the identification and definition of the goal; strategy development; project planning; required resource estimation; project organization; proposal development; project approval; project staffing; team building; implementation of the project-managing scope, performance, schedule and resources; and project termination. (Completion of required courses in CIM curriculum) **Credit 4**

0617-897 MS Thesis
Interdisciplinary thesis on CIM or electronics packaging research area to be monitored and advised by committee of two faculty or one faculty with an industry representative. This thesis work may serve as the capstone course of the CIM degree. (Defense of thesis requires completion of all required courses.) **Credit 0–4**

0617-898 Graduate Seminar
Special Offering of advanced graduate level topics. These topics are developed and taught on a special offering basis and will vary from year to year. **Credit 1–4**

0617-899 Graduate Independent Study
Faculty directed study of appropriate topics on a tutorial basis. This course is generally used to allow an individual to pursue topics in depth under faculty sponsorship. **Credit 1–4**

0617-999 Manufacturing Graduate Co-op
Work experience in manufacturing position appropriate to selected major in graduate program. Position to be obtained through interviewing process with the assistance of Cooperative Education and Career Services Office. **Credit 0**

Computer Engineering Technology

0618-700 Introduction to Digital Electronics
An introductory course in digital electronics intended for K–12 technology teachers based on "Project Lead the Way" curriculum. Emphasis will be placed on both theoretical and practical skills needed to teach high school classes in this field. Laboratory assignments will include the computer simulation of circuits, the wiring of prototype circuits. The lecture will touch on the printed circuit board design and implementation of digital circuits. **Class 4, Lab 4, Credit 6**

Hospitality-Tourism Management

0624-770 Service Leadership Examining and Implementing Change
This is a capstone course that examines various personal and personnel leadership functions as applied to the delivery of service excellence. Current literature is used to explore the interrelationship of various conceptual paradigms. The goal is to enhance individual's understanding and to augment his or her ability to interact in the service environment, and to critically understand strategies founded in continuous learning, change and learning organizations. Concepts discussed include: relationship management, empowerment, team building, corporate culture and opportunity management. **Credit 4**

0624-825 Strategy Process of Service Firms
An analysis of the organizational structure, operational procedures, corporate policies, financial growth and related factors of service firms. The course traces the evolution of various companies to reveal individual growth strategies. Service discovery, building service relationships, and understanding service as experiences are necessary skills that will be learned and used. **Credit 4**

0624-826 Tourism Policy Analysis
An analysis of the goals and objectives for tourism development in geographic areas of different size. Topics include employment, income redistribution, cultural impact, labor supply and tourism resource base. Specific policies for touristic regions are compared for effectiveness and overall cost benefits. Local, state, national and international examples are included. **Credit 4**

0624-846 Travel Marketing Systems
Includes the identification of markets, product pricing strategies and mixes of communication as they relate to the tourism distribution system. The efficiencies of various channel configurations and their resultant organizational patterns are evaluated. **Credit 4**

0624-867 Tourism Planning and Development
Tourism planning defines the frames of reference used in making choices concerning the development of tourism facilities and use of space. Topics include: tourism income and expenditure; pricing policy; taxing authorities; ownership patterns; financing and leakage potentials of the various tourism infrastructures. This course focuses on the planning and development of tourism as it is "packaged" through its distribution channels. **Credit 4**

0624-890 Practicum in Hotel Training
An opportunity for the student to apply skills learned in previous courses in a work or laboratory setting. A proposal must be approved by the director of the program prior to enrolling in the course. **Variable credit 1–6**

0624-896 Graduate Project
This course number is used to fulfill the graduate paper requirement under the non-thesis option for the MS degree in hospitality/tourism management. The candidate must obtain the approval of the director of the program and, if necessary, an appropriate faculty member to supervise the paper before registering for this course. A formal written paper and an oral presentation of the project results are required. **Variable credit 1–3**

0624-898 Thesis
Thesis based on experimental evidence obtained by the candidate in an appropriate topic demonstrating the reduction of theory into practice. A formal written thesis and oral defense are required. The candidate must obtain the approval of the director of the program and, if necessary, an appropriate faculty member to guide the thesis before registering for the thesis. **Variable credit 1-6**

0624-899 Independent Study
An opportunity for the advanced student to undertake independent investigation in a special area under the guidance of a faculty member. A written proposal is to be forwarded to the sponsoring faculty member and approved by the director of the program prior to registering for this course. The independent study must seek to answer questions outside the scope of regular course work. **Variable credit 1–6**

Service Management

0625-750 Elements of Service Management: A Systems Approach
A general systems framework is used to explore the major components of service management using a variety of service sectors—health care, banking, insurance, real estate and hospitality-tourism. The course examines the interactions, interdependencies, and interactivity of service systems—to learn about the synergistic effects of the current changeable markets. In addition to this organizational focus above, the course begins the process of examining the learning organization from a professional and personal focus. Lastly, the course provides insights and practical applications to the evolving e-commerce environment and to lean service principles. **Credit 4**

0625-841 Benchmarking and Continuous Process Improvement
This course examines the benchmarking process as a means of achieving continuous service improvement. Among the topics discussed are proactive management, measuring performance, out-of-the-box thinking, internal, competitive, industry, and best-in-class benchmarking. The critical success factors at each stage of benchmarking in service industries are investigated. **Credit 4**

0625-842 Customer Relationship Management
The Customer Relationship Management (CRM) course develops the learners ability to help their organization manage its interactions with its customers across multiple channels, maximize revenue opportunities, build foundations to increase customer satisfaction and drive customer retention and loyalty. **Credit 4**

0625-843 Empowered Teams
This course focuses on the service organization's internal customers—the employee and middle management. It examines the prerequisites, transformation, and assumptions needed to decentralize the service firm and implement self-directed, empowered teams. Among the issues examined are accepting more responsibility for the service performance assuming accountability for customer satisfaction, and planning with the "customer-in" decision-making framework. **Credit 4**

0625-844 Breakthrough Thinking: Creativity and Innovation
Learning to solve problems, create profound decisions, and continuously change our organizations has always been a function of leadership. Today's fast-paced global business environment requires that we utilize equally insightful, aggressive, and distinctly new processes to change. This course examines the global phenomenon and builds in the learner new methods to achieve leadership in an age of change—breakthrough thinking, creativity, and innovation. The learner will become adept at true value innovation in a knowledge/service economy. **Credit 4**

0625-845 Relationship Management in Service Firms
This course examines the nature of managing the on-going relationships that characterize the service process. Relationships both internal and external to the organization are considered. Organizational implications of developing service recovery systems are also investigated. **Credit 4**

0625-846 Service Leadership Futures
This course changes each year as it evolves from students' interpretations of what it should entail. In general, students will gain the capacity to examine both current status and future route(s) of service industries. It is a first in a series of courses that will prepare career-minded individuals to function in our rapidly changing environment and, more important, in the future. The goal is to create leaders for tomorrow's service organizations and society. **Credit 4**

0625-849 Service Performance Metrics
This course examines the various self-assessment processes associated with improving service quality. The seven Malcolm Baldrige National Quality Award categories, the eight President's Award for Quality and Productivity categories (Federal Quality Institute), and the ISO 9000 categories are examined. These guidelines are oriented towards systems and are used to probe relationships that reach across departments and disciplines, with the goal of achieving and maintaining total quality service management. **Credit 4**

0625-896 Graduate Project
The course number is used to fulfill the graduate paper requirement under the non-thesis option for the MS degree in Service Management. The candidate must obtain the approval of the Graduate Coordinator and if necessary, an appropriate faculty member to supervise the paper before registering for this course. A formal written paper and an oral presentation of the project results are required. **Variable credit 1–4**

0625-898 Research Thesis
Thesis based on experimental evidence obtained by the candidate in an appropriate topic demonstrating the reduction of theory into practice. The candidate must obtain the approval of the Graduate Coordinator and if necessary, an appropriate faculty member to supervise the paper before registering for this course. A formal written paper and an oral presentation of the project results are required. **Variable credit 1–6**

0625-899 Independent Study
An opportunity for the advanced student to undertake independent investigation in a special area under the guidance of a faculty member. A written proposal is to be forwarded to the sponsoring faculty member and approved by the Graduate Coordinator prior to registering for this course. The independent study must seek to answer questions outside the scope of regular coursework. **Variable credit 1–6**

Human Resource Management

0626-701 Business Acumen
This course provides students will an understanding of how different business types create wealth and helps them build literacy in key business terms and concepts. Students in this course examine different business models, research industry trends, and explore the impact of human resource decisions on business strategy, costs and results. The course is designed for individuals in non-financial roles. It prepares them to collaborate effectively with senior leaders to make sound human capital decisions utilizing economic, financial, and organizational data. **Credit 4**

0626-702 Leveraging Technology
Knowledge of HR technology (how to leverage technology for HR practices and use e-HR/Web-based channels to deliver value to customers) has become and increasingly important competency for HR practitioners. As companies strive to reduce costs, improve performance, align employee development efforts with business strategy, and adapt more quickly to changes in the marketplace, literacy with technology becomes more essential. Students in the course review the effective application of technology to improving HR efficiency. They are given hands on experience with software tools ranging from performance management, assessment, and competency development to electronic job postings and employee self-serve. Students learn to collaborate effectively with IT professionals and senior executives to make technology-related decisions. **Credit 4**

0626-707 Applied Data Analysis
Explores statistical concepts and procedures as applied to typical human resource, training and career counseling situations. Participants apply a computer program to the analysis of data. **Credit 4**

0626-710 Theory of Organization Development
This course introduces the student to organization development theories and their application in an organizational setting. Consideration is given to the psychological, sociological, and historical constructs upon which the field is based. Students will be come familiar with the philosophical foundations for the key theories as well as the practical work of key theorists. This course will also examine how theories of organization development are being applied in organizations to foster change, innovation, and the revitalization of the organization. **Credit 4**

0626-720 Theories of Career Development
This course introduces students to traditional and emerging career development theory and its application to workplace issues. Theories such as trait and factor, type, developmental, psychodynamic, work adjustment, life span, social learning, and career decision-making are covered using a systems theory approach. Additional topics include organizational and strategic career development, application of theory to modern problems and issues, and contemporary issues in career development. The course is participative and draws heavily on case studies, role-playing, self assessment and group work to understand the theory and workplace application issues. **Credit 4**.

0626-730 Strategic Employee Development
This course provides individuals with a framework needed to successfully design learning interventions that drive performance improvements in their organizations. They examine adult learning principles and learning styles as well as best practices in organizational learning, employee development, and alternative delivery strategies. They identify how to link learning initiatives with corporate strategy and gain commitment to those initiatives from senior leaders. **Credit 4**

0626-732 Design Delivery of Training
Emphasizes the techniques used for design and development of instruction. During the course, participants design and training module, deliver a portion of it, and evaluate its success. (0626-730) **Credit 4**

0626-734 Global HR Practices
Global HR Practices is an elective course designed to increase the knowledge, skills, and effectiveness of HR professionals and managers working in international and multi-cultural settings. Topics include global strategy, the influence of culture, workforce staffing, compensation, training, business ethics, and legal and financial considerations. **Credit 4**

0626-735 Human Capital Strategies
This course examines how to develop a human capital strategy to acquire, retain, and engage the best available talent required for current and future success. It examines tools and techniques for human capital planning, sourcing, retention, and development. Students in this four-credit course examine benchmark practices from all industry types to derive effective strategies for their own organizations. They develop a human capital strategy and complete an integrated set of projects to implement selected components of the strategy. **Credit 4**

0626-780 Human Resource Management I
Suitable for managers as well as human resource staff, this course examines the formal systems in an organization which ensure the effective and efficient use of human talent to accomplish organizational goals. Major topics include job analysis, job descriptions, employee recruitment employee selection, and performance management. **Credit 4**

0626-781 Human Resource Management II
The bottom-line business of human resources must be the delivery and or development of human capital that enable the enterprise to become more competitive, to operate for maximum effectiveness, and to execute its business strategies effectively. HR embodies organizational programs and processes that can enhance individual competencies and organizational capabilities. This course will prepare individuals to evaluate HR programs/processes and redesign these to meet the changing needs of the organization. **Credit 4**

0626-782 Human Performance Management Practices
This course focuses on Human Performance Management, or the effective use of human resources in order to enhance organizational performance and drive business results. The elements necessary to become a "high performance" organization and the unique role of the HR professional in performance management are important elements of study. Students in the course explore a range of human resource management practices that are drawn from many disciplines including, behavioral psychology, instructional systems design, organizational development, and human resources management. They learn to design and manage a variety of performance management interventions and work collaboratively with managers and employees. **Credit 4**

0626-850 Special Projects
Provides for designing and carrying out a project for academic credit. Proposals approved by a supervising faculty member and the department director are required prior to registration. This course may be taken more than once, but for no more than a total of 6 credit hours. **Credit variable 1–4**

0626-877 Internship
The internship is required of all students. This course consists of four parts: at least 200 hours of professional accomplishments in an appropriate setting, attendance at a seminar, an oral presentation and formal summary report. Students will work with their advisors to complete all necessary arrangements. Students should plan to meet with their advisors at least two months before planning to take the internship. Proposals for the internship must be approved and on file before registration. **Credit 1–6**

0626-890 Independent Study
Provides for independent study or research activity in subject matter areas not included in any existing course in the degree program, but having specialized value to students. Proposals approved by a supervising faculty member and the program chairperson are required prior to registration. This course may be taken more than once, but for no more than a total of 6 credit hours. **Credit 1–6**

0626-891 Selected Topics
Selected Topics are innovative courses not reflected in the curriculum. Titles will appear in the course listing each quarter. The course may be taken more than once as topics change. **Credit 4**

0626-893 Facilitation Skills
Emphasizes the techniques used for design and development of instruction. During the course, participants design a training module, deliver a portion of it, and evaluate its success. (0626-730) **Credit 4**

Environmental, Health and Safety

0630-710 Special Topics
This course permits students to pursue certain advanced undergraduate course work at a graduate level. Examples include contaminant hydrology, wetland delineation and remedial investigation/corrective action. **Credit 1–4**

0630-711 Occupational Health
This is an intensive foundation course that provides students with an overview of the fundamentals of Industrial Hygiene. Emphasis will be placed on a) the toxicological effects of various industrial substances on the body; b) monitoring and personal sampling for these substances and c) personal protection against such substances. (Graduate students who have completed Biology 1004-212 or 1101-201 and Chemistry 1011-208 or 1011-211 or by permission of Department. Students who have completed 0630-450, 451 or 0630-610 may not take this course.) **Class 4, Credit 4**

0630-712 Occupational Safety
This course is an overview of the safety management tools utilized in today's industry. Students are expected to have a foundational knowledge of safety management techniques upon completion of this course. Topics examined include recordability and safety indices; incident investigation; guarding; electrical and material handling; welding, fire prevention; excavation; medical surveillance and worker's compensation; inspection and techniques and auditing; committees; incentives, and voluntary programs. Students will be required to research a leading edge safety topic. (No prerequisites. Open to all graduate students. Students who have completed 0630-454 or 0630-611 may not take this course.) **Class 4, Credit 4**

0630-713 Solid and Hazard Waste Management
This is an intensive foundation course for students who lack academic preparation or practical experience in solid and hazardous waste management. Introduces principles, strategies, technologies and regulations for reducing, recycling, handling, treating, storing and disposing of solid and hazardous waste. (Permission of department. Students who have completed 0630-350 or 0630-620 may not take this course.) **Class 4, Credit 4**

0630-714 Industrial Wastewater Management
This is an intensive foundation course for students who lack academic preparation or practical experience in wastewater management. Identifies and characterizes the sources of industrial wastewater and examines the related environmental impacts, regulatory implications, and technical and cost considerations of treatment and disposal methodologies. Open to all graduate students. Students who have completed 0630-352 or 0630-622 may not take this course. (1011-211 or permission of instructor) **Class 4, Credit 4**

0630-715 Air Emissions Management
This intensive foundation course will present an overview of industrial air emissions management. The course will teach students how to identify and categorize industrial air pollutants and their sources. Applicable state and federal laws and regulations will be covered. Air emissions reduction strategies will be covered, along with control technologies, testing, monitoring, and reporting requirements. By the end of the course, students will be able develop a comprehensive facility air emissions management plan. Students who have completed 0630-354 or 0630-622 may not take this course. **Class 4, Credit 4**

0630-720 Environmental Health and Safety Management
This course presents an overview of environmental, health and safety management, and provides students with an introduction to management systems for EHS operations. Explores the motivations and strategies for environmental, health and safety management, identifies EHS management components and presents the fundamentals of developing EHS visions and policies. This course includes an on campus executive leader session. **Credit 4**, **Credit 4**

0630-725 EHS Accounting and Finance
Pollution and accidents impose costs-not just remedial costs, but also time, lost opportunities, long term liabilities and even company image. These costs are often overlooked by current accounting practices. This course will train students to make good business decisions when all the EHS costs of economic decision, as well as the economic of EHS decisions, are taken in consideration. The course will focus on decisions made at the company level. Methods will be taught to identify and quantify the full-costs of projects and activities. A more accurate approach towards EHS accounting will result in a safer environment and increased competitiveness. **Class 4, Credit 4**

0630-735 Resource Reduction
This course will focus on strategies for reducing the use of materials, energy and environmental resources. It builds upon courses for controlling air emissions, wastewater and solid and hazardous waste and moves upstream into the production process to reduce or eliminate waste by not producing it in the first place. Students learn how to conduct resource reduction assessments and identify opportunities to reduce or conserve resources. This course will take you beyond end-of-pipe controls and look at life-cycle assessment as an environmental management tool. **Class 4, Credit 4**

0630-740 EHS Management System Design
This course examines the design and development of environmental, health and safety management systems to implement an organization's vision, mission and policies. Provides strategies for determining what needs to be measured in order to assess performance and ensure continual improvement. Discusses metrics and EHS management system intervention; significant team project work as well as individual work (0630-720 or permission of instructor) **Class 4, Credit 4**

0630-750 EHS Project Management
This course focuses on unique factors in environmental, health and safety project management. It covers the nine major areas of project management: integration, scope, time, cost, quality, human resources, communication, risk and procurement. Discusses modern project management techniques, including program evaluation and review techniques (PERT), critical path method (CPM), and various budgeting and resource allocation techniques. Includes an introduction to Microsoft Project for Windows software. Applies project management concepts and software to simulated EHS projects. **Class 4, Credit 4**

0630-760 Integrating EHS into Business Management
This course examines strategies for integrating EHS systems and processes into business management. Using case studies, the course explores the interrelationships between EHS and total quality management, reporting, financial value, and approaches for sustainable business development. Students will be prepared to select appropriate quality tools to improve EHS processes; identify opportunities, strategies and tools for integrating EHS into business management; and identify best practices in EHS/business integration. (0630-720 or permission of the instructor) **Credit 4, Credit 4**

0630-765 Product Stewardship
This course examines the principles of product stewardship. The ethical, legal, liability and economic issues which product manufacturers face will be covered. In addition, students will be exposed to the methods used to identify and manage product environmental, health and safety (EHS) in today's world. The concept of sustainability will be covered and students will learn the principles of product life cycle assessment. Students will also learn and use specific EHS analysis techniques. Case studies will also be reviewed and students will complete a group or individual capstone project. This course is open to all graduate engineering technology, packaging, and environmental, health and safety management students or with permission of the instructor. **Class 4, Credit 4**

0630-770 Risk Assessment Management Communication
This course presents an overview of risk assessment methodologies and history, along with current practices and developing trends. It takes a close look at strategies for reducing and managing EHS risks, and provides an introduction to the elements of internal and external risk communication. Students will gain skills in evaluating risk assessment and identifying associated strengths and weaknesses with respect to the EHS management needs of their respective organizations. They will be prepared to design and implement risk reduction and management plans for EHS-related activities and is able to identify essential risk-related elements that need to be communicated internally and externally. (0630-720 and course work in occupational health or permission of instructor) **Class 4, Credit 4**

0630-780 Practical EHS Law
This course provides a detailed examination of the EHS legal and regulatory framework, with emphasis on developing compliance strategies. It addresses strategies for advocating and negotiating flexible permits, enforcement matters and other legal requirements. Students will be prepared to discern the intent and applicability of EHS laws and regulations, prepare summary documents incorporating legal concerns and concepts, understand different approaches to negotiations, and work effectively with attorneys to achieve desired objectives. (0630-720 or permission of instructor) **Class 4, Credit 4**

0630-790 EHS Internal Auditing
This course addresses establishing and maintaining EHS auditing systems to examine how environmental, health and safety aspects are being managed relative to voluntary and regulatory standards. Students will be prepared to design, implement and evaluate auditing programs, and will practice auditing skills. This course includes an Executive Leader session. (0630-740 and all required foundation courses, or permission of instructor) **Class 4, Credit 4**

0630-799 Independent Study
Students will have the opportunity to pursue relevant environmental, health and safety topics related to their work or professional interests at an advanced level. Students will gain added depth and/or specialized skill in a specific EHS area. **Credit 1–4**

0630-810 Special Topics
This course discusses new and developing EHS topics in selected areas, such as Workers Compensation, environmental economics, incident management, design for the environment, life-cycle assessment, industrial hygiene monitoring and measurement, regulatory strategy and compliance alternatives. **Credit 1–4**

0630-999 **Graduate Co-op**
Students will have the opportunity to gain appropriate work experience and applied knowledge of the profession working in one or more EHS areas. The graduate committee determines whether enrollment for one or more co-op quarters will be required. **Credit 0**

0630-890 **Graduate Project/Thesis Plan**
This is the first of a two-course sequence in which each EHS Management graduate student will design and conduct graduate thesis research or a graduate project. In this course graduate students will rigorously develop their research or graduate project ideas, conduct literature reviews, prepare bibliographies, identify and plan methodologies, identify deliverables, prepare schedules, become familiar with report formats and the proper use of literary guides, and gain a clear understanding of the expectations of the faculty and the discipline. Each student will be required to prepare a complete committee approved thesis research or graduate project as a final requirement of this course. **Credit 2**

0630-891 **Graduate Project**
Graduate projects are an applied research project, reflecting the student's ability to utilize professional skills to design, develop and/or evaluate a project and/or management decision. A formal written paper, and/or a draft article suitable for publication in an appropriate journal and an oral presentation are required. (Permission of advisor) **Credit 1–4**

0630-899 **Graduate Thesis**
The graduate thesis is a formal research document that empirically relates theory with practice. A formal written thesis and oral defense are required. (0630-890) **Credit 1–4**

Facility Management

0632-700 **Principles and Practice in Facility Management**
This course presents the overall practical methodology of facility management including organizational, managerial, ethical, and legal principles for the delivery of facility services. Topics discussed include: relationship, between the facility unit and the overall corporate structure; history of FM; regulatory and legal issues; corporate culture; contracts; purchasing and procurement; and management of projects and personnel. **Class 4, Credit 4**

0632-720 **Environmental Health and Safety Management for Facility Management**
According to the International Facility Management Association the primary goal of facility managers is the management of safe, humane and functional work environments in the context of sound ecological practices. This course will provide students with a solid foundation in environmental, health and safety management which will enhance their ability to develop and implement practices that promote and protect health, safety, security, the quality of work life, the environment and organizational effectiveness pertaining to facilities. Topics examined include: EHS moral, legal and economic issues, EHS related laws and regulations (OSHA, EPA, ADA), principles of accident causation and prevention, EHS management systems, fire protection and life safety codes, emergency preparedness, ergonomics, indoor air quality, mold, solid and hazardous waste, recycling, sustainable design, other environmental related issues, environmental psychology and impacts of facilities on individual, group and organizational performance, comfort and satisfaction. (This course is open to all facilities management graduate students or by permission of department.) **Class 4, Credit 4**

0632-760 **Space Planning in Facility Management**
This course provides the technical and strategic tools for space planning in a facility. Topics such as knowledge of long range planning, organization of sites/structures/interiors, building types, cost estimating techniques, contracts and specifications, construction management and documentation, and relocation management will be covered. **Class 4, Credit 4**

0632-800 **Operation and Maintenance I**
This is a first course in operations and maintenance of facilities and provides a basic understanding of the physical plant. Students will learn about common systems within facilities including HVAC, communications, building's structural components, and exterior elements. **Class 4, Credit 4**

0632-810 **Operation and Maintenance II**
This is the second course in the O&M sequence and involves the activities and functions that support the facility. **Class 4, Credit 4**

0632-830 **Real Estate of Facilities**
Managing Property assets as an investment and profit center is an important aspect of facility management. Emphasis will be placed on: real estate master planning; properly acquisition and disposal; leasing practices and management; real estate marketing and analysis; feasibility analysis; taxation; real estate finance; urban planning and development; site evaluation and selection; occupancy and use constraints; regulations and incentives. **Class 4, Credit 4**

0632-850 **Digital Communication and Analysis Tools in Facility Management**
Information Technology systems are critical to supporting an organization's business. This course will clover the basic logistical requirements for operating and supporting local area networks as well as internet connections, digital security, common application software, and CAD systems. In addition, instruction will be provided on FM software for energy management, project management, asset management, and space planning. **Class 4, Credit 4**

0630-891 **Graduate Project**
Graduate projects are an applied research project, reflecting the student's ability to utilize professional skills to design, develop and/or evaluate a project and/or management decision. A formal written paper, and/or a draft article suitable for publication in an appropriate journal and an oral presentation are required. (Permission of advisor) **Credit 1–4**

Environmental Health and Safety

0633-712 **Fire Protection**
This course introduces fundamentals concepts in protection of industrial workers and property from fire and explosion. Fire chemistry, control of ignition sources in industry, and properties of combustible materials are discussed. A major facility review project is completed. Fire detection and extinguishments are covered along with building construction for fire prevention, life safety, fire codes and related topics. (EHS graduate students or engineering technology, industrial engineering graduate students only) **Class 4, Credit 4**

0633-726 **Occupational Health II**
This course focuses on industrial hygiene applications and hands on participation. Particular attention will be given to sampling strategies from similar exposure grouping, actual sampling experiences with a wide range of industrial hygiene instruments, and sampling analysis using statistical protocols. Field experience with instrumentation, as well as professional written and oral communication of results is emphasized. There are several out of classroom learning experiences required (team based). This course also explores environmental health engineering applications including ventilation systems, process safety and inspection/audit protocol skill building for many different types of processes, including: laboratories, machining centers, painting and solvent usage. This course culminates in a one week block of emerging issues in occupational health—the content of which is expected to change. **Class 4, Credit 4**

0633-730 **Mechanical and Electrical Controls and Standards**
Discussion of machinery safety with emphasis on hazard analysis, risk estimation, safeguarding techniques and electrical considerations. Particular attention will be paid to applicable OSHA regulations, ANSI, NFPA and EN standards as they relate to wood, metal, films and automation. A portion of the course will change regularly to reflect emerging issues in industry. (EHS graduate students or engineering technology, industrial engineering graduate students only.) **Class 4, Credit 4**

Health Systems Administration

0635-715 **Information Systems in Health Administration**
Theory and use of computers and information systems in health care delivery and administration is covered in depth. The information needs of clinical and administrative personnel are examined with an emphasis on developing and evaluating comprehensive information systems for health care organizations. **Credit 4**

0635-716 **Law Policy Senior Retirement Living Options**
Retirement living in the United States has evolved to be a significant industry. Legislation and regulations govern the continuum of care for the independent as well as corporate organizations that provide senior living. The purpose of this course is to review the federal and state regulations governing senior retirement living, discussion of senior living models and the leadership requirements to operate and manage such facilities. **Credit 4**

0635-752 **Clinical Information Systems**
This course will present an overview of several of the evolving clinical information systems present in the healthcare marketplace. A sampling of computerized systems including those

found in the hospital, payer, nursing home, physician office, and other healthcare settings will be explored. Emphasis will be placed on the understanding of the changes involved in transitioning from manual systems to computerized systems in each of the above named areas. In particular, the student will be exposed to a variety of current technologies, which are being deployed in these areas. The benefits of the use of such technology will be analyzed and the requirements for planning and deployment of such systems will also be studied. (Health care information systems 0635-715-90, introductory technology/systems course or relevant experience. Computer systems hardware and software in health care recommended). **Credit 4**

0635-753 Health Administration Applications
This course presents an overview of the various types of application used in the health administration arena. Emphasis will be placed on understanding the terminology and functionality of the basic software components that make collect and utilize health care data for administrative support and decision-making as well as insurance, billing and reimbursement. Students will examine the software infrastructure needed to support health care enterprises such as hospitals and smaller health care entities. The goal of this course is to provide students with a sufficient application familiarity so they can make meaningful IT and IT decisions. **Class 4, Credit 4**

0635-754 Ehealth
This course will give students a broad overview of essential concepts in, and applications of, web based technologies in healthcare. EHealth topics covered will include review, discuss and analyze industry trends explore emerging ECare solutions and investigate EHealth ethical guidelines and governmental regulations established to ensure privacy, standardization and health content reputability. **Credit 4**

0635-777 Health System Administration Internship
This is a health systems administration internship. Consists of a professional placement in an appropriate health care organization of at least 240 hours. Required for students without health care work experience. Can be taken in place of electives. Students will arrange with their program chair or assigned adviser, negotiate any arrangement necessary for on-site supervision and develop a written proposal. Students will present an oral evaluation of their experiences at the final course seminar. **Variable credit 2–8**

0635-796 Risk Management in Health Systems
This course identifies the risk inherent within health care- institutions, organizations, agencies and for individual providers. The management of risk is explored as part of a strategic response of an organization or individual within health care. Specifically the risk inherent within health care organizations; in communications and sharing of data; in the embracing of new technologies and drug treatment therapies; and the expectations of corporate compliance will be discussed. The role of quality assurance will be reviewed as a strategy to control risk. **Credit 4**

0635-797 Strategies Health Systems Accountability
Consumers, the government and the third party payers have developed numerous strategies to try to hold health care systems accountable for performance and utilization of best practices. Financial reimbursement is often directly linked to compliance to these strategies. This course will discuss the current status of health care in America, review the strength and weaknesses of the system and what a redesigned health care model should hope to accomplish. A determination of accountability strategies for each interest group will be reviewed with a study of their unique financial and operational implications upon the health care system. Each analysis will include a discussion of what could be done to make these strategies work in the new model of health care. **Credit 4**

0635-798 Special Topics
Experimental courses are offered under this number; Titles appear in each quarter's course listing. **Credit 1–5**

0635-810 Health Systems Administration
The development, structure and current forces transforming the health care system will be considered. Topics will include the status of the national and regional populations; manpower issues; hospital services; ambulatory care and alternative delivery systems; and mental health; long-term care. Administration in health care facilities including roles, functions, and responsibilities; organizational design and structures; problem solving; motivation; communication; leadership; change; human resources; and health care practices focusing on patient care and education. (0635-730) **Credit 4**

0635-815 Finance for Operation
This course is an introductory course that examines the responsibilities of the finance function in health care entities and its relations to the operating responsible centers (or departments). Subject matter is broad enough to include both not-for-profit and for profit organizations in the allied health field. While this is a distance learning course, students are invited to participate in the first two on-campus lectures (attendance is optional, and those not attending will receive a videotape of the campus sessions). Topics include terminology and measurement, cost finding and allocation, budgeting and the budgeting process, report, reimbursement, interpretation of financial statements, and facilities and materials management. Students must be matriculated in the health systems masters program or have permission of the department chairperson. **Credit 4**

0635-820 Health Systems Economics and Finance
Investigation of the efficiency, effectiveness and equity of the economics of health care and a conceptual and practical knowledge of health care finance. Reviews sources of funding, the accounting and reporting process, and the influence of third-party payers on the provision of health care through applied exercises. Provides an integrated overview of managerial economics, financial management, and product management for distinct health care organizations composing the overall health care system. (Accounting Concepts for Managers) **Credit 4**

0635-830 Health Systems Planning
A review of the methodology of planning effectively for health care systems. The use of data systems, forecasting, and identifying and analyzing problems is explored, along with the process of strategic planning, setting priorities, developing projects, and allocating resources. Students will prepare actual business plans and applications for new health care programs to regulatory agencies. (Permission of program chair) **Credit 4**

0635-840 Health Systems Policy and Law
An examination of the roles and responsibilities of policy makers on the health care system. Compares and contrasts the regulatory functions of varying levels of government and the political process as it relates to health care systems. Examination of control issues and regulatory dynamics, the legislative process, and regulatory trends in the United States. Assessment of health systems' strategies and responses to regulatory oversight. An overview of legislation as it applies to health facilities and administrative law using case studies. **Credit 4**

0635-876 Health Systems Issues
This is the health systems administration research project capstone course, required for all graduate majors. Students will research and discuss contemporary issues of health care delivery and management. Course work from the program will be integrated by the instructor in order to reinforce a systems approach to health care administration. An original research project, which utilizes a systems approach to health care delivery or administration and culminates in a written report, is required. (Permission of program chair) **Credit 4**

0635-881 Health Insurance Reimbursement
An in-depth look at characteristics of successful managed care plans. The course will familiarize the student with all essential elements of managed care, using the tools needed to model and compare various managed care structures. **Credit 4**

0635-882 Bioethics
An overview of what ethics means, the principal ethical theories, and their application to specific bioethical issues. The course will familiarize students with ethics and ethical principles, the role of ethics in professional life, what is bioethics and an appreciation of ethical issues and arguments surrounding contemporary bioethical issues such as death, rationing health care and managed care. **Credit 4**

0635-890 Health Systems Administration Independent Study
Provides for independent study or research activity in subject areas not included in any existing course in the degree program, but having special value to students. Proposals approved by a supervising faculty member and the program chair are required prior to registration. This course may be taken more than once. **Variable Credit 4–8**

0635-896 Health Systems Administration Thesis
An independent research project on a specific health system administration topic or problem, developed by the student with input from a faculty thesis adviser. The research must culminate in a formal written thesis and oral defense. Approval by the program chair and a faculty thesis adviser is required for this course. **Variable Credit 4–8**

Project Management

0681-710 Introduction to Project Management
Addresses project management from a multidisciplinary perspective, covering the fundamental nature of managing a broad range of projects public, business, engineering, manufacturing, medical, non-profit, and information systems-as well as techniques required to manage specific types of projects. Topics include Project Environment, Planning, Conflict & Negotiation, Budgeting, Scheduling, Resource Allocation, Monitoring and Controlling, and Project Termination. Addresses the unique and demanding role of the project manager, the challenges of cross-cultural projects, and the behavioral and quantitative facets of project management. Introduces the major areas of the Project Management Body of Knowledge (PMBOK) as defined by the Project Management Institute. (Introductory course(s) in management, college-level business math, and computer, network, and internet environments; Equivalent experience or instructor permission.) **Credit 4**

0681-711 Advanced Project Management
Course covers the advanced project management topics necessary for implementation of and excellence in project management. Deals with turning the principles and theory of project management into practice. Addresses the best practices for project management in the world; project portfolio management; the project office; project risk management; multinational cultures and cultural failures; integrated project teams; and virtual project teams. Incorporates aspects of the Project Management Body of Knowledge (PMBOK). (Introduction to Project Management 0681-710; or equivalent experience; or by permission of the instructor) **Credit 4**

0681-712 International Project Management
With the increasing frequency of globalization, mergers, and acquisitions, international projects are becoming more prevalent and approaching the norm for many organizations. This course addresses a wide range of international projects-based in different industries and multiple countries. Deals with cultural and social differences within firms; cultural and social differences among countries and within countries; languages and dialect variations; different management practices and structures; religious practices; legal, regulatory, and reporting requirements; technology differences in different areas; and time zone differences. Incorporates aspects of the Project Management Body of Knowledge (PMBOK). (Introduction to Project Management 0681-710 and Advanced Project Management 0681 711; or equivalent experience; or permission of the instructor) **Credit 4**

Quality Management

0684-780 Introduction to Asset Management
Unscheduled downtime costs businesses millions of dollars each year, but asset management and maintenance is often the last area to attract the attention of managers trying to lower costs. Usually thought of as non-value-added, maintenance and asset management policies can have significant impact on a company's profit. This course introduces the student to the wide range of policies and practices, including capital budget issues related to asset acquisition, cost of ownership, and depreciation; inventory/procurement; maintenance policies such as run-to-failure, preventive maintenance, and reliability centered maintenance; training issues; and developing performance indicators for management programs. Co-listed with 0684-480 Note: Students may not receive credit for both 0684-480 and 0684-780. This is an online course. **Credit 4**

Global Sourcing

0685-700 Issues in Strategic Sourcing-Government Military
As business increasingly engage in international purchasing and manufacturing, unique problems and opportunities arise in government and military sourcing. In this course, students explore the scope of sourcing in the government and military, relevant policies and regulations, the impact of privatization, and critical homeland security/national interest issues in resource management. **Credit 4**

0685-701 Strategic Sourcing Across the Enterprise
Increasingly, businesses are embracing a broader view of sourcing that reaches beyond the plant floor. This course introduces new research and approaches in strategic sourcing intended to maximize profitability throughout the enterprise. Topics also include information and data management problems, decision analysis, outsourcing, and approaches in virtual and geographically distributed enterprises. **Credit 4**

0685-702 Global Sourcing, Ethics, and Contracts
This introductory course in global sourcing discusses issues in contract negotiation, foreign trade practices, and the moral dilemmas stemming from the conflicts between cultural norms, legal standards, and mores and western business practice, law, and ethics. Topics include vendor analysis and selection; the strategic sourcing continuum; establishing and maintaining effective business contracts; and monitoring contract compliance. Includes discussions on international law as it relates to business contracts. **Credit 4**

Technical Communication

0688-711 Technical Information Design
Intensive practice in the creation of content for online and multimedia documents with emphasis on the presentation of technical and scientific concepts, products, and processes. A survey of graphic methods for the display of complex technical relationships and ideas. Students will also explore contemporary topics (international technical communication, the future of on-line documentation, ethical considerations in technical information design, etc.) and applications (legal, medical, electronics, environmental, etc.) in Technical Information Design. (0688-333 or equivalent, or permission of instructor) **Credit 4**

0688-712 Advanced Photoshop Techniques
This course offers a strategic view of the Photoshop/digital imaging work environment, with an emphasis on preparing high-quality images for print. Instead of specific tools, it will focus on broader techniques and strategies with an emphasis on preparing high-quality images for publication. Topics such as image correction, color models, file formats and additional image types such as duotones will be discussed in detail. **Credit 3**

0688-713 Introduction to XML
This course provides an introduction to XML (Extensible Markup Language) and its applications in information management and a variety of fields. Students will learn how to use this flexible text format that is playing an increasingly important role in the exchange of a wide variety of data on the Web and elsewhere. Programming experience is not required for this course. **Credit 3**

0688-714 Science Writing
Students learn the special requirements for gathering information and writing articles about changes and new developments in the world of science. Students look at contemporary outlets for science writing, read and study examples of science journalism from a variety of fields and prepare a feature length science article. Class articles are published in an on-line journal. **Credit 4**

0688-716 Design Non-traditional Learning Programs
High performance workplace is more than a buzzword in today's organizations; it is the key to viability in the global marketplace. Instructional design professionals must be able to help organizations improve performance without taking employees away from revenue generation activities. The four-credit course examines the development of non-traditional learning programs and tools that drive performance, such as special project assignments, job shadowing, and hiring criteria. Students in the course learn to identify effective non-training interventions and design useful tools and materials to support performance improvements. (0626-730 Strategic Employee Development (equivalent experience or courseware) and 0688-750 Performance-based Training Design) This course is offered only online. **Credit 4**

0688-717 Designing Interactive Training
As employers become more focused on the need to engage employees to order to improve retention and increase productivity, learning strategies for employee development must model engagement. Employers and employees are seeking well designed, engaging learning programs that link to corporate strategies. This four-credit course examines how to use games, simulations, cases, and other learning experiences to create an interactive, job-relevant training program. Students in the course practice developing learning activities that engage adults, drive learning objectives, and that can be effectively replicated by any number of trainers and across a variety of delivery mechanisms. (0626-730 Strategic Employee Development (or equivalent experience or courseware) and 0688-750 Performance-based Training Design). This course is offered in both traditional and blended modes. **Credit 4**

0688-718 Designing On-the-Job Training
Research has shown that adults learn best and retain the most when are actively engaged in the task they must master. Traditional approaches to training set up an environment where adults are shown and told what to do. An on-the-job approach to training shortens overall training time and helps new employees get productive sooner. This four-credit course focuses on creating training materials to support on-the-job training of technical tasks. Students in the course learn to write job aids and create training modules that any job expert can use to effectively train peers. They practice writing clear instructions and documenting critical job knowledge. (0626-730 Strategic Employee Development (or equivalent experience or courseware) and 0688-7xx Performance-Based Training Design) This course is offered in both traditional and on-line modes. **Credit 4**

0688-721 Creating Technical Proposals
The elements of proposal writing, including responsiveness, establishing credibility, and technical clarity, The proposal process as practiced in government and industry, including an understanding of RFPs, RFIs and the decision process. Specialized proposals including NDAs, on-line and multimedia proposals and technical marketing presentations. (0688-333 or equivalent or permission of instructor) **Credit 4**

0688-731 Technical Procedures
Development of task-oriented and process and documentation. Procedures for complex physical and mental tasks including tine-constrained activities, emergencies, diagnostics and troubleshooting, and multiple-path processes. Formats for print, electronic, and multimedia instructions. An introduction to the creation of online help including Web-delivered and HTML help. (688-333 or equivalent or permission of instructor) **Credit 4**

0688-732 Managing Technical and Scientific Communications
Course covers the management of technical and scientific communication projects and organizations, including managerial roles, practices, and responsibilities as well as management strategies for content and audience evolution. Covers management of parallel (print and online) projects, single-sourcing, and documentation localization; technological factors in the production and distribution of technical documentation; and consideration of career options and independent contracting. (Technical Writing and Editing 0688-333 or equivalent or permission of the instructor) **Credit 4**

0688-741 Usability Design and Test
The elements of successful electronic and print document design. The use of design concepts and tools to increase usability. Introduction to information mapping. Design and usability test considerations for multi-media and user-centered media. (0688-333 or equivalent or permission of instructor) **Credit 4**

0688-750 Performance-based Training
This course provides individuals with the tools needed to develop performance-based, instructor-led learning programs. Students learn techniques to assess performance needs, identify learning gaps, analyze job tasks, write performance-based learning objectives, design learning modules, benchmark content, and test learner comprehension. The course provides the opportunity to complete an actual work-related learning module as an alternative to a case-based module. Students will determine the need to build or buy training, complete the plan phase for project management, how to source effective training to meet given objectives, and tools to communicate with and assess effectiveness of suppliers. Offered only in on-line format. This course is co-listed with 0688-476 Instructional Design Principles; students taking 0688-476 may not receive credit for 0688-750. (0626-730 Strategic Employee Development) **Credit 4**

Math and Science

0692-700 Applied Data Mining
This course is intended to provide students with the knowledge and expertise to leverage data mining's strengths in various domains. The course will cover the data mining methodology, data cleaning and preparation, unsupervised learning algorithms, supervised learning algorithms, new research in the field, and ethical/privacy issues. The focus is on applying data mining methods to a variety of fields; no computer programming experience is necessary. Students should have a computer capable of running Java-based programs and will make extensive use of an open-source data mining application. (Basic statistics and computer literacy, or permission of instructor) **Credit 4**

0693-701 Introduction to Geographic Information Systems
This course will introduce students to the world of Geographic Information Systems (GIS). Course readings lectures and labs cover a mix of practical and technical GIS topics including: fundamental GIS concepts, ArcGIS software competency, spatial data and spatial analysis fundamentals, and cartography. This course is co-listed with 0693-401 and my not be taken for graduate level credit if the student has earned credit for 0693-401 **Credit 4**

Security Technology

0696-700 Security Technology Management
This four-credit course examines security threats and technologies, associated R&D processes and relationships among technology developers, and numerous management concerns pertaining to the adoption, implementation and utilization of security enhancing technologies throughout society. **Credit 4**

0696-701 Security Technology Policy, Law and Ethic
This course will introduce the ethical component of security policies and practices especially those involving security systems, tools and related technologies. Within this general framework several specialized topics are addressed including: scientific misconduct in security technology R&D, regulation construction and ethical enforcement practices, reasonable expectations of privacy established in case law rulings, abusive/illegal use of security technologies, causes of personal and vicarious civil liability, and links between personal integrity and professional ethics. **Credit 4**

0696-702 Managing Critical Infrastructure Threats CII
The course explores economic, political, cultural, organizational and technological factors underlying information security threats, conflicts, competitions, and response capabilities, and how these may compromise national, organizational and personal security. (Security Technology Management or with permission of instructor) **Credit 4**

0696-703 Security Enhancement - Environ Design
This course will provide students with an understanding of the integration of technology into security designs. Physical barriers, locks, lighting, alarm, and CCTV systems are just of few of the many relatively low-to-high technologies that will be addressed with regard to public and private facilities, landscaping and architecture planning. (Security Technology Management or with permission of instructor) **Credit 4**

0696-704 Internal Organizational Security Management
This course provides an essential overview of internal security theory, fundamentals, laws, regulations and best investigative practices with an emphasis on innovative tools and methods now available to enhance internal security functions in all types of organizations. (Security Technology Management or with permission of instructor) **Credit 4**

0697-701 Psychology of Terrorism
This course provides a brief background of terrorist groups and leads into the psychological aspects of terrorism and terrorists themselves. By examining who becomes a terrorist and why, a better understanding of terrorism as a whole can be formed. In addition, this course will examine the psychological effects of terrorism and their reproductions through the media and the public. (Permission of instructor) **Credit 4**

Cross–Disciplinary Studies

0697-702 Examining Terrorist Groups
To give students a broad understanding of terrorist groups from a variety of cultures and backgrounds, their motivations, and operating procedures so that the bio threat posed may be accurately assessed. Students will study the history of known organized terrorist activity, including study of common cultural historical correlations, and groups' modus operandi. The latest developments in terrorist profiling will also be discussed. (Permission of the instructor) **Credit 4**

0697-703 Economics of Political Violence
Terrorist groups have successfully financed their terrorist activities through illegal means such as criminal activities, the heroin market, or the black market. While not ignoring their religious, political, and ideological motives, the course will focus on the economics of modern terrorist groups. An overview of the financial and economic aspects of political violence and terrorism, this course provides students with a closer look into terrorist financing, vulnerabilities and openness of the global financial networks, and economies of violence. Economics of Political Violence offers global and strategic approaches to fighting political violence through information economies, media, and soft power. Students will undertake short research projects as well as engage in small group activities and in-class presentations. (Permission of instructor) **Credit 4**

0697-710 Toxin Chemical Weapons Threat and Defense
This course will introduce students to the toxins secreted by bacteria and fungi, as well as marine, venom and plant toxins. Chemical weapons and regulatory peptides will also be discussed. Lectures will include the structure of each toxin type and the mechanism of action of each, as well as various aspects of protection against toxin and chemical weapons. **Lecture 4, Credit 4**

0697-711 Intelligence Analysis
This overview will encompass analytical methodologies, direct and indirect challenges, the various types, categories, and modalities, tactical vs. strategic issues, information sources, customers, clients, and policymakers, and current issues in the intelligence field. Students will undertake short research projects as well as engage in small group activities and in-class presentations. During the quarter guest speakers will be invited to present their particular expertise on key issues. **Class 4, Credit 4**

0697-712 Bacterial and Viral Weapons Threat Defense
This overview will introduce student to those bacteria that are potential agents of bioterrorism. Lecture topics will include the metabolism, virulence factors, physiology, immunology, and genetics of these agents, as well as the pathology and prevention of disease. **Class 4, Credit 4**

0697-713 Radiological Threats and Defense
We are all well aware of the threat that terrorist groups will use radiological weapons against us or our allies, yet the effects of these weapons is not well known. Mitigation and defense measures are equally poorly understood. In this class, students will learn the basics of radiation science, the characteristics and risks posed by radiological terrorism, and how to respond in the event such a device is used. **Credit 4**

0697-798 Special Topics
Special Topics are experimental graduate courses announced quarterly. Watch for titles in the course listing each quarter. **Variable credit**

0699-705 Context and Trends
This course introduces students to interdisciplinary thinking, problem solving and research techniques and also print and electronic information resources appropriate to the student's individualized plan-of-study. **Credit 4**

0699-775 Capstone Project
This course is a supervised, hands-on experience in which the students apply the skills and knowledge developed through their individualized plans-of-study and concludes with a specific product and an oral and written presentation. **Credit 4**

0699-798 Independent Study
This course number should be used by students who plan to study a topic on an independent study basis. The student must obtain the permission of the appropriate faculty member before registering for the course. **Credit 1–12**

E. Philip Saunders College of Business

www.saunders.rit.edu/

Ashok Rao,
Dean

Success in the 21st century business environment requires leadership and management attuned to rapid changes in technology and increasingly vigorous global competition. Astute problem solvers who have gained a systems perspective must be able to convert product development and management challenges into competitive advantages. The E. Philip Saunders College of Business offers a portfolio of comprehensive, vigorous programs of study. Our innovative, multidisciplinary curriculum—embedding an international perspective and current technology throughout—produces graduates able to convert managerial learning into pragmatic business applications.

Faculty

Our faculty members combine teaching excellence, innovative research and personalized attention to meet student needs. Our setting, in a technological university embarked on creative business partnering and entailing joint programs across colleges, opens unique opportunities for all partners—industry leaders, faculty and students.

Master of Business Administration

Brian F. O'Neil, Ph.D., Associate Dean and Director, Graduate Programs
(585) 475-7784, boneil@cob.rit.edu

The master of business administration degree provides students with the capabilities for strategic and critical thinking needed for effective leadership in a global economy where creative management of both people and technology is vital. The curriculum begins with a solid, mainstream grounding in the functional areas of business and combines that foundation with the flexibility that allows students to specialize in one or two areas of expertise. In the classroom, students learn the latest theories and concepts, and how they can be immediately applied to solve problems in the workplace.

The MBA program requires 72 quarter credit hours and consists of 18 courses, nine of which are devoted to core functional areas and nine available in concentration areas and as electives. All courses in the Saunders College of Business carry four credit hours. Students create at least one concentration by selecting a four-course sequence in a particular area of specialization. Concentrations include accounting, e-business marketing, entrepreneurship, environmentally sustainable management, finance, international business, management and leadership, management information systems, marketing and sales management, marketing research, operations manage-

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ment, product commercialization, quality and applied statistics, quality and organizational improvement, supply chain management and technology management. Concentrations are available outside the college from departments within RIT's other colleges. Some of these concentrations include communication and media technology, health systems administration, human resource management, industrial and systems engineering management, information technology, printing management and public policy.

The Saunders College of Business is accredited by the Association to Advance Collegiate Schools of Business (AACSB International).

Admission requirements

Applications are accepted for all four academic quarters. Most full-time students begin their program of study in the fall. Prerequisites for admission include a baccalaureate degree from an accredited institution and a working knowledge of algebra and statistics. All entering students are required to successfully complete math review courses in algebra and statistics during their first quarter of study. This requirement is waived for students who pass a math diagnostic exam administered during orientation.

MBA-accounting students must begin studies in the fall quarter. Any exceptions must obtain the approval of a graduate adviser.

All full-time students are required to complete Professional Skills Seminar I and II (0102-070, 071). These noncredit courses give students the skills to successfully complete their graduate degree and prepare them to obtain a job or co-op position.

Completed applications for admission should be on file in the Office of Graduate Enrollment Services four weeks prior to registration for the next academic quarter for students from the United States, and up to 10 weeks prior for students applying for student visas. Transcripts from all previous undergraduate and graduate work, a Graduate Management Admission Test score, relevant professional experience, a personal statement and résumé are evaluated by the Graduate Admissions Committee. International applicants must submit the results of the Test of English as a Foreign Language with a minimum score of 580 (paper-based), 237 (computer-based) or 92 (Internet-based) as part of the application. The TOEFL requirement is waived for native speakers of English and for those submitting transcripts and diplomas from American institutions.

Accepted students can defer enrollment for up to one year. After one year, a new application must be submitted and will be re-evaluated based on the most current admission standards.

Nonmatriculated status

Students with strong undergraduate records are permitted to take two graduate courses on a nonmatriculated basis. To become a matriculated student and admitted formally to the MBA program, the regular admissions process should be followed. Graduate credits earned while a nonmatriculated student may be applied to the student's degree program.

Academic standards

The MBA normally requires 72 quarter credit hours. In certain cases, total credit hours may be reduced by the use of waiver or transfer credit. Students have the responsibility of applying for these credits.

Graduate students must maintain a grade of B or better for all courses taken at the Saunders College of Business. Grades of all repeated MBA courses will be counted in the GPA computation. The policy on probation and suspension is explained in the "Registration and Degree Requirements" section of this bulletin.

Program completion requirement

University policy requires that graduate programs be completed within seven years of the student's initial registration for courses in the program. A grade point average of at least 3.0 must be maintained.

Orientation

All new students are required to attend an orientation session prior to beginning their studies. Students must take the math waiver exam, administered during orientation, before enrolling in courses. Course selection, career planning, program planning and academic advising also are discussed during orientation.

Waiver policy/transfer credit

Students can waive up to six MBA foundation courses. Prior academic preparation must be from an institution accredited by AACSB International, and the course work must be equivalent to the graduate courses that make up the MBA foundation courses. These courses must be completed within the last five years, with a grade of B or better. Courses may be waived either outright or through an examination.

A maximum of 12 credit hours may be awarded as transfer credit from other graduate programs. The courses must have been taken within the last five years at an institution accredited by AACSB International and the student must have earned a grade of B or better. The courses must be relevant to the student's MBA program of study.

Credits for waiver, transfer or undergraduate courses are not counted in the GPA computation. Students must apply for transfer/waiver credit.

Placement

Preparation for professional placement begins early in the graduate student's program with completion of Professional Skills Seminar II (0102-071). The Office of Cooperative Education and Career Services offers individualized career counseling, provides critical job leads, coordinates employers' annual campus recruiting visits and sponsors two career fairs annually.

Cooperative education

Cooperative education in the MBA program is optional. Co-op experience affords graduate students the opportunity to obtain a paid position for three to six months and gain valuable work

experience. Academic credit is not granted, but formal recording of the co-op experience is made on the student's transcript. The associate director for graduate business programs approves the student's written report analyzing the company and experience. Students in good academic standing are eligible for co-op after completing the foundation courses Professional Skills Seminar I and II (0102-070, 071) and a substantial portion of their concentration courses. They also must attend a series of co-op and career services workshops. RIT does not guarantee that all students will be placed.

Financial assistance

Financial assistance is awarded for outstanding scholarship and professional promise without consideration of financial need. Matriculated full- and part-time students are eligible for scholarships. Matriculated full-time students also are eligible for graduate assistantships. Students awarded assistantships are assigned to work with Saunders College of Business faculty or staff. All applicants are automatically reviewed for these awards. Several alternative loan programs and federal and state programs also are available. Please contact the Office of Financial Aid and Scholarship for further information.

Course offerings

Since it is sometimes necessary to make changes in course schedules or instructors, up-to-date information about courses to be offered in a given quarter is available online at www.cob.rit.edu. RIT makes no guarantee that every catalog course will be offered in any given year or that courses will be offered in a particular quarter or sequence. All MBA students take the following eight foundation courses:

		Qtr. Cr. Hrs.
0101-703	Accounting for Decision Makers*	4
0102-740	Organizational Behavior and Leadership*	4
0102-759	Competitive Strategy	4
0103-705	Economics for Managers*	4
0104-721	Financial Analysis for Managers*	4
0105-761	Marketing Concepts*	4
0106-743	Operations Management*	4
0106-782	Statistical Analysis for Decision Making*	4
Choose one from the following:		
0102-742	Introduction to Technology Management	4
0113-710	Global Business Environment	4
0104-760	Finance in a Global Environment	4
0112-710	Management Information Systems Concepts	4
0112-715	Information Technology and Globalization	4

**Up to six of these courses can be waived, thus reducing the number of courses required to graduate.*

Students have the option of choosing one or two concentration areas. A concentration is a sequence of four courses in a specialized area of business, thus giving students in-depth knowledge in that particular field.

Students with one concentration area take:

- Nine foundation courses
- Four courses in a concentration area
- Five electives, outside the selected concentration area (no more than four of these can be taken in any one discipline)

Students with two concentration areas take:

- Nine foundation courses
- Four courses in a concentration area
- Four courses in a second concentration area
- One elective, outside the selected concentration areas

Notes:

- Students cannot complete more than two concentration areas.
- No course can be counted in more than one concentration.
- No more than four electives can be completed in any one discipline.
- Students taking two concentration areas need to meet with an adviser.
- Finance is a five-course concentration.

Concentrations

Accounting

This concentration is intended for students planning to enter corporate accounting. It is also an excellent complement to a concentration in finance or management information systems.

		Qtr. Cr. Hrs.
0101-704	Corporate Financial Reporting I	4
0101-705	Corporate Financial Reporting II	4
0101-706	Cost Management	4
Choose one from the following:		
0101-707	Advanced Accounting	4
0101-708	Auditing	4
0101-709	Basic Taxation	4

E-Business Marketing

The Internet has become one of the most significant forces to affect marketing since the emergence of mass media. The Internet has introduced a global electronic marketplace that has caused a dramatic shift in standard business practices. This has given rise to an enormous need to understand the implications of these shifts for strategic initiatives in marketing and advertising. The e-business marketing concentration exposes students to the uniqueness of marketing goods and services to other companies and individual consumers via the Internet.

		Qtr. Cr. Hrs.
0105-772	Internet Marketing: Strategy and Tactics	4
0105-775	Business to Business E-Marketing	4
	Two marketing electives	8

Entrepreneurship

Entrepreneurship is a necessary component in today's fast-paced business environment. It involves both the recognition of business opportunities and methods, and the means to commercialize these opportunities. The entrepreneurship concentration is designed to enable students to recognize and commercialize attractive business opportunities—either by new independent ventures or by established firms seeking growth or rejuvenation. It involves integrating all functions of business (strategy, marketing, innovation, finance, accounting, etc.) within one concerted value-creating initiative.

The concentration requires an applied entrepreneurial learning experience that may be satisfied through either the

Field Experience in Business Consulting (0102-753) course or an approved commercialization project. These projects may involve students developing their own businesses or working with RIT incubator companies, local startup firms or RIT multidisciplinary commercialization projects. Students interested in high-technology initiatives are encouraged to enroll in Introduction to Technology Management (0102-742) as the fourth course in the concentration.

		Qtr. Cr. Hrs.
0102-720	Entrepreneurship and New Venture Creation	4
0105-776	Product and Brand Management	4
0102-753	Field Experience in Business Consulting*	4
Choose one from the following:**		
0101-709	Basic Taxation	4
0102-742	Introduction to Technology Management	4
0104-722	Financial Management II	4
0104-735	Valuing Private Enterprise	4
0105-763	Buyer Behavior	4
0105-772	Internet Marketing: Strategy and Tactics	4
0110-730	Business Legal Concepts	4

**Or an approved entrepreneurial field experience*
***Or a management course, with approval of graduate adviser*

Environmentally Sustainable Management

The goal of this concentration will familiarize students with environmentally sustainable business practices. This concentration is attractive to students with an overall interest in understanding how firms can manage social and political demands for more environmentally sustainable products and operations. It may be of particular interest to those students interested in industries with a significant environmental impact such as the automotive, chemical, energy, transportation or agricultural industries, where environmental issues are central to operational and strategic decision making.

		Qtr. Cr. Hrs.
0102-745	Social and Political Environment of Business	4
0102-710	Managing for Environmental Sustainability	4
Choose two from the following:		
0630-720	Environmental Health and Safety Management*	4
0630-765	Product Stewardship	4
0102-775	Business Ethics	4
0303-790	Fundamentals of Sustainable Design	4
0303-791	Lifecycle Assessment/Costing	4
0521-751	Energy Policy	4
0630-760	Integrating Environmental Health and Safety into Business Management	4

**Online course. As a part of this class, students are required to attend a four-day executive leader session held on campus at RIT. Contact the instructor for more information on the dates for this session.*

Finance

This concentration is designed to provide a foundation of knowledge in finance and allow students to choose courses appropriate for a career in investments or corporate finance. Students interested in investments have the opportunity to acquire advanced skills in securities evaluation and portfolio management. Those interested in corporate finance have the opportunity to acquire advanced skills in budgeting, planning, global financing and operations and corporate risk management. Finance is a five-course concentration.

		Qtr. Cr. Hrs.
0104-722	Financial Management II	4
0104-725	Securities and Investment Analysis	4
One advanced economics course		4
Choose two courses from the following:		
0104-724	Problems in Corporate Finance	4
0104-729	Seminar in Finance	4
0104-730	Financial Institutions and Markets	4
0104-732	Portfolio Theory	4
0104-734	Working Capital Management	4
0104-740	Options and Futures	4
0104-760	Finance in a Global Environment	4

International Business

Competition stems from many different companies around the world. The rules of international trade are changing, as is the speed and ease with which global business is transacted. This makes almost all business international, which requires executives to view business challenges in a global context. Wherever students find employment (finance, marketing, manufacturing, etc.), an MBA with a concentration in international business will arm them with the skills necessary to rise to these challenges and be successful.

		Qtr. Cr. Hrs.
0113-710	Global Business Environments	4
0113-780	Global Issues and Strategies	4
Choose two from the following:		
0113-730	Managing in a Global Business	4
0104-760	Finance in a Global Environment	4
0113-750	Marketing in a Global Environment	4

Management and Leadership

Modern organizations require managers who can combine effective leadership with analytical reasoning. The management and leadership concentration prepares students with the leadership skills needed to be successful managers in business, nonprofit and public organizations. Successful students will develop analytical and decision-making skills essential for leaders in today's rapidly changing world. They will learn why change is difficult, when to initiate change and how to introduce and manage change in the workplace. The courses also will prepare students for the demands of managing people and projects.

		Qtr. Cr. Hrs.
0102-741	Managing Organizational Change	4
Choose three from the following:		
0102-720	Entrepreneurship and New Venture Creation	4
0102-745	Social and Political Environment of Business	4
0102-750	Human Resource Management	4
0102-756	Power and Influence	4
0102-758	Seminar in Management	4
0102-763	Behavioral Skills for Managers and Professionals	4
0102-775	Business Ethics	4
0110-745	Legal and Ethical Issues in Technology Intensive Environments	4
0102-742	Introduction to Technology Management	4

Management Information Systems

A concentration in management information systems is designed to enhance students' understanding of modern information systems. It is designed so that a student need not have a background in computers or information systems. Students may elect courses in systems analysis and design, data management, systems management, integrated business systems, applications programming and information systems consulting, as well as a seminar covering current topics in information systems.

Students may choose one of four different concentrations that focus on systems consulting, information system management, enterprise systems management with an emphasis on SAP/R3 or information systems.

In all concentrations, students gain an understanding of the foundation of management information systems and what is needed to develop and implement an information system. Electives chosen will strengthen their ability for MIS consulting, systems management or working with large-scale enterprise resource planning systems.

Information Systems Consulting		Qtr. Cr. Hrs.
0112-720	Information Systems Design	4
0112-730	Information Systems Consulting	4
0112-755	Information Systems Management	4
Choose one from the following:		
0112-745	Information Systems Development	4
0112-795	Seminar in MIS	4

Information Systems Development		Qtr. Cr. Hrs.
0112-720	Information Systems Design	4
0112-725	Data Management	4
0112-745	Information Systems Development	4
Choose one from the following:		
0112-735	Network Technologies	4
0112-755	Information Systems Management	4
0112-795	Seminar in MIS	4

Enterprise Information Systems		Qtr. Cr. Hrs.
0112-755	Information Systems Management	4
0112-760	Integrated Business Systems	4
0112-761	Business Process Analysis and Workflow Design	4
Choose one from the following:		
0112-720	Information Systems Design	4
0112-725	Data Management	4
0112-795	Seminar in MIS	4

Information Systems		Qtr. Cr. Hrs.
0112-720	Information Systems Design	4
0112-725	Data Management	4
Choose two from the following:		
0112-730	Information Systems Consulting	4
0112-735	Network Technologies	4
0112-755	Information Systems Management	4
0112-795	Seminar in MIS	4

Marketing and Sales Management

Marketing is a key to success in any business today. The overall process of entering markets, creating value for customers and developing profit for the firm are the fundamental challenges for today's marketing manager. Effective marketing must consider the target audience, along with the changing business environment and competitive pressures of technological and global challenges. These marketing basics apply to governmental agencies, not-for-profit organizations and profit-making firms.

		Qtr. Cr. Hrs.
0105-762	Advanced Marketing Management	4
0105-764	Channel Management	4
0105-765	Professional Sales Management	4
Choose one from the following:		
0105-758	Seminar in Marketing	4
0105-763	Buyer Behavior	4
0113-750	Marketing in a Global Environment	4
0105-767	Marketing Communications	4
0105-771	Marketing Research Methods	4
0102-770	Business Research Methods	4
0105-772	Internet Marketing: Strategy and Tactics	4
0105-773	Database Marketing	4
0105-776	Product and Brand Management	4

Marketing Research

How do you identify your customers' needs and wants, and respond with the most profitable product or service? Marketing research analysts take a leading role in identifying and defining marketing problems. Relying on communication as well as analytical and conceptual skills, a market researcher can evaluate the market, generate product ideas, refine the delivery process, monitor marketing performance and improve the company's profitability. Increasing numbers of specialized research firms add more opportunities to the traditional marketing profession.

		Qtr. Cr. Hrs.
0307-801	Design of Experiments I*	4
Choose one from the following:		
0105-770	Business Research Methods	4
0105-771	Marketing Research Methods	4
Choose two from the following:		
0105-762	Advanced Marketing Management	4
0105-772	Internet Marketing: Strategy and Tactics	4
0105-773	Database Marketing	4
0307-802	Design of Experiments II*	4
0307-831	Multivariate Analysis Applications*	4
0307-841	Regression Analysis*	4

** Student must register for the four-credit-hour option of these courses.*

Operations Management

The operations management concentration is designed to enhance the student's understanding of manufacturing and service functions as they exist in modern business. In addition to key courses covering project management, quality control and improvement and manufacturing strategy, an extensive set of electives allows students the ability to broaden their knowledge base.

		Qtr. Cr. Hrs.
0106-744	Project Management	4
0106-745	Quality Control and Improvement	4
Choose one from the following:		
0101-794	Cost Accounting in Technical Organizations	4
0102-741	Managing Organizational Change	4
0102-742	Introduction to Technology Management	4
0106-749	Manufacturing Strategy and Tactics	4
0307-781	Quality Management*	4
0307-782	Quality Engineering*	4
0307-721	Statistical Process Control*	4
0307-731	Statistical Acceptance Control*	4
0303-690	Seminar in Computer Integrated Manufacturing	4

** Student must register for the four-credit-hour option of these courses.*

Product Commercialization

This concentration is targeted to students who are interested in developing expertise in managing the marketing-related activities required to move new products and services through the pre-launch business stages to a successful launch. The commercialization of new corporate offerings is increasingly important as product life cycles get shorter.

		Qtr. Cr. Hrs.
0105-776	Product and Brand Management	4
0105-777	Commercializing New Products	4
Choose one from the following:		
0102-770	Business Research Method	4
0105-771	Marketing Research Methods	4
Choose one from the following:		
0102-742	Introduction to Technology Management*	4
0102-762	Managing New Process and Product Development*	4

**If Introduction to Technology Management (0102-742) is taken as part of the MBA core, Managing New Process and Product Development (0102-762) is required.*

Quality and Applied Statistics

This concentration is for those students who would like to study the technical aspect of managing quality, i.e., statistical quality control. Depending on the courses chosen, students may gain an understanding of the basics of statistical process control, quality improvement, acceptance sampling and off-line quality control techniques such as the design of experiments.

Choose four from the following:		Qtr. Cr. Hrs.
0106-745	Quality Control and Improvement	4
0307-721	Statistical Process Control*	4
0307-731	Statistical Acceptance Control*	4
0307-782	Quality Engineering*	4
0307-801	Design of Experiments I*	4
0307-802	Design of Experiments II*	4

**Student must register for the four-credit-hour option of these courses*

Quality and Organizational Improvement

This concentration is designed for students who would like to learn more about the organizational and managerial (i.e., "soft") aspects of quality. The courses offered help students lead organizational change and manage quality improvement projects.

		Qtr. Cr. Hrs.
0102-741	Managing Organizational Change	4
0106-745	Quality Control and Improvement	4
Choose two from the following:		
0105-771	Marketing Research Methods or	4
0102-770	Business Research Methods	4
0307-782	Quality Engineering*	4
0307-721	Statistical Process Control*	4
0307-731	Statistical Acceptance Control*	4
0625-841	Benchmarking and the Process of Continuous Improvement	4
0106-744	Project Management	4

**Student must register for the four-credit-hour option of these courses.*

Supply Chain Management

Supply chain management is an integrated approach to managing the total flow of a distribution channel from the supplier to the customer. This concentration prepares students to effectively manage this key element of corporate strategy.

		Qtr. Cr. Hrs.
0106-760	Managing the Supply Chain	4
0112-760	Integrated Business Systems	4
Choose one from the following:		4
0105-764	Channel Management	4
0105-775	Business to Business E-Commerce	4
Choose one from the following:		4
0102-741	Managing Organizational Change	4
0102-756	Power and Influence	4
0106-745	Quality Control and Improvement	4
0106-795	Seminar in Decision Sciences	4
0303-703	Supply Chain Management	4

Technology Management

In a constantly changing environment, the ability of an organization to innovate and renew itself is critical if it is to survive and prosper. Technology managers, who typically are responsible for the innovation and application of new technology, are central to the long-term strategy and success of their companies. To manage these processes well, managers need to understand both business and technological perspectives. Co-op or internship experience in high-technology settings may be helpful to students pursuing a specialty in technology management.

		Qtr. Cr. Hrs.
0102-742	Introduction to Technology Management	4
Choose one or both from the following:		
0102-761	Managing Research and Innovation	4
0102-762	Managing New Product and Process Development	4
If both courses directly above are taken, choose one course from the following; otherwise choose two:		
0102-741	Managing Organizational Change	4
0110-745	Legal and Ethical Issues in Technology Intensive Environments	4
0105-776	Product and Brand Management	4
0106-744	Project Management	4
0106-749	Manufacturing Strategy and Tactics	4

Additional Concentrations

In addition to the business-related concentrations listed prior, several concentrations are available to MBA students from outside the Saunders College of Business. To register for courses in the following concentrations, students are advised to see a graduate adviser

Communication and Media Technologies

Communication, and the technologies for message creation and dissemination, is at the center of dramatic economic, social and cultural changes occurring as a result of technological development and global connectedness. This concentration, offered by the College of Liberal Arts, prepares students for careers as communication experts in commerce and industry, education and entertainment, and government and the not-for-profit sector.

Health Systems Administration

This concentration is specifically designed for those students who are employed in the health care environment. Offered by the College of Applied Science and Technology, the courses in this concentration introduce up-to-date, industry-relevant content that is continually developed in response to the changing health care environment. All courses in this concentration are offered online.

Human Resource Management
The field of human resource development has grown in both size and importance over the past decade, leading to a high demand for educated and skilled human resource professionals. This concentration, offered by the College of Applied Science and Technology, provides education in training, human resource management and career and organizational development.

Industrial and Systems Engineering Management
Organizations need individuals who possess a blend of technical and business skills, as well as the integrated systems perspective needed to commercialize complex products and services. This concentration, offered by The Kate Gleason College of Engineering, may be significantly interdisciplinary.

Information Technology
Corporations are aware of the cost savings and performance improvement possible when information technology is applied in a systematic manner, improving organizational information flow, employee learning and business performance. Information technology includes a mixture of computers and other multipurpose devices, information media and communication technology, all filtered through an understanding of how humans need to use these evolving systems. Students may choose from the following areas of specialization for a concentration in information technology: Web programming/multimedia, software project management, programming and telecommunications. This concentration is offered by the B. Thomas Golisano College of Computing and Information Sciences.

Printing Management
Leadership and management in the print media industry require an understanding of the cutting-edge technology and emerging markets to articulate a corporate vision that encompasses new opportunities and directions. This concentration, offered by the College of Imaging Arts and Sciences, is designed to provide a solid technical background in cross-media digital workflow processes and a keen understanding of the issues and trends in the print media industry.

Public Policy
Careers are available at all levels of government, as well as in not-for-profit organizations and the private sector—where an understanding of the formulation and impact of public policy are critical. This concentration, offered by the College of Liberal Arts, gives students the skills to effectively formulate public policy and understand its impact, particularly as related to science and technology issues. The courses focus on policy formation, implementation and analysis.

Executive MBA

Brian F. O'Neil, Ph.D., Associate Dean and Director, Graduate Programs
(585) 475-7784, boneil@cob.rit.edu

The Executive MBA is an integrated, 15-month, five-quarter, cohort-based program designed to develop future leaders and general managers in organizations serious about improving customer satisfaction, product quality and organizational success.

A team of RIT faculty and executives from all sectors of business and industry designed the Executive MBA program for professionals with substantial career experience. Through the use of practical approaches to improving business results and increasing personal productivity, participants in the program will:

- strengthen their leadership and interactive skills by collaborating with teams of professional peers and faculty.
- develop strategic perspectives consistent with the needs of customers, stockholders, employees, the community and other organizational stakeholders.
- apply cross-functional approaches to enhance their a nalytical and decision-making capabilities.
- obtain a solid foundation in the functional areas of business.

Executive MBA students must have a minimum of six years of professional work experience. Courses are conducted all day Friday and Saturday on alternating weekends. Participants work in teams, studying a curriculum that focuses on developing general management skills with a strategic focus. The Executive MBA program is structured in an interactive fashion, with an emphasis on cross-functional integration.

Admission requirements
In order to be considered for admission to the Executive MBA program, a candidate must:

1. have a minimum of six years of professional work experience.
2. have earned a bachelor's degree.
3. be interviewed by a representative of the Executive MBA team.
4. submit a completed admission package.

Sponsorship
Employer sponsorship includes several dimensions. The sponsor must permit the candidate to attend scheduled Friday/Saturday classes, plus three required one-week sessions. These weeklong sessions will occur in the summer and spring, and include a one-week international study trip in the student's final quarter. Business owners or individuals may sponsor themselves.

Program structure and content
The Executive MBA program consists of six weekends per quarter, for a total of 30 weekends over the program's 15 months. Students also must attend two one-week on-campus sessions and a one-week international study trip.

The first two quarters of the curriculum focus on core business concepts, providing fundamental skills, knowledge, and perspectives in accounting, statistics, leadership, finance,

and economics. The remaining three quarters of the program extend that foundation and develop cross-functional analysis skills, with an emphasis on strategy, marketing, technology and international business. Interdisciplinary examples, case analyses and an applied orientation are key components of the program.

The Executive MBA program also includes practical experience obtained through capstone consulting projects; ongoing support for career-oriented skills such as career development planning, communications and team building; the application of a cross-functional business simulation model; and a week-long international business trip.

Curriculum

Mid-August

0102-806	Team Building and Business Ethics (one week)

Quarter One, Fall

0101-801	Accounting and Organizational Goals
0101-802	Managerial Accounting
0101-810	Leadership
0103-840	Microeconomics
0102-800	Leadership Development Skills I

Quarter Two, Winter

0104-845	Valuation and Capital Budgeting
0104-846	Financial Planning and Analysis
0103-841	Macroeconomics
0106-860	Data Analysis
0102-801	Leadership Development Skills II

Quarter Three, Spring

0102-818	Strategic Thinking I
0102-819	Strategic Thinking II
0105-851	Marketing Strategy
0106-861	Statistics for Decision Making

Late May

0106-875	Business Simulation: Consulting Skills (one week)

Quarter Four, Summer

0105-860	Internet Marketing
0106-864	Systems Support for Operations
0102-889	Capstone Consulting Project I
0102-816	Technology Management

Quarter Five, Fall

0102-820	International Business
0104-850	International Finance
0102-890	Capstone Consulting Project II
0102-802	Leadership Development Skills III
0102-825	International Seminar
0102-860	Executive Leadership

Information and application

All correspondence regarding Executive MBA admission and required documents should be sent to:

Executive MBA Program
E. Philip Saunders College of Business
Rochester Institute of Technology
107 Lomb Memorial Drive
Rochester, NY 14623-5608
(585) 475-7435
(585) 475-6441 (fax)
embamail@rit.edu

Master of Business Administration—Accounting

Brian F. O'Neil, Ph.D., Associate Dean and Director, Graduate Programs
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In addition to the educational preparation for a career leading to top management, the Master of Business Administration—Accounting program fulfills the education requirements that allow students to sit for the New York State Certified Public Accountancy exam. The program also stresses the skills necessary for the design, operation and control of accounting information systems. The program offers two tracks, one for students with an undergraduate degree in accounting and one for students who have an undergraduate degree in a field other than business or accounting.

Program for students with an undergraduate degree in accounting

Students with an undergraduate degree in accounting may be able to complete the program with as little as 12 graduate courses containing 48 quarter hours. Full-time students starting in the fall quarter may be able to complete the degree in three quarters. With some required courses only offered once a year, additional completion time may be required for full-time students entering in other quarters. The program also is available on a part-time basis for practicing professionals. Typical course work for students with an undergraduate degree in accounting is as follows:

MBA Foundation Courses:

0102-740	Organizational Behavior and Leadership
0102-759	Competitive Strategy
0105-761	Marketing Concepts

Additional Accounting Courses:

0101-707	Advanced Accounting*
0101-722	Advanced Cost Management
0101-738	Information Systems Auditing and Assurances Services
0101-795	Financial Accounting Theory and Research

Additional Business Courses:

0110-731	Commercial Law*
0112-725	Data Management
or	
0112-745	Information Systems Development
0112-760	Integrated Business Systems
or	
0101-737	Accounting and Enterprise Information Systems
	Two non-accounting professional electives

**Students taking these courses as part of their undergraduate program may substitute electives or other courses to fulfill the education requirements for the CPA exam.*

Program for students without undergraduate business course work

For students without undergraduate business course work, but with an undergraduate degree meeting CPA liberal arts and science requirements, the program consists of 27 courses that may be completed in seven quarters (two academic years) of full-time study. Because of the length of prerequisite strings, seven-quarter completion for full-time students is based on fall quarter entry. Variations will likely extend the time needed to complete the program.

Curriculum

The MBA—Accounting program consists of three sets of courses: MBA foundation courses additional accounting courses and additional business courses.

MBA Foundation courses:

0101-703	Accounting for Decision Makers
0102-740	Organizational Behavior and Leadership
0102-759	Competitive Strategy
0103-705	Economics for Managers
0104-721	Financial Analysis for Managers
0105-761	Marketing Concepts
0106-743	Operations Management
0106-782	Statistical Analysis for Decision Making
Choose one of the following:	
0102-742	Introduction to Technology Management
0113-710	Global Business Environments
0104-760	Finance in a Global Environment
0112-710	Management Information Systems Concepts

Additional Accounting Courses:

0101-704	Corporate Financial Reporting I
0101-705	Corporate Financial Reporting II
0101-706	Cost Management
0101-707	Advanced Accounting
0101-708	Auditing
0101-709	Basic Taxation
0101-710	Advanced Taxation
0101-722	Advanced Cost Management
0101-738	Information Systems Auditing and Assurances Services
0101-795	Financial Accounting Theory and Research
	A course in Accounting Information Systems
	Accounting elective

Additional Business Courses:

0110-730	Business Legal Concepts
0110-731	Commercial Law
0112-760	Integrated Business Systems
or	
0101-737	Accounting and Enterprise Systems
	Finance elective
	Two non accounting professional electives

Fast Track: One-Year MBA

An accelerated, intensive MBA program is available to full-time students. The program begins in the summer with six courses in a two-week modular format, followed by mainstreaming with the traditional MBA program courses. The following five concentrations are offered in this program: entrepreneurship, finance, management and leadership, marketing and technology management. Early commitment and merit-based scholarships are available. The course requirements and total credit hours are the same as those for the traditional MBA.

Master of Science in Innovation Management

Brian F. O'Neil, Ph.D., Associate Dean and Director, Graduate Programs
(585) 475-7784, boneil@cob.rit.edu

The master of science degree in innovation management supports the development of technology workers as they move into leadership roles in the high-technology domains in the world economy. Graduates of the program will have a unique combination of technical and business expertise and will be able to communicate at all levels of an organization. The program is designed to be interdisciplinary, including courses from a number of academic departments and colleges. The degree is offered by the Saunders College in collaboration with the B. Thomas Golisano College of Computer and Information Sciences and the College of Science.

The program requires students to complete 46-48 quarter credit hours consisting of five required business core courses, two innovation courses, one four-course sequence from a technology specialization area, and a capstone experience. The five business core courses increase a student's knowledge of accounting, organizational behavior and leadership, technology management, marketing, and project management. The two innovation courses allow students to pursue entrepreneurial, product commercialization, or research management expertise. The technology specialization area develops a student's expertise in one of five areas: bioinformatics, game programming, game design, software project management, and system security.

The degree culminates in a capstone course. This course is an opportunity for students to integrate their business and technology expertise through a full-quarter applied project or research paper.

Curriculum

Required business courses (24 credit hours):

0101-703	Accounting for Decision Makers
0102-740	Organization Behavior and Leadership
0102-742	Introduction to Technology Management
0105-761	Marketing Concepts
0106-744	Project Management
0102-795	Innovation Management Capstone

Innovation courses (8 credit hours):

Choose two from the following:	
0105-778	Commercializing New Products
0102-720	Entrepreneurship and New Venture Creation
0102-761	Managing Research and Innovation

Technology specialization area (14-16 credit hours):
(Select one of the following areas.)

Bioinformatics

1001-725	Ethics in Bioinformatics
1001-759	Bioinformatics Resources
1001-722	Bioinformatics Seminar
1001-759	Case Studies in Genomics
1001-759	Advanced Data Management Topics

Game Programming

4004-746	Programming for Interactive Multimedia
4002-734	2-D Graphics Programming
4002-735	3-D Graphics Programming
4002-836	Game Engine Design and Development

Game Design

4004-731	History and Critical Analysis of Computer Games and Interactive Entertainment
4004-728	Interactive Narrative
4004-732	Game World Design
4004-793	Business and Legal Aspects of Game Development

Software Project Management

4002-752	Themes in Software Development and Management
4002-830	Project Management
4002-831	Process Management
4002-820	Economics of Software Development

System Security

4055-761	Principles of System Administration
4055-780	Computer System Security
Select two of the following:	
4055-755	Secure Wireless and Wired Data Networks
4055-760	Computer Viruses and Malicious Software
4055-841	Advanced Computer Forensics
4055-863	Protocol Design and Implementation
4055-882	Enterprise Security

Online courses

Several of the courses offered in the MS in innovation management program may be completed online. Students should contact their adviser for more information, or refer to the course registration booklet from the Registrar's Office for a complete list of online courses available per quarter.

Master of Science in Finance

Brian F. O'Neil, Ph.D., Associate Dean and Director, Graduate Programs
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The master of science degree in finance is designed to prepare students for managerial careers in corporate finance, investment analysis and portfolio management, financial consulting and financial institutions. The courses will prepare students to sit for the Certified Financial Analyst exam. To complete the program in one year, full-time students must begin their studies in the fall or winter quarter. Part-time students may enter the program in any quarter.

Admission requirements

Applicants should have baccalaureate degrees from accredited programs. To be considered for admission, it is necessary to file an application, submit official transcripts of all previous undergraduate and graduate course work, submit results of the Graduate Management Admissions Test and provide a current résumé. International applicants must submit the results of the Test of English as a Foreign Language with minimum scores of 580 (paper-based), 237 (computer-based) or 92 (Internet-based). The TOEFL requirement is waived for native speakers of English and those candidates submitting transcripts and diplomas from American undergraduate schools.

Curriculum

The graduate program of study consists of 12 courses and a comprehensive exam. The candidate must successfully complete a comprehensive field exam based on the required finance courses completed.

MS in Finance

0103-703	Accounting for Decision Makers
0104-721	Financial Analysis for Managers
0104-722	Financial Management II
0104-725	Securities and Investment Analysis
0104-740	Options and Futures
0104-760	Finance for Global Business
0106-782	Statistical Analysis for Decision Making
	One finance elective
	Two breadth electives*
Choose two of the following:**	
0103-705	Economics for Managers
0103-711	Microeconomics
0103-712	Macroeconomics

**Breadth elective courses may be chosen from the graduate business courses in accounting, international business, management, marketing, management information systems or technology management.*

***Specific economics courses selected by the finance faculty adviser depend on the student's previous economic course work, if any.*

Master of Science in Management

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The master of science in management is a specialized program designed to provide students with the knowledge and problem-solving skills needed to function effectively in a variety of management positions in complex organizations that are impacted by technological change and globalization. Students choose between two tracks, technology management or global management. After taking several courses in research tools, the program culminates with a two-course thesis or practicum.

Full-time students must begin the program in the fall quarter in order to complete the program in 12 months.

Admission requirements

Applicants should have a baccalaureate degree from an accredited program. To be considered for admission, it is necessary to file an application, submit official transcripts of all previous undergraduate and graduate work, submit the result of the Graduate Management Admissions Test and provide an up-to-date résumé. International applicants must submit the results of the Test of English as a Foreign Language with minimum scores of 580 (paper-based), 237 (computer-based) or 92 (Internet-based). The TOEFL requirement is waived for native speakers of English and those submitting transcripts and diplomas from American undergraduate schools.

Curriculum

The graduate program of study consists of 12 courses and a thesis or practicum.

Global Management Track

0113-710	Global Business Environments
0113-780	Global Issues and Strategy
Choose two from the following:	
0113-730	Managing in a Global Environment
0104-760	Finance in a Global Environment
0113-750	Marketing in a Global Environment
	Two courses in research tools
	Four breadth-of-field courses*
	Two courses in a thesis or practicum

**See graduate adviser before choosing courses*

Technology Management Track

0102-742	Introduction to Technology Management
0102-762	Managing New Process and Product Development

Choose two from the following:

0102-741	Managing Organizational Change
0102-761	Managing Research and Innovation
0105-776	Product and Brand Management
0106-744	Project Management
	Two courses in research tools
	Four breadth-of-field courses:
0113-710	Global Business Environments
	Three additional management courses*
	Two courses in a thesis or practicum

Graduate Faculty

Ashok Rao, BS, Indian Institute of Technology; MS, Ph.D., University of Iowa—Dean

Wayne J. Morse, BBA, Siena College; MBA, Cornell University; Ph.D., Michigan State University—Senior Associate Dean

Brian F. O'Neil, BS, Syracuse University; MS, Ph.D., Purdue University—Associate Dean, Director, Graduate Programs

Jerry H. Curnutt, AB, William Jewell College; MS, Ph.D., University of Illinois—Assistant Dean for Administration

Accounting

Mithu Dey, BBA, Howard University; MBA, Ph.D., George Washington University; CPA, Maryland—Assistant Professor

William T. Evans, BS, Rensselaer Polytechnic Institute; MBA, University of Rochester—Visiting Lecturer

Khondkar E. Karim, B.Com., M.Com., University of Dhaka; MSA, Eastern Michigan State University; DBA, Mississippi State University; CPA, Mississippi—Professor

Francis E. Kearns, AB, Cornell University; BD, Harvard University; MBA, Ph.D., State University of New York at Buffalo; CPA, New York—Assistant Professor

Roberta L. Klein, BS, State University of New York at Brockport; MBA, Rochester Institute of Technology; CPA, New York—Lecturer

Wayne J. Morse, BBA, Siena College; MBA, Cornell University; Ph.D., Michigan State University; CPA, Illinois—Professor, Senior Associate Dean

Bruce L. Oliver, BA, MBA, University of Cincinnati; Ph.D., University of Washington—Professor

Daniel D. Tessoni, BBA, St. John Fisher College; MS, Clarkson University; Ph.D., Syracuse University; CPA, New York—Assistant Professor

Decision Science

John E. Ettlie, BS, MS, Ph.D., Northwestern University—Director, Technology Management Center; Professor

A. Erhan Mergen, BS, Middle East Technical University; MS, Ph.D., Union College—Professor

William J. Stevenson, BS, MBA, Ph.D., Syracuse University—Associate Professor

Finance and Economics

Steven C. Gold, BA, BS, Rutgers University; MA, Ph.D., State University of New York at Binghamton—Acting Interim Chair, Accounting and Finance; Professor

Chun-Keung (Stan) Hoi, BS, MS, University of North Texas; Ph.D., Arizona State University—Associate Professor

Jeffrey P. Lessard, BS, BA, University of New Hampshire; MBA, Plymouth State College; MA, Ph.D., University of Arkansas—Professor

Robert Manning, BA, Duke University; MA, Northern Illinois University; Ph.D., Purdue University—Research Professor of Consumer Finance

Melissa Palmer, BBA, St. Bonaventure University; MBA, University of Rochester; CPA, New York—Visiting Lecturer

Ashok J. Robin, B.Com, University of Madras; MBA, Ph.D., State University of New York at Buffalo—Associate Professor

Patricia L. Wollan, BS, York University; MBA, Old Dominion University; Ph.D., Pennsylvania State University—Assistant Professor

Management

Robert J. Barbato, BA, LeMoyne College; Ph.D., Michigan State University—Professor

Richard DeMartino, BA, Roanoke College; MPA, Ph.D., University of Virginia—Associate Professor

Brenda Ghirulescu, BS, MS, Polytechnic University of Bucharest—Instructor

A. Clyde Hull, BA, Yale University; MB, MBA, Ph.D., Indiana University—Assistant Professor

Shalini Khazanchi, BS, South Gujarat University; MBA, University of Pune; Ph.D., University of Cincinnati—Assistant Professor

Martin Lawlor, BS, State University of New York at Buffalo; MBA, Rochester Institute of Technology—Visiting Lecturer

Steven Luxmore, BA, MA, University of Guelph; Ph.D.; University of Toronto—Assistant Professor

David McHardy Reid, BS, University of Salford; MS, University of Manchester; Ph.D., University of Edinburgh—Professor

Sandra L. Rothenberg, BS, Syracuse University; MS, Ph.D., Massachusetts Institute of Technology—Associate Professor

Delmonize Smith, BBA, Faulkner University; MS, Troy University—Instructor

Zhi Tang, BS, Shandorun University; MS, Fudon University; Ph.D., University of Arizona—Assistant Professor

Donald O. Wilson, BS, Oklahoma State University; MS, MPA, University of Southern California; Ph.D., University of California at Irvine—Assistant Professor

Management Information Systems

James Baroody, BS, University of Richmond; MS, College of William and Mary; Ph.D., University of Wisconsin at Madison—Chair, Decision Sciences and Management Information Systems; Distinguished Lecturer

Jack S. Cook, BS, MA, MBA, University of South Dakota; MS, Ph.D., Washington State University—Associate Professor

Daniel A. Joseph, BS, Niagara University; MA, State University of New York at Albany; MBA, Ph.D., State University of New York at Buffalo—Associate Professor

Koffi N'Da, BS, Inset, Abidjan, Cote d'Ivoire; MS, Ph.D., Laval University—Assistant Professor

M. Pamela Neely, BS, State University of New York at Buffalo; MS, University of Colorado; Ph.D., State University of New York at Albany—Assistant Professor

Victor J. Perotti, BS, MS, MA, Ph.D., Ohio State University—Associate Professor

Quiang (John) Tu, BS, MS, Xian Jiaotong University; Ph.D., University of Toledo—Associate Professor

Marketing

Robert B. Boehner, BA, MA, Siena College; JD, University of North Carolina at Chapel Hill—Visiting Lecturer

Deborah Colton, BA, State University of New York at Buffalo; MBA, Rochester Institute of Technology; Ph.D., University of South Carolina—Assistant Professor

Neil Hair, BS, University of Wales; MS, Sheffield Hallam University; Ph.D., Cranfield University—Assistant Professor

Kevin Scully, BS, State University of New York at Geneseo; MBA, Rochester Institute of Technology; Ed.D., Columbia University—Lecturer

Philip R. Tyler, BS, Rochester Institute of Technology; MBA, DBA, Michigan State University—Associate Professor

John Ward, BS, Georgia Institute of Technology; MS, Purdue University—Visiting Lecturer

Stanley M. Widrick, BS, Clarkson University; MBA, State University of New York at Buffalo; Ph.D., Syracuse University—Chair, Management, Marketing and International Business; Professor

Accounting

0101-703 Accounting for Decision Makers
An introduction to accounting concepts and the use of accounting information by decision makers. Topics include financial statements; measurement of assets, equities, and income; financial statement analysis, cost behavior and measurement; profitability analysis; relevant costs for special decisions; budgeting; and responsibility accounting. **Credit 4**

0101-704 Corporate Financial Reporting I
A comprehensive exposure at an intermediate level to accounting theory and practice. Emphasis is placed on applying underlying accounting theory to complex accounting measurement problems. The effects of alternative methods are considered throughout the entire course. (0101-703) **Credit 4**

0101-705 Corporate Financial Reporting II
Continuation of Corporate Financial Reporting I with emphasis on equity and special measurement and reporting problems. Topics include statement of cash flows, pensions, leases, revenue recognition and investments. (0101-704) **Credit 4**

0101-706 Cost Management
The development and use of cost data for external reporting and internal cost management (planning and control). Topics include job costing, process costing, joint product costing, cost reassignments, standard costs, activity based costing, decentralization and transfer pricing, and cost variances. Consideration is given to manufacturing, service and retail organizations. (0101-703) **Credit 4**

0101-707 Advanced Accounting
The analysis of financial reporting issues encountered in branch operations, business combinations, inter-corporate investments, international business, not-for-profit and government organizations, and partnerships. (0101-705 or equivalent) **Credit 4**

0101-708 Auditing
The theory and practice of auditing examined; critical study of auditing procedures and standards in the light of current practice; measurement and reliance of internal control, covered by case studies; modern auditing techniques by statistical sampling and electronic data processing applications; audit reports and the legal liability exposure of auditors. (0101-705) **Credit 4**

0101-709 Basic Taxation
A basic introductory course in federal income taxation. Emphasis is on taxation of individuals and sole proprietorships. Topics include income measurement and deductibility of personal and business expenses. (0101-703) **Credit 4**

0101-710 Advanced Taxation
A continuation of Basic Taxation. Emphasis is on the tax treatment of property transactions and the taxation of business entities. Also covers the use of technology to prepare complex returns and to research tax issues. (0101-709) **Credit 4**

0101-722 Advanced Cost Management
A study of alternative approaches to identifying and proactively managing the costs of providing services and/or manufacturing and distributing products. The focus is on the development of cost data in ambiguous situations to assist managers in decision-making about future activities. Current issues in cost management receive special attention. (0101-706 or permission of instructor) **Credit 4**

0101-737 Accounting and Enterprise Information Systems
Planning, designing, acquiring, implementing, using, and managing accounting information systems in complex settings. Emphasis is on accounting applications of enterprise resource planning systems. Students may not receive credit for 0101-737 and 0112-760 Integrated Business Systems. (Accounting Information Systems, 0101-345 or equivalent) **Credit 4**

0101-738 Information Systems Auditing and Assurance Services
An examination of the unique risks, controls, and assurance services resulting from and related to auditing financial information systems with an emphasis on enterprise resource systems. (1010-708 or equivalent) **Credit 4**

0101-758 Seminar in Accounting
Special topics seminars offer an in-depth examination of current events, issues and problems unique to accounting. Specific topics will vary depending upon student and faculty interest and on recent events in the business world. Seminar topics for a specific quarter will be announced prior to the course offering. These seminars may be repeated for credit since topics normally vary from quarter to quarter. (Depends upon topic) **Credit 4**

0101-794 Cost Accounting in Technical Organizations
A first course in accounting for students in technical disciplines. Topics include the distinction between external and internal accounting, cost behavior, product costing, profitability analysis, performance evaluation, capital budgeting, and transfer pricing. Emphasis is on issues encountered in technology intensive manufacturing organizations. This course is not intended for College of Business students. **Credit 4**

0101-795 Financial Accounting Theory and Research
This course examines the theoretical concepts, definitions, and models espoused in the accounting literature and relevant to analyzing various contemporary issues in financial accounting and reporting. (0101-705 or equivalent) **Credit 4**

Management

0102-710 Managing for Environmental Sustainability
Environmental sustainability means satisfying today's ecological needs without compromising the ability to meet tomorrow's needs. This course will examine how firms can use sustainable practices, such as pollution prevention and green design, and still be successful in a competitive marketplace. The course will look at the concept of environmental sustainability and the current state of social and political pressures for more sustainable business practices. It will also explore successful sustainable business strategies, and the management processes needed to support them. **Credit 4**

0102-720 Entrepreneurship and New Venture Creation
This course studies the process of creating new ventures with an emphasis on understanding the role of the entrepreneur in identifying opportunities, seeking capital and other resources, and managing the formation and growth of a new venture. Students will typically write a business plan in this course. **Credit 4**

0102-740 Organizational Behavior and Leadership
This course examines why people behave as they do in organizations and what managers can do to improve organizational performance by influencing people's behavior. Students will be exposed to the ways in which organizations and their members affect one another and to different frameworks for diagnosing and dealing with problems in organizational settings. Topics include motivation, team building, conflict resolution, leadership, organizational change, and managing organizational cultures. **Credit 4**

0102-741 Managing Organizational Change
This course examines various theories and approaches currently used to assist organizations in achieving change. The features of successful change in organizations will be discussed, with an emphasis on the structural, motivational, interpersonal, and social aspect of organizational change. Topics include the processes of envisioning and implementing change, as well as, the roles and perspectives of change agents and change recipients. (0102-740) **Credit 4**

0102-742 Introduction to Technology Management
This course is an introduction to the technological process in organizations and the factors, both internal and external, that influence the rate, timing and success of industrial innovations. The interrelationship between science and technology and the importance of these two disciplines on the process of technological innovation is examined. Also discussed is the process of R&D management, the strategic management of technology, the dynamics of technology life cycles and organizational influences on engineering and manufacturing processes. (0102-740 or permission of instructor) **Credit 4**

0102-745 Social and Political Environment of Business
This class focuses on the interactions among business, government and society. The course illuminates the role of ethics, social ideology and government policy in guiding business decisions and in providing the conditions for successful competitive activity. Attention is given to understanding the reason for government regulation, as well as the pros and cons of various regulatory approaches. The class also looks at current debates on corporate social responsibilities with regard to stakeholders, including government, consumers, employees, communities and the environment. **Credit 4**

0102-750 Human Resource Management
This course focuses on the importance of managing human resources with an awareness of the legal and regulatory environment. Attention is given to the increasing importance of cooperation among top management, HR managers, line managers and employees. Students will become familiar with workplace planning and employment, human resource development, compensation and benefits, employment and labor relations, occupational health and safety, and managing diversity. (0102-740) **Credit 4**

0102-753 Field Experience in Business Consulting
Students work in consulting teams to assist startup ventures and/or small businesses. Problems are isolated and solutions are then developed. Affiliated course projects may focus on a number of areas. For example, they may seek to develop commercialization plans for specific technologies, products or services; focus on unique problems associated with small businesses, and develop growth strategies. Recommended for students nearing the completion of their program. (0101-703, 0104-721, 0105-761 for business majors; permission of instructor for other colleges) **Credit 4**

0102-756 Power and Influence
Power and influence processes are pervasive and an important part of organizational life. This course has as its objectives enhancing the understanding of these processes and increasing the student's skills in using them. Topics covered include the conditions under which power and politics are more likely to dominate decision processes, assessing the relative power of various actors, understanding the basis for their positions on issues, the sources of both individual and departmental power, power and influence strategies and tactics, and some functional and dysfunctional aspects of organizational politics for both individuals and the organizations involved. (0102 740) **Credit 4**

0102-758 Seminar in Management
Special topics seminars offer an in-depth examination of current events, issues and problems unique to management. Specific topics will vary depending upon student and faculty interest and on recent events in the business world. Seminar topics for a specific quarter will be announced prior to the course offering. These seminars may be repeated for credit since topics will normally vary from quarter to quarter. (Prerequisite depends on topic) **Credit 4**

0102-759 Competitive Strategy
Strategic management involves cross-functional thinking and the integration of different business disciplines such as finance, marketing, organizational behavior and operations. The aim of the course is to provide the techniques and tools to help develop an understanding of how competitive advantage can be created and sustained. Topics include analysis of mission and vision, industry attractiveness, value-chain analysis, firm resources and capabilities, and business-level and corporate-level strategies. There is extensive use of cases. (All other required courses) **Credit 4**

0102-761 Managing Research and Innovation
This course deals with the responsibilities of, and operating problems faced in managers responsible for the research function within high- technology firms. Topics will include: internal technology assessments, the acquisition of technology, domestic and international technology transfer, and the selection and management of R&D projects. Particular attention will be given to motivating and managing creative individuals, organizational alternatives for R&D, and techniques for overcoming barriers to innovation. (0102-742 or permission of instructor) **Credit 4**

0102-762 Managing New Process and Product Development
The course deals with the internal organizational challenges faced by managers of technology-intensive companies. Particular attention is given to management techniques for successfully developing and introducing into the marketplace new products and services. Also discussed is the management of technical groups and project teams, cross-functional integration, organizational support of innovation and creativity and organizational alternatives such as matrix management and skunk works. (0102-742 or permission of instructor) **Credit 4**

0102-763 Behavioral Skills for Managers and Professionals
This course provides the opportunity to develop individual and interpersonal skills that enhance managerial performance in today's high-performance organization. Each student will perform in each of the major skill dimensions and will be given evaluative feedback and the opportunity to incorporate the implications of that feedback into additional performance opportunities. Course participants are also provided with the opportunity to assess their career work preferences and to compare them with the performance expectations of managerial positions. The management styles of each participant are also assessed, and the impact is clarified of the behaviors that flow from each style on the perceptions and performance of others in the organization. (0102-740) **Credit 4**

0102-765 Applied Venture Creation
This project oriented course enables students to gain multidisciplinary experience in entrepreneurship, venture creation, or product/service commercialization through a number of alternative venues. Student teams gain applied and practical knowledge by participating in an actual entrepreneurial or commercialization project. These projects could include: advancing/maturing a student originated business concept through the RIT Student Business Development Laboratory, developing commercialization plans in partnership with various RIT college product/service development projects, or creating commercial business plans for RIT generated intellectual property. Students meet with supervising faculty on a weekly basis. (Faculty permission is required to enroll in the course. See a COB graduate advisor for details.) **Credit 4**

0102-770 Business Research Methods
This course concerns the development, presentation and use of research in managerial decision making. Included are the processes by which meaningful research problems are generated, identification of the relevant literature, rationalizing of the research design and interpretation of findings. Students typically work in small groups to execute a research project in one of the functional areas of business. (0106-782 or equivalent) **Credit 4**

0102-775 Business Ethics
This course examines business ethics from both an organizational and managerial perspective. Students will examine the goal of business organizations, as well as individual conduct in business settings. Ethical reasoning and ethical leadership will guide debate on topics such as: creating an ethical climate in an organization, honesty, affirmative action, environmental ethics, ethics in advertising and sales, financial management, personnel management, and the role of character and virtues in effective leadership. **Credit 4**

0102-795 Innovation Management Capstone
In this MS in innovation management capstone course, students work with faculty and/or industry advisors to integrate their business and technology learning through a substantial research paper or applied project. Both papers and projects will be under the supervision of an instructor from the technology partner college and the course instructor. For research papers, students will review the current research literature and build on the present knowledge base. Their research paper may: discover new knowledge, integrate knowledge from different sources or apply existing knowledge. For applied projects, real-world business problems will be identified and scoped; solutions will be planned and developed. Learning from the applied project will be generalized so that the importance of the work in a broader business context will be clear. (Last quarter of academic program) **Credit 4**

0102-891 Graduate Project
This course number is used to fulfill the graduate paper requirement under the non-thesis option for the MS degree in management. The candidate must obtain approval from an appropriate faculty member to supervise the paper before registering for this course. A practitioner-corporate-oriented research project designed by the candidate and his/her adviser to explore a salient management-related issue. **Variable credit 4–8**

0102-892 Thesis
The thesis is designed to expose the candidate to procedures of research methodology, data gathering and data analysis. A conceptual and theoretical research project will be designed by the candidate and his/her adviser to explore a salient management-oriented issue. The candidate must obtain the approval of an appropriate faculty member to guide the thesis before registering for the thesis. **Variable credit 4–8**

Economics

0103-705 Economics for Managers
The course focuses on the fundamental economic theories most useful for the management of the firm. Applications drawn from current economic events are utilized to better understand the internal and external environments of the firm and to help managers formulate effective business strategies and policies. Although no prior knowledge of economics is required, this is more than just a survey or principles course. Some important intermediate level economics tools of analysis (both microeconomic and macroeconomic) are introduced to provide managers with the skills necessary to apply economics in a meaningful way to enhance business decision-making. (0106-066, algebra or equivalent) **Credit 4**

0103-711 **Microeconomics**
Microeconomics introduces the principles of economic analysis as applied to micro decisions to determine how an organization can achieve its aims most efficiently. This course applies statistical and quantitative tools and the methodological approaches commonly used by economists to business problems such as demand estimation, product pricing, profit maximizing level of output, cost minimizing level of input use, and forecasting. (0103-705 or two economics courses, one in microeconomics and one in macroeconomics with a grade of B or better) **Credit 4**

0103-712 **Macroeconomics**
This is an intermediate macroeconomics course with a focus on the global environment. A framework of product and money market equilibrium is developed that recognizes all economies are linked through international markets for goods, services and capital. Open-economy models are developed to explain economic growth, inflation, interest rates, foreign exchange rates and trade balances. (0103-705 or two economics courses, one in microeconomics and one in macroeconomics with a grade of B or better) **Credit 4**

0103-716 **Seminar in Economics**
Special topics seminars offer an in-depth examination of current events, issues and problems unique to economics. Specific topics will vary depending upon student and faculty interests and on recent events in the business world. Seminar topics for a specific quarter will be announced prior to the course offering. These seminars may be repeated for credit since topics will normally vary from quarter to quarter. (Dependent on topic) **Credit 4**

Finance

0104-721 **Financial Analysis for Managers**
An examination of basic financial theories, techniques, and practices. Topics include: time value of money, valuation, capital asset pricing, risk and diversification, cost of capital, capital budgeting techniques. (0101-703, pre- or corequisite 0106-782) **Credit 4**

0104-722 **Financial Management II**
This advanced course in corporate finance focuses on financing policies, financial planning/control, and other advanced corporate topics. Specific topics include the financing process, alternative financing instruments, restructuring, cost of capital, corporate applications involving options, working capital management and the use of financial budgets/forecasts. (0104-721) **Credit 4**

0104-724 **Problems in Corporate Finance**
This course is designed to give the student greater in-depth understanding of contemporary problems in finance. The focus will be on state-of-the-art techniques of corporate financial management from both a theoretical and practical perspective. Examples of specific topics include: working capital management, capital asset acquisition, capital structure, financial analysis, dividend policy, financial strategy and special topics. The case approach will be the primary method of instruction. The emphasis will be on the analytical and decision making techniques used to develop acceptable solutions. (0104-721, 0104-722) **Credit 4**

0104-725 **Securities and Investment Analysis**
Study of securities and other investment media and their markets. Analysis of investment values based on fundamental analytic procedures, technical analytic procedures, and the impact that modern portfolio theory has on the value of financial assets. Topics include return, growth, risk, accounting procedures, tax considerations and the impact of various institutional arrangements on value determination. (0104-721) **Credit 4**

0104-729 **Seminar in Finance**
Special topics seminars offer an in-depth examination of current events, issues and problems unique to finance. Specific topics will vary depending upon student and faculty interests and on recent events in the business world. Seminar topics for a specific quarter will be announced prior to the course offering. These seminars may be repeated for credit since topics will normally vary from quarter to quarter. (Dependent on topic) **Credit 4**

0104-730 **Financial Institutions and Markets**
An examination of the role of financial intermediation in the economy. The existence of regulations and the expanding level of competition among intermediaries are discussed. The importance of interest rate risk and hedging such risk is extensively covered. Topics include regulatory laws, gap analysis, hedging duration gap exposure, bank performance, pension funds, insurance companies and mutual funds. (0104-721) **Credit 4**

0104-732 **Portfolio Theory**
This course extends the knowledge of risk and return in a portfolio context to active portfolio management. The measurement and evaluation of portfolio performance are analyzed. The importance of asset allocations, international diversification, pension fund management and the use of a wide range of derivative securities to manage risk are explored. (0104-721) **Credit 4**

0104-734 **Working Capital Management**
This course is an examination of the management of current assets and current liabilities. Emphasis is placed upon cash and marketable securities management, cash budgeting, inventory control, accounts receivable management, and short-term and intermediate-term financing. (0104-721) **Credit 4**

0104-735 **Valuing Private Enterprises**
This course revises and extends valuation models for publicly held firms and applies them, with appropriate modification, to private firms. Such methods are useful for valuing new entrepreneurial ventures as well as subsidiaries of public firms. This is a hands-on course where students perform multiple real-world exercises using Economic Value Added (EVA), Market Value Assets (MVA), and Discounted Cash Flow (DCF) as well as hybrid valuation techniques. (0104-721) **Credit 4**

0104-740 **Options and Futures**
This course focuses on financial derivative securities. Their role in financial management is becoming increasingly important, especially in portfolio management. This course covers valuation of various options and futures as well as their use in risk management. Specific topics include option and futures pricing models, option strategies and contemporary topics such as index arbitraging. (0104-721) **Credit 4**

0104-760 **Finance in a Global Environment**
This course has a specific focus on international business problems that are financial in nature. Topics include an examination of the international environment the firm operates in, international investment, exchange rates and the management of risks arising from shifting exchange rates, and the problems of short and long term asset and liability management. (Pre- or corequisite 0104-721) **Credit 4**

Marketing

0105-758 **Seminar in Marketing**
Special topics seminars offer an in-depth examination of current events, issues and problems unique to marketing. Specific topics will vary depending upon student and faculty interests and on recent events in the business world. Seminar topics for a specific quarter will be announced prior to the course offering. These seminars may be repeated for credit since topics will normally vary from quarter to quarter. Prerequisites will vary according to topic. **Credit 4**

0105-761 **Marketing Concepts**
A graduate level introduction to the marketing function, its roles in assessing customer satisfaction, its relationship to finance and manufacturing, and its utilization of quantitative and qualitative management tools. Focus is on the strengths and limitations of using the marketing concept in understanding and resolving end-user concerns in profit and nonprofit environments. The course is structured around the managerially controllable elements of product, price, promotion and distribution, as well as the interrelationships of these elements. **Credit 4**

0105-762 **Advanced Marketing Management**
A course designed to give the student an in-depth knowledge of middle- and upper-level marketing problems and processes. Topics include the tools used by marketing managers in the development, implementation, and control of marketing plans and strategies. (0105-761) **Credit 4**

0105-763 **Buyer Behavior**
The course reviews the major theories that frame the understanding of both consumer (end-user) and business buying behavior. Topics include the buying decision process, the impact of emotion, product knowledge and product involvement on purchasing decisions. In addition, behavioral and social psychology perspectives will be discussed. All perspectives will be applied to designing marketing strategy. (0105-761; corequisite 0106-782) **Credit 4**

0105-764 Channel Management
This course involves a study of the elements and management of marketing channels. A marketing channel is viewed as an interorganizational system involved with the task of making goods, services and concepts available for consumption by enhancing their time, place and possession utilities. The course focuses on how institutions can effectively and efficiently transmit things of value from points of conception, extraction and/or production to points of value consumption. (0105-761, pre- or corequisite: one advanced marketing course) **Credit 4**

0105-765 Professional Sales Management
A critical examination of the activities functions, challenges and opportunities of the sales force manager. The sales management functions will be related to other sectors of the promotion mix as well as the remainder of the marketing mix. An examination of the long term selling process will provide a foundation for this course. (0105-761) **Credit 4**

0105-767 Integrated Marketing Communications
An in-depth view of tools of advertising, sales promotion, public relations, personal selling, direct marketing and Internet marketing. Basic concepts of advertising using print, broadcast, Internet and outdoor media are studied. Planning, budgeting and the roles of advertising agencies are also covered. Students develop a comprehensive promotion plan beginning with the marketing strategy and ending with implementation and evaluation. The project, in which the student plans and prepares a promotion/advertising campaign for a product or service in consultation with the instructor is an integral part of the course. (0105-761) **Credit 4**

0105-771 Marketing Research Methods
This course provides an overview of marketing research and practice especially the methods of measuring, examining, and predicting factors that affect the marketing process. Students will learn about the process of conducting surveys and experiments that includes the following: determining customer requirements, questionnaire design, telephone, mail and electronic surveys, sampling plan design and data analysis. (0105-761, 0106-782 or equivalent) **Credit 4**

0105-772 Internet Marketing: Strategy and Tactics
This course examines the impact that the Internet has on traditional and contemporary business-to-consumer marketing activities. It explores these implications in both strategic and tactical terms to enhance organizations' levels of competitiveness. The course identifies the use of the Internet in enhancing value for consumers and considers the leverage of: the latest technologies, trends, e-culture and innovation through the medium of the Internet. (0105-761) **Credit 4**

0105-773 Database Marketing
This course provides the student with the application of database management to the challenges of relationship marketing. The students will be taught datamining tools which they will use to conduct an analysis of a database and apply it to the design of a relationship marketing plan. (0105-761, 0106-782) **Credit 4**

0105-775 Business-to-Business e-Marketing
The focus of this course is on the effective integration and coordination of various business to business marketing operations within the realm of e-commerce. The course explores from a marketing perspective factors critical to the success of e-business operations and examines the strategies and tactics that organizations can use to build and/or enhance their business to business relationships using electronic tools. (0105-761) **Credit 4**

0105-776 Product and Brand Management
An essential element of corporate success is the management of products and brands. Firms in both consumer and commercial industries often manage their marketing strategies and tactics through the activities of their product and brand managers. This course will examine the role of product and brand managers in the development and execution of strategies that deliver value to targeted customers and grow the business. The role of product and brand managers will be examined through all phases of the firm's product and brand life cycle. The course emphasizes the decisions that firms expect product and brand managers to make to achieve market share and financial objectives. (0105-761) **Credit 4**

0105-778 Commercializing New Products
This course emphasizes the marketing and product strategy-related activities required to create, develop and launch successful new products. Topics covered include identifying the market opportunity for new products, defining the product strategy, understanding customer requirements, developing and updating the product business plan, marketing's role in the firms product development process, developing the marketing plan for launching new products, and managing the product life cycle. The course emphasizes best practices in marketing-related activities required for successful new product commercialization. (0105-761, pre- or corequisite 0102-742) **Credit 4**

Decision Science

0106-743 Operations Management
Study of the management of production and operations management. Encompasses both manufacturing and services. Topics include operations strategy; forecasting; work systems; inventory management; capacity and materials planning; JIT; supply chain management; international operations; quality management, quality control, and quality improvement; project management; and current issues. (0106-782 or equivalent) **Credit 4**

0106-744 Project Management
A study in the principles of project management and the application of various tools and techniques for project planning and control. This course focuses on the leadership role of the project manager, and the roles and responsibilities of the team members. Considerable emphasis is placed on statements of work and work breakdown structures. The course uses a combination of lecture/discussion, group exercises, and case studies. **Credit 4**

0106-745 Quality Control and Improvement
Study of total quality management (TQM), including Deming's philosophy, quality planning, quality cost principles, problem solving methods and tools, the use of statistical methods for quality control and improvement, supplier relations, reliability concepts, and recent developments in quality. The course focus is on the management and continuous improvement of quality and productivity in manufacturing and service organizations. (0106-782 or equivalent) **Credit 4**

0106-747 Managing Manufacturing Resources
This course focuses on the effective management of resources in manufacturing companies. Topics focus on: manufacturing strategy from a business perspective; business process improvement and change management; human resource management—current relationships/compensation, diversity, career management; risk management including how to identify and risk mitigation; value/supply chain management with strategic make/buy. (This course for MM&L degree program) **Credit 4**

0106-749 Manufacturing Strategies and Tactics
This course integrates the skills learned in operations management with the fundamental disciplines of accounting, financial, and marketing management. Key focuses in the course are manufacturing strategy, the creation and maintenance of a culture for continuous improvement, and the management of change. Manufacturing is investigated in a global context, including the foreign and domestic firms and the strategies and tactics employed by them. The viability of an economy without a manufacturing base is questioned. Teams develop, execute, and report on a manufacturing strategy audit. (0106-743 or equivalent) **Credit 4**

0106-760 Managing the Supply Chain
Supply chain management is about the management of material, information and cash flows from raw material to the ultimate customer. Fierce global competition and advanced information technology have forced companies to manage the supply chain to increase responsiveness to market dynamics. The course integrates the fundamental disciplines of operations, purchasing, inventory management, distribution, logistics, and marketing. This course provides students with the knowledge and tools necessary to develop, implement, and sustain strategies for effectively managing supply chain issues. (0106-743 or equivalent) **Credit 4**

0106-780 Management Science
This course develops and applies quantitative methods to solve business problems. Tools such as linear and integer programming, sensitivity analysis, simulation and risk analysis are explained. Applications with real and simulated business data are emphasized. (0106-782 or equivalent) **Credit 4**

0106-782 Statistical Analysis for Decision Making
This is a course in applied statistics emphasizing inference (estimation and testing). Topics to be covered include: review of descriptive statistics, normal distribution, sampling distributions, estimation, test of hypothesis for single and two populations, linear, multiple regression and model building methods. (Grad Math Review 0106-066 or equivalent statistics course) **Credit 4**

0106-795 Seminar in Decision Science
Special topics seminars offer an in-depth examination of current events, issues and problems unique to decision sciences. Specific topics will vary depending upon student and faculty interests and on recent events in the business world. Seminar topics for a specific quarter will be announced prior to the course offering. These seminars may be repeated for credit since topics will normally vary from quarter to quarter. (Dependent on topic) **Credit 4**

Business Legal Studies

0110-730 Business Legal Concepts
This course provides an introduction to legal procedure and the substantive laws that govern businesses. The course explores the background and origin of the US legal system as well as its legal and regulatory agencies. Representative topics will include review of the U.S. Constitution and the U.S. court system, basics of civil and criminal procedures, torts, contracts, criminal law, bankruptcy, antitrust, intellectual property, and business and consumer protection. **Credit 4**

0110-731 Commercial Law
Explores the impact of the Uniform Commercial Code on business operations. Emphasis on topics included on certified public accounting exam. Topics covered include sales, commercial paper, corporations, partnerships, joint ventures, sole proprietorships, bailment and agency. Topical cases and examples are used to help the student grasp the business implications of the law and its nomenclature. A research project on legal issues is an important aspect of this course. (0110-730 or equivalent) **Credit 4**

0110-740 Legal Aspects of Electronic Commerce
This course introduces the student to legal issues unique to electronic commerce. Utilizing legal research, writing and analytical skills, students will examine jurisdiction, e-contracts, forum selection, click on agreements, shrink wrap agreements, electronic transfers, work place privacy, torts and selected statutes such as the Digital Millennium Copyright Act. Students learn how to analyze the information researched; and communicate, in writing, the substantive and analytical findings in the appropriate legal format to advise a fictitious e-commerce business and solve its legal problems. (0110-730 or equivalent) **Credit 4**

0110-745 Legal and Ethical Issues in Technology Intensive Environments
The course confronts graduate students with a wide variety of legal and ethical issues in organizational environments that are technologically intensive, such as information technology and the life sciences. Impacts of intellectual property legislation and legal cases in national and international venues are investigated. Legal and social issues involving individual privacy are argued. This exposure to legal and ethical dilemmas is an important tool as the graduates encounter such situation throughout their careers. Coupled with technical proficiency the ability to deal with legal and ethical issues shapes professional successes and failures. Not available to students who have completed 0102-785. **Credit 4**

0110-758 Seminar in Business Legal Studies
Special topics seminars offer an in-depth examination of current events, issues and problems unique to business legal studies. Specific topics will vary depending upon student and faculty interest and on recent events in the business world. Seminar topics for a specific quarter will be announced prior to the course offering. These seminars may be repeated for credit since topics normally vary from quarter to quarter. (Prerequisites depend upon topic) **Credit 4**

Management Information Systems

0112-710 Information Systems Concepts
This course is an introduction to the conceptual and theoretical foundations of management information systems and their role in modern organizations. The course will provide students with the concepts, tools, and techniques needed to understand and interpret information management issues, such as how to best incorporate information technology into an organization, from a managerial perspective. **Credit 4**

0112-715 Information Technology and Globalization
This course explores the professional and organizational implications of managing in an era of expanding globalization and revolutionary change in Information Technology (IT). Course participants will 1) Develop awareness of critical intersections between IT and globalization; 2) Address the challenges facing world business through a series of timely projects that address an individual culture's adoption of IT. A unique aspect of the course is the interaction of two very current business forces, around which revolve some of the most significant business questions of our time. **Credit 4**

0112-720 Information Systems Design
This course provides students with fundamental knowledge and skills required for successful analysis of problems and opportunities and the design and implementation of information systems. Students are provided with knowledge and experience that will be useful in determining systems requirements and developing a logical design. (0112-710) **Credit 4**

0112-725 Data Management
This course discusses issues associated with data capture, organization, storage, extraction, and modeling for planned and ad hoc reporting. Enables student to model data by developing conceptual and semantic data models. Techniques taught for managing the design and development of large database systems including logical data models, concurrent processing, data distributions, database administration, data warehousing, data cleansing and data mining. (0112-710) **Credit 4**

0112-730 Information Systems Consulting
This course provides students with fundamental knowledge and skills required for information systems consulting. Topics covered include client relationship management, information systems requirements analysis, proposal development, scope negotiation, costing, knowledge acquisition and management, system design, solutions deployment and systems integration, outsourcing and change management. (0112-720) **Credit 4**

0112-735 Network Technologies
This course is designed to give students basic knowledge of the networking strategies that are utilized within the corporate IS environment. Emphasis is on the current trends in local area networking as they relate to business needs. Class sessions are composed of lectures and discussions. **Credit 4**

0112-745 Information Systems Development
Systems Development provides MBA students with the fundamental techniques and concepts necessary for programming in a modern programming language. Emphasis will be placed on Object Oriented programming concepts. By the end of the course, students will demonstrate core programming concepts, and will be able to write simple business applications. **Credit 4**

0112-755 Information Systems Management
This course involves the study of information systems (IS) management and focuses on issues and problems faced by managers of information technology. Topics include information systems planning, computer integrated manufacturing, systems development, establishment of IS standards, e-business, and other management principles relevant to IS. The course utilizes Harvard cases and research papers to illustrate important concepts. (0112-710) **Credit 4**

0112-760 Integrated Business Systems
This course focuses on basic concepts and technologies associated with integrated enterprise-wide business information systems. It includes a small amount of hands-on experience with the navigation of the SAP R/3 system. Topics include an overview of Enterprise Resource Planning (ERP) systems, the concepts and technologies required to integrate the systems of large business organizations, and implementation issues associated with integrated business systems. (Familiarity with MS Office Suite and Internet browsers) **Credit 4**

0112-761 Business Process Analysis and Workflow Design
Everyone who works in any organization is involved in a process. This course is about the evaluation, design, and, where possible and useful, automation of processes in organizations. Approaches to analyzing and designing processes are covered as well as the use of graphic modeling techniques that will allow for clear and simple definition of processes. Systems used for automating process workflow will be introduced and hands-on use of SAP's R/3 workflow application will be introduced. (Familiarity with MS Office Suite and Internet browsers) **Credit 4**

0112-795 Seminar in Management Information System
Special topics seminars offer an in-depth examination of current events, issues and problems unique to MIS. Specific topics will vary depending upon student and faculty interests and on recent events in the business world. Seminar topics for a specific quarter will be announced prior to the course offering. These seminars may be repeated for credit since topics will normally vary from quarter to quarter. **Credit 4**

International Business

0113-710 Global Business Environments
In this introduction to global business we consider the opportunities and threats posed by global changes, especially those of major market groupings such as NAFTA and EU and the emergence of China as an economic force. In response to these changes, new modes of doing business as well as categories of business are developing and these will be studied, specifically: drivers to globalization, alternative business environments and risk, foreign exchange risk, trade theory, market entry strategies, alliances, foreign direct investment, outsourcing, intellectual property (IP) and its protection. Note: Prior to Fall 20071, this course was numbered 0102-780. **Credit 4**

E. Philip Saunders College of Business

0113-730 **Managing in a Global Environment**
An analysis of comparative global business behavior and organization with particular emphasis on values, authority, individual and group relations, labor-management ties, risk tolerance, and motivational techniques. The course will prepare students to recognize different values and cultural factors in the global business community and how these shape and determine appropriate management behavior. The problems and opportunities of transferring management practices from one culture to another will also be examined. (0102-740) Note: Prior to Fall 20071, this course was numbered 0102-760. **Credit 4**

0113-750 **Marketing in a Global Environment**
This course has a specific focus on the international marketing challenges facing firms operating in developing and developed country markets. Topics will include an examination of the international environment and its impact on marketing decisions, international pricing and promotion, product-market entry and penetration strategies, and how to organize international marketing operations for maximum effectiveness. (0105-761) Note: Prior to Fall 20071, this course was numbered 0105-766. **Credit 4**

0113-720 **Global Issues and Strategies**
This capstone course will focus on either contemporary issues or problems in international business or regional studies analysis (e.g., Europe, Eastern Bloc, Pacific Basin). It will emphasize faculty-directed student research projects. (0113-710) Note: Prior to Fall 20071, this course was numbered 0102-782. **Credit 4**

B. Thomas Golisano College of Computing and Information Sciences

www.gccis.rit.edu

Jorge L. Diaz-Herrera, Dean

Established in the summer of 2001, the B. Thomas Golisano College of Computing and Information Sciences is the newest and one of the largest at RIT. Included in the college are the departments of computer science; information technology; networking, security, and systems administration; software engineering; and the Center for Advancing the Study of Cyberinfrastructure. With its focus on interdepartmental and intercollege cooperation, the college addresses computing in the broadest sense. The Golisano College of Computing and Information Sciences has more than 90 faculty, 2,700 students, more than 40 technical and support staff and extensive, state-of-the-art facilities dedicated to teaching, research and development. Offering degree programs in computing at the doctoral, master's and bachelor's levels, the college is one of the most comprehensive computing colleges in the United States, and is positioned to become a national leader in the computing disciplines.

The college's programs address the growing need for experts in the fields of computational science, gaming, simulation, edutainment, management of complex information technology infrastructures and software engineers. They offer the most current thinking in computing and information sciences technology, and are supported by extensive laboratory facilities.

Courses are available during the day and evening, allowing for full- or part-time study. The MS degrees in software development and management, learning and knowledge management systems and portions of the information technology and networking programs also are offered in online or distance learning format. The advanced certificate in learning and knowledge management is offered online.

Programs

Doctor of Philosophy degree in:

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Master of Science degrees in:

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Advanced Certificates in:

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⇆ Learning and Knowledge Management Systems	p. 72

⇆ *Online learning option available*

Research

The Golisano College of Computing and Information Sciences supports learning and research across disciplines through our Center for Advancing the Study of Cyberinfrastructure, where students, faculty and industry converge to explore and develop innovative applications of emerging technologies. Typically, the center and an industry partner develop a proposal and plan of work. A project team (often multi-disciplinary) is formed consisting of RIT technical staff, faculty and students. The center has conducted projects for the United States Department of Education, Microsoft, Hewlett-Packard, IBM, Cisco, Xerox and Sun Microsystems, among others.

Faculty

Any academic unit can be only as strong as its faculty. The college's faculty is a dedicated group of teacher-scholars and scholar-teachers, performing applied research with an emphasis on student involvement and career preparation. Faculty members provide leadership by implementing innovative teaching techniques and anticipating and meeting the needs of students and our industrial partners. Most have significant industrial experience in addition to outstanding academic credentials.

Resources

The highly technical nature of our programs demands excellent facilities and equipment. The college houses extensive laboratories containing powerful computing devices and workstations, as well as appropriate, up-to-date software. Labs are available to students 16 to 18 hours a day. Network, wireless and Web access also are available throughout the college, insuring that our students have the tools necessary to complete their assignments and projects.

To provide adequate space for this equipment, a 126,000 square-foot building was completed in 2003. This allows for both general-use and specialized labs, such as those dedicated to networking, security, entertainment technology, human-computer interaction and computer vision. Students and faculty also have access to the Lab for Applied Computing. Equipped with more than 1,500 computer workstations and more than 50 classrooms, labs and studio labs, all with the latest technology, the college prides itself in having the very best for students.

Financial Aid

Scholarships and graduate assistantships are available in each department. Details can be obtained from the departmental graduate program coordinator.

Cooperative Education

An optional cooperative educational experience is available for those MS students who wish to participate, in order to gain industrial experience. Students register for a zero-credit graduate cooperative education course at no cost. The Office of Cooperative Education and Career Services will assist students in finding co-op placements, but students may find positions on their own. Normally, students should have completed at least two-thirds of the required course work before finding a co-op position.

Additional Information

B. Thomas Golisano College of
Computing and Information Sciences
Rochester Institute of Technology
20 Lomb Memorial Drive
Rochester, NY 14623-5608
(585) 475-7203

Doctor of Philosophy in Computing and Information Sciences

Evelyn Rozanski, Ph.D., Interim Associate Dean, Graduate Studies and Research
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This use-inspired basic research degree is designed to produce independent scholars, well-prepared educators, and cutting-edge researchers poised to excel in their work within interdisciplinary environments and industries. The degree highlights two of the most unique characteristics of the Golisano College—the breadth of its program offerings and its scholarly focus on discovering solutions to real-world problems by balancing theory and practice.

The Ph.D. program focuses on the theoretical and practical aspects of cyberinfrastructure as applied to specific problems across multiple domains. It is a blend of the intra-disciplinary computing knowledge areas of interaction, informatics, and infrastructure, with interdisciplinary domain areas.

Cyberinfrastructure

The National Science Foundation defines cyberinfrastructure (CI) as a comprehensive infrastructure integratin hardware, data, networks, and digitally-enabled sensors to provide secure, efficient, reliable, accessible, usable, and interoperable suites of software and middleware services and tools. This Ph.D. program is playing a leadership role in the CI research area by providing human-centered CI tools for the science and engineering communities. The worls-class CI tools and services focus on such areas as high performance computing; data analysis and visualization; cyber-services and virtual environments; and, learning and knowledge management.

Intra-disciplinary knowledge areas

The intra-disciplinary computing knowledge areas are organized into three areas: interaction, informatics, and infrastructure. Interaction refers to topics related to the combined action of two or more entities (human or computational) that both affect one another and work together when facilitated by technology. It in turn encompasses several subtopics relating to how people and technology interact and interface. There are several common threads that weave through all of the areas Many of them rely heavily and build upon foundations in the social, cognitive, and behavioral sciences with an emphasis on understanding human phenomena and social/organizational phenomena. To some extent, these fields follow an engineering approach to the design of interactions in which solutions are based on rules and principles derived from research and practice, but require analyses that go beyond the analytical approach. From this perspective, solutions can be measured and evaluated against goals and intended outcomes. However, while efficiency and effectiveness are often the watchwords of these fields in practice, this is also where science meets art in computing, and creative design,

and sensitivity to human needs and aesthetics are critical.

Informatics is the study of computational/algorithmic techniques applied to the management and understanding of data-intensive systems. It focuses on the capture, storage, processing, analysis, and interpretation of data. Topics include primarily algorithms, complexity, and discovery informatics. Data storage and processing require investigation into tools and techniques for modeling, storage, and retrieval. Analysis and understanding require the development of tools and techniques for the symbolic modeling, simulation, and visualization of data. The increased complexity of managing vast amounts of data requires a better understanding of the fundamentals of computation. These fundamentals include complexity theory to determine the inherent limits of computation, communication, cryptography, and the design and analysis of algorithms to obtain optimal solutions within the limits identified.

Infrastructure comprises aspects primarily related to hardware, software (both system software and applications), communications technology, and their integration with computing systems through applications. The focus is on the best organization of these elements to provide optimal architectural solutions. It includes, on the hardware side, system-level design (e.g., for system-on-a-chip solutions) and their building block components. On the software side, it covers all aspects of systems and applications software development, including specification and design languages and standards; validation and prototyping, and multi-dimensional Quality-of-Service management; software product lines, model-driven architectures, component-based development, and domain-specific languages; and project estimation, tracking, and oversight. The communications subtopic includes sensor networks and protocols, as well as active networks, wireless networks, mobile networks, configurable networks, and high speed networks; as well as, network security and privacy, quality of service, reliability, service discovery, and integration and interworking across heterogeneous networks. At the system level there are issues related to conformance and certification; system dependability, fault tolerance, verifiable adaptability, and reconfigurable systems; and real-time, self-adaptive, self-organizing, autonomic systems.

Interdisciplinary domain areas

The Ph.D. program also focuses on the interaction between computing and non-computing disciplines, or areas of *domain-specific computing,* in science, engineering, arts, humanities, and business. By incorporating *domain-specific computing*, following the philosophy of use-inspired research, the research conducted in this program applies computing and information science principles to the solution of problems in application domains that lie outside of the scope of the traditional computing discipline. The research requirement incorporates fundamental concepts in cyberinfrastructure necessary for understanding the problems commonly encountered in advancing scientific discovery and product development in cross-disciplinary domains.

Some of the interdisciplinary domain research areas are: astro-informatics; bio-medical informatics; computational biology; computational science; environmental informatics; services sciences; and, electronic commerce.

Admission requirements

Entry into the Ph.D. program is typically directly from a baccalaureate program. Students with graduate degrees are also encouraged to apply.

Admission to the Ph.D. in computing and information sciences is highly competitive and successful applicants will, in general, have records considerably stronger in breadth or quality than the minimum standards suggest. Applicants should also be aware that meeting the requirements does not guarantee admission.

Applicants will be evaluated on the basis of their prior academic record and their potential for creative research. Admissions decisions are made by the admissions committee, which is comprised of the faculty members of the program. Admissions decisions will generally be made in the winter for admissions in the Fall quarter.

Minimum requirements for consideration include:

- Baccalaureate degree or its recognized equivalent. Since the doctoral program in computing and information sciences encompasses a wide variety of disciplines, we seek students with diverse backgrounds. While most students will come from a computing-related discipline, students in engineering, science, humanities, fine arts, business, and other disciplines along with computing backgrounds are encouraged to apply.
- Strong record of academic achievement as indicated by official transcripts.
- Mathematical skills equivalent to college-level courses in discrete mathematics, and probability and statistics.
- Recommendations from at least two individuals who are well-qualified to assess the student's potential for success in a doctoral program.
- Professional or research paper writing sample(s), if available.
- Written statement defining the student's research interests.
- Current resume with current position, if applicable.
- Optional portfolio of previous work.

GRE Scores

Recent results (within five years) of the Graduate Record Examination (GRE) are required.

TOEFL Scores

The Test of English as a Foreign Language score is required for every applicant for whom English is not the native language. A score of at least 570 (paper-base), 88 (Internet-based), or 230 (computer-based) is required. Exceptions can be made for an applicant whose academic record is strong. Upon arrival at RIT, students whose native language is not English may be required to take the Michigan English Test and follow the recommendations of RIT's English Language Center.

Interview
An interview by one or more of the doctoral program faculty and/or admissions committee will be required for candidates considered for admission prior to final selection. This interview may be via telephone.

Transfer Credit
Students transferring into the program from a masters program in a computing and information sciences discipline, or in a related domain-specific discipline, may be granted up to 28 quarter-based credit hours towards the Ph.D. degree requirements. However, students are not eligible to earn an additional master's degree if the student already holds an MS degree in a computing and information sciences or related field from RIT or another university.

The transfer credit evaluation will not be made until after the first year of study. Consideration for transfer credit will include the appropriateness to the student's intra and inter-disciplinary program of study and research interests.

Assistantships
A limited number of assistantships, including tuition and stipend, are available and awarded on a competitive basis. Students working on funded research projects will be required to be available during the day for project commitments

Curriculum
The program requires a minimum of 111 quarter-credit hours beyond the baccalaureate level. These credit hours are comprised of graduate-level coursework, including seminar attendance and research credits.

Required Courses

4040-810	Research Methods
4040-820	Discovery
4040-830	Connectivity
4040-840	Security and Trust
4040-850	Design
4040-900	Collaborative Practicum
4040-801	Student Research Seminar*
4040-896	Cyberinfrastructure Colloquium
4040-807	Teaching Skills Workshop I
4040-808	Teaching Skills Workshop II
4040-809	Teaching Skills Apprenticeship

**Student Research Seminar (4040-801) may be taken more than once.*

Intra-disciplinary specialty electives (20 quarter credit hours)
The curriculum draws from the offering of the graduate programs within the Golisano College as well as from domain-specific graduate offerings from other colleges at RIT. A large selection of graduate level courses already exists in the college, as well as in other colleges at RIT. These courses are taught on a regular basis in support of the various master's programs being offered, and are the bulk of the elective courses for students' area of specialization.

Students are required to take courses from two of the three knowledge specialty areas: interaction, informatics, or infrastructure.

Interaction
Some of the specialties available in this area are:

4004-745	Foundations of Human-computer Interaction
4004-748	Usability Engineering
4004-749	Usability Testing
4004-755	Advanced Topics in HCI
4002-765	User-centered Design Methods
4002-892	CSCW and Groupware

Computer-Based Instructional Systems – Courses in this area will allow students to conduct research on the effectiveness of instructional systems and be involved in the development and evaluation of new instructional tools.

4002-723	Interactive Courseware
4002-820	Simulations and Learning Environments
4002-828	Intelligent Computer Based Instruction
4002-812	Knowledge and Content Objects
4002-728	Models of Human Performance
4002-845	Economics of Human Performance

Informatics
Some of the specialties available in this area are:

Core Informatics – Courses in this area cover the increased complexity of managing vast amounts of data.

4005-700	Foundations of Computing Theory
4005-709	Combinatorial Computing
0301-794	Information Theory
4005-704	Complexity Theory
4005-705	Cryptography
4005-780	Computer System Security
4005-735	Parallel Computing
4010-750	Software Modeling
4005-800	Theory of Computer Algorithms

Discovery Informatics – Courses in this area study the closely related problems of data management, knowledge discovery, and pattern recognition.

4005-771	Database Systems
4005-759	Data Mining
4005-759	Database Management Concepts
4005-772	Database Systems Implementation
4005-779	Secure Database Systems

Intelligent Systems – Courses in this area focus on developing models that are biologically inspired and that leverage current knowledge in cognitive science, neuroscience, computer science, and engineering with the goal of developing systems that understand a given environment.

4005-750	Introduction to Artificial Intelligence
4005-759	Biologically Inspired Intelligent Systems
4005-755	Neural Networks and Machine Learning
0301-770	Pattern Recognition
4005-757	Introduction to Computer Vision
4005-759	Advanced Computer Vision

Infrastructure
Some of the specialties available in this area are:

Networks and Security – Courses provide in-depth study in design, modeling, and implementation in the security-related and performance analysis aspects of data/communication networks.

0306-710	Network Design, Modeling and Simulation
4002-817	Emerging Network Technologies
4005-742	Ad-hoc Networks
4002-755	Secure Wireless and Wired Data Networks
4005-743	Secure Operating Systems and Networks
0306-772	Wireless Networks
4002-760	Computer Viruses and Malicious Software
4002-780	Computer System Security
4002-841	Advanced Computer Forensics
4002-882	Enterprise Security

Digital Systems and VLSI – Courses in this area cover the design, modeling, and evaluation of modern computing systems, including hardware, software, and their integration.

0306-756	Multiple Processor Systems
0306-722	Advanced Computer Architecture
0306-772	Embedded and Real-time Systems
0306-731	VLSI Design Projects
0306-772	Advanced Digital Modeling
0301-730	Advanced Analog IC Design
0301-726	Mixed Signal IC Design
4005-730	Distributed Systems I

Inter-disciplinary Domain Courses (12 quarter credit hours) in an area directly related to the student's research project. Example areas include: astro-informatics; bio-medical informatics; computational biology; computational science; environmental informatics; services sciences; and, electronic commerce.

Advanced Electives (8 quarter credit hours), with adviser approval, are designed to further a intra-disciplinary computing specialty or inter-disciplinary domain area.

Dissertation (32 quarter credit hours)
Students will be required to conduct original, use-inspired research involving two of the three knowledge areas of interaction, informatics, and infrastructure, and apply them to a domain.

Residency Requirement

Two years of full-time residency (minimum of 9 quarter credit hours for 6 consecutive quarters, not including summer) and register each quarter during their residency for the Student Research Seminar course.

Assessments

Each student must pass four (4) examinations in the following order:

- Breadth Assessment after the core coursework (after the first year)
- Depth Assessment after the computing specialization and domain coursework (typically after the second year)
- Thesis Proposal Defense (committee approval) after the thesis proposal is written
- Dissertation Defense after all coursework, research, and the first three assessments have been successfully completed and the dissertation written

Networking, Security and Systems Administration Department

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The MS in networking and systems administration recognizes two potentially opposing trends currently at work in industry. One trend is for a reduction in staffing levels and increased calls for efficiency and management oversight in the provision of information technology services. The opposing trend is for increasingly complex network environments, and a greater recognition of the power of information technology to be a strategic enabler of corporate adaptation. These trends can only coexist through a reliance on a highly educated and technologically proficient networking, security and system administration staff that understands both the technology and the application of that technology to business issues and opportunities.

The MS in networking and system administration is designed to provide students with the educational background and skills to compete successfully in this environment. Additionally, two graduate certificates, one in networking and system administration and the other in computer and network system security, are under development.

Laboratory facilities

Most networking, security and system administration courses are laboratory-based. The computing facilities of the department are driven solely by curricular and research needs. Students use these facilities to investigate concepts and design and develop systems to meet the needs of the ever-evolving information age. Many of our students also work as lab assistants or graduate assistants, adding an additional practical dimension to their educational experiences.

The five labs supporting the curriculum are:

- Projects Lab
- NetLab
- SysLab
- Telephony Integration and Real Time Data Lad
- Security Lab

Master of Science in Networking and Systems Administration

The master of science degree in networking and systems administration enables the matriculated student to study, develop and become proficient in the practices, methodologies and techniques used in the management of a modern IT infrastructure. The focus is on enterprise-level problems and solutions, addressing the needs of a medium- to large-scale organization.

The underlying principle of this program is that effective technical leadership in modern enterprises relies on a combination of technical knowledge with an understanding of basic business concepts. This program is designed for part-time study at a distance (online learning), as well as full-time, on-campus education.

Admission requirements

Applicants should have a baccalaureate or equivalent degree from an accredited institution and a minimum cumulative grade point average of 3.0 (B). Applicants must submit two professional recommendations.

Applicants from foreign universities must submit Graduate Record Examination scores. The GRE score also is recommended for those whose undergraduate grade point average is less than 3.0. Visa forms cannot be issued by RIT for part-time or distance education.

Applicants whose native language is not English must take the Test of English as a Foreign Language examination; a minimum score of 570 (paper-based) or 230 (computer-based) is required. Applicants with a lower TOEFL score may be admitted conditionally and will be required to complete a prescribed program in English, along with a reduced program course load.

Bridge program

Students wishing to enter the master's program must have a solid educational or employment record in networking, security and systems administration. If a student does not have the necessary background, bridge courses are provided to allow students to meet these prerequisites. Formal acceptance into the master's program may be possible even though the applicant must complete bridge program courses.

Students whose undergraduate preparation or industrial experience does not satisfy the technical prerequisites of this degree can make up this deficiency through study, taking one or more of the following RIT courses, as prescribed by the graduate program coordinator:

Technical prerequisites

4055-716	C++ for System Administration
4055-721	PERL for System Administration
4055-761	Principles of System Administration
4055-746	Telecommunications Network Protocols

The bridge program courses are not part of the 48 quarter credits required for the master's degree. Grades for bridge courses are not included in a student's graduate GPA if the courses are taken before matriculation; courses that are competed after matriculation are included.

A bridge program can be designed in a variety of ways. Other courses can be substituted, or courses at other colleges can be applied. Contact the graduate program coordinator for approval.

Curriculum

The graduate program of study consists of 12 courses (48 quarter credit hours), which include eight courses (32 quarter credit hours) of required core courses plus another four courses (16 quarter credit hours) as electives from an approved set. Two quarters of optional cooperative work experience are possible.

Core courses:

0102-740	Organizational Behavior and Leadership
0106-744	Project Management
4055-726	Research Methods
4055-817	Emerging Network Technologies
4055-850	Network Design and Performance
4055-863	Protocol Design and Implementation
4055-882	Enterprise Security
4055-897	MS Thesis

Electives must be chosen from the following set of courses:

0101-703	Accounting for Decision Makers
4055-755	Secured Wireless and Wired Networks
4055-760	Computer Viruses and Malicious Software
4055-780	Computer System Security
4055-818	Network Management
4055-841	Advanced Computer Forensics
4055-862	Advanced Routing Protocols
4055-883	Enterprise Networking
4055-884	Enterprise Service Provisioning

Advanced Certificate in Information Assurance

The advanced certificate in information assurance provides students with the knowledge and expertise to: identify and deploy tools and techniques used to secure individual computers and networks from attack; utilize tools and techniques for the analysis of a compromise; and understand and utilize policies, procedures, and standards used to enhance the security of networks and computing systems at all levels including large enterprises.

This program consists of a four-course sequence for those with prerequisite knowledge, and is available in either an online or on-campus format. The online availability of this program will provide a career-enhancing educational opportunity to those who are currently employed in a computing field. If desired, the four courses in the certificate transfer into the following master of science programs: information technology; computing security and information assurance; or the master of science in networking, security, and systems administration.

The advanced certificate program of study consists of the following four courses:

4055-755	Secure Wireless and Wired Data Networks
4055-780	Computer System Security
4055-841	Advanced Computer Forensics
4055-882	Enterprise Security

Admission requirements

Applicants should have a baccalaureate or equivalent degree from an accredited institution, and an undergraduate grade point average of 3.0 or higher on the 4.0 scale.

Those applicants with a GPA that is less than 3.0 may be considered, but may be required to take the Graduate Record Exam (GRE) exam. International students must submit scores from the Test of English as a Second Language of at least 570

(paper-based), 230 (computer-based) or 88 (Internet-based).

Computer Science Department

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The MS program in computer science consists of a core curriculum, a diverse set of clusters and many additional electives. The core provides students with a solid background in the theoretical principles underlying computer science, which ensures that graduates acquire the intellectual tools necessary to keep up-to-date in this rapidly evolving discipline. The clusters provide students with the opportunity to obtain depth in a computer science discipline. The electives add the necessary breadth of knowledge required by industry. This combination prepares our graduates to engineer modern computing systems and contribute in all aspects of systems life cycles. The program helps students prepare for academic or research careers in computer science or a related discipline, as well as further academic study.

Clusters are offered in a variety of areas, such as computer graphics and visualization, data management, distributed systems, intelligent systems, languages and tools, security and theory. Certain preapproved courses from other departments also may be counted toward the degree.

Faculty members in the department are actively engaged in research in the areas of artificial intelligence, wireless networks, computer vision, computational and data management, combinatorics and distributed computing systems. There are many opportunities for graduate students to participate in these activities toward thesis or project work and independent study.

Related MS programs at RIT are computer engineering, in the Kate Gleason College of Engineering, and information technology and software development and management, both in the Golisano College's department of information technology.

Computer facilities

The computer science department provides extensive facilities for students and faculty. The hardware associated with these facilities represents current technology, including:

- a graduate lab with 17 Sun Blade 150 workstations and a graduate library,
- more than 100 Sun Blade 150 workstations,
- wireless access,
- a networking/distributed systems lab with 10 dual-processor Pentiums and its own internal network and
- specialized labs in vision, security, wireless networks, database and artificial intelligence.

Computer science students also have access to computers in the information technology labs (PCs and Macs) and RIT's main Information and Technology Services facilities.

Master of Science in Computer Science

http://www.cs.rit.edu/masters/index.php

The MS in computer science is designed for students who have an undergraduate major or minor in computer science, as well as those who have a strong background in a field in which computers are applied, such as engineering, science or business. Students can concentrate in intelligent systems, languages and tools, distributed systems, security, theory, databases/data mining or graphics.

Some of our graduate students are employed and are pursuing the degree on a part-time basis. Subsequently, computer science graduate courses are generally offered in the afternoon and evening. A full-time student, one who takes three courses per quarter, may be able to complete the course work in one year; part-time students can finish in two to four years. The time required to complete a master's thesis or project varies according to the student and the scope of the project; two quarters is typical.

Admission requirements

Applicants should have a baccalaureate or equivalent degree from an accredited institution and a minimum grade point average of 3.0 (B). RIT undergraduate students in computer science, computational math, biomedical computing or computer engineering technology may study for both their BS and MS degrees through accelerated programs.

Applicants from foreign universities must submit Test of English as a Foreign Language and Graduate Record Exam scores. GRE scores also can be considered for applicants whose undergraduate grade point average is lower than 3.0.

Prerequisites

Applicants must satisfy prerequisite requirements in mathematics and computer science:

Mathematics
Differential and Integral Calculus
Probability and Statistics
Discrete Mathematics

Computing
Experience with a modern high-level language (e.g., C++, Java)
Data Structures
Assembly Language Programming
Software Design Methodology
Introductory Computer Architecture and Digital Logic
Operating Systems
Programming Language Concepts

The Bridge Program

If an applicant lacks any of the prerequisites, bridge program courses are available to allow students to achieve the required knowledge and skills. Generally, formal acceptance into the master's program is deferred until the applicant has made

significant progress through these necessary courses.

Students whose undergraduate preparation or industrial experience does not satisfy the above content or grade point requirements may make up these deficiencies through up to a year of study, taking one or more of the following RIT courses, as prescribed by the graduate coordinator:

Mathematics

1016-281, 282, 283	Calculus
1016-351	Probability and Statistics (Calculus-based)
1016-265	Discrete Mathematics

Computing

4003-231	Computer Science I
4003-232	Computer Science II
4003-233	Computer Science III
4003-334	Computer Science IV
or	
4003-236	Accelerated Computer Science I
4003-233	Computer Science III
4003-334	Computer Science IV
or	
4003-707	Advanced Programming
4003-334	Computer Science IV
and	
4003-710	Computer Organization
4003-709	Programming Language Concepts
4003-713	Operating Systems

If any bridge courses are indicated in a student's plan of study, the student may be admitted on the condition that he or she will successfully complete the bridge program courses with a grade of B or better. All remaining bridge program courses must be completed with a grade of at least B; courses with lower grades must be repeated. The bridge program courses are not part of the 45 quarter credits required for the master's degree.

A bridge program can be designed in different ways. Often, other courses can be substituted, and courses at other colleges can be applied. (See the Computer Science Graduate Studies Handbook for more details.) All programs must be approved in advance by the graduate coordinator.

The curriculum

The graduate program of study consists of 45 credits. There are two tracks to the degree, the thesis track and the project track. The computer science core consists of three courses:

4005-700	Foundations of Computing Theory
4005-800	Theory of Computer Algorithms
4005-893	Graduate Seminar

The thesis track:

- Four courses from a cluster (16 credits)
- Three electives (12 credits)
- Master's thesis (seven credits)

The project track:

- Four courses from a cluster (16 credits)
- Four electives (16 credits)
- Master's project (three credits)

The topic of the project must be in the cluster domain. Only the graduate coordinator can approve an exception to this rule. For either track, students with a strong background in a core area may receive permission from the graduate coordinator to replace a core course with another course, generally in the same area. Only the graduate coordinator can approve changes to a student's program of study.

Clusters and electives

- Computational Vision and Acoustics
- Computer Graphics and Visualization
- Data Management
- Distributed Systems
- Intelligent Systems
- Languages and Tools
- Security
- Theory

In addition, a student is allowed to design his or her own cluster, with the consent of an adviser and the graduate coordinator. A subset of electives and advanced electives is shown below; advanced electives are indicated by "†."

4005-704	Complexity and Computability
4005-705	Cryptography
4005-709	Combinatorial Computing
4005-709	Crytography II†
4005-709	Privacy and Security
4005-710	Programming Language Theory
4005-711	Compiler Construction†
4005-713	XML-Arch, Tools and Techniques†
4005-714	Programming Skills
4005-719	Topics in Programming Languages†
4005-720	Computer Architecture
4005-729	Topics in Computer Architecture†
4005-730	Distributed Operating Systems I
4005-731	Distributed Operating Systems II†
4005-735	Parallel Computing I
4005-736	Parallel Computing II†
4005-739	Topics in Operating Systems†
4005-740	Data Communications and Networks I
4005-741	Data Communication and Networks II†
4005-742	Ad-Hoc Networks
4005-743	Secure Operating Systems Networks†
4005-749	Enterprise Computing
4005-750	Introduction to Artificial Intelligence
4005-751	Knowledge-Based Systems†
4005-755	Neural Networks and Machine Learning†
4005-756	Genetic Algorithms†
4005-757	Introduction to Computer Vision†
4005-759	Artificial Intelligence for Games
4005-761	Computer Graphics I
4005-762	Computer Graphics II†
4005-769	Topics in Computer Graphics†
4005-771	Database Systems
4005-772	Database System Implementation
4005-774	Secure Database Data Mining
4005-779	Advanced Data Mining†
4005-784	Privacy and Security

†*advanced elective.*

Students also may include elective courses from other departments' graduate offerings. See www.cs.rit.edu/~csdoc/graduate for a list of approved courses. Other departments' courses are primarily for their own majors and may have prerequisites that are not approved for degree credit.

Electives provide breadth of experience in computer science

and applications areas. Students who wish to include courses from departments outside of computer science need prior approval of the graduate coordinator. Refer to the course descriptions in the departments of computer science, engineering and business for possible elective courses.

A program of study must be designed in cooperation with the graduate coordinator.

The master's thesis or project

A thesis paper or project forms the capstone of the MS program. In order to register for either, a student must complete the graduate seminar and submit an acceptable proposal to the computer science faculty.

Requirements for the degree must be completed within seven years of the date of the oldest course counted toward the student's program. Bridge courses are excluded.

Information Technology Department

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The information technology department offers master of science degrees in information technology, software development and management, learning and knowledge management systems, game design and development, and programs of study leading to advanced certificates in interactive multimedia development and learning and knowledge management. Graduate courses are given at times of the day convenient to both part-time and full-time graduate students—usually late afternoon and evening. MS degree programs typically take at least one and a half to two years to complete. The MS in game design and development is a full-time, two-year program. Advanced certificates may be accomplished in one calendar year or less.

The master of science degree in information technology enables graduates to contribute to the emerging interdisciplinary field of information technology in a variety of capacities. Students will learn a systematic approach to the design of information technology solutions for contemporary problems, including those found in business and education. All students develop a plan of study that focuses on specific areas of interest within the information technology discipline. For example, students could develop skills in interface design and user task analysis; design and develop interactive Web- or multimedia-based applications with backend database technologies; develop a strategic and technical understanding of networks and communication systems; or apply cognitive and organizational theories to the design of information technology applications and systems. The curriculum for this program is offered on-campus. Portions are available through online learning.

The master of science degree in software development and management prepares students for a broad spectrum of careers in the field of software development. Graduates acquire a solid base of technical and design skills, along with insights into the importance of services science and project management for software development. This program is offered entirely through online learning.

The master of science in learning and knowledge management systems addresses the need for business and industry to create corporate learning resources and to manage both the learning process and corporation knowledge assets. The program covers the knowledge and skills necessary for the planning, creation and implementation of innovative instructional, performance support and knowledge-sharing environments, with a strong social science emphasis. An advanced certificate, based on the first four courses in the MS degree program, also is available. These programs are offered through online learning.

The master of science in game design and development prepares individuals for successful employment in the game and entertainment industries, as well as in other related fields. This is a full-time, two-year program in which students work both individually and in teams that are modeled upon development practices common in the games industry. This program is offered on campus only.

The advanced certificate in interactive multimedia development provides an opportunity for students to gain firsthand knowledge and expertise in the art and science of interactive multimedia design. The focus of this certificate is the enhancement of human communication in electronic environments. Students explore related issues through a series of six core courses in interactive multimedia development. This certificate program is only available on campus.

Laboratory facilities

The computing facilities of the information technology department are driven by curricular needs and the needs of our students, who use our labs to investigate concepts and design and develop content for either stand-alone computers or network delivery. Many of our students also work as lab assistants, adding a practical dimension to their educational experiences.

Many information technology courses are laboratory-based. Some courses have separately scheduled laboratory sessions in which an instructor provides a structured learning experience that reinforces lecture concepts. Other courses are taught in specially designed active learning labs in which each student has a computer. These courses use alternating lecture and hands-on sessions to facilitate student learning. The information technology active learning labs also have display facilities with one or more large screens located at the front of the room, so students can see demonstrations of work and immediately apply them.

Our open labs provide students with access to computing resources outside of scheduled lab and class times. In addition to general laboratory facilities, the IT department has specialized labs that support curriculum in the areas of website design, streaming media, computer games, human-computer interaction, programming and database implementation and administration. Our curriculum is further supported by the laboratory facilities

in the networking, security and systems administration department. Due to our cross-platform commitment, many of our computing labs contain Windows and Macintosh platforms. UNIX is used in several specialized labs.

The information technology database labs are designed to facilitate experimentation with database administration and client/server database concepts. The labs have benches consisting of a mix of Linux- and Windows-based machines that can be configured as either servers or clients. Students can begin by configuring single-user, one-tier environments and progress to multitier networked configurations, where multiple clients interact with typical database management software such as Oracle, through middle-tier or Web server environments.

The information technology streaming-media lab houses the department's video and audio studios, which support sound and video content creation for digital video and animation courses. The digital video production studio has a talk-show style set for streaming video productions, SDI cameras and a chroma key screen. The lab's audio studio is designed for voiceover/narration work, group dialogue and recorded music. In addition to supporting class work, this lab is a creative environment available for student and faculty use. A professional, digital control room complete with soundboard, professional-quality microphones and industry-standard sound editing equipment, as well as video switchers, encoders and media servers, links the two studios.

The entertainment technology laboratory is designed for small-group study. The lab contains high-end PC and Macintosh computers outfitted with state-of-the-art graphic cards and dual monitors on a gigabit network. This lab is used primarily to develop multi-user gaming and social environments. Students in this lab have access to a variety of digital cameras, camcorders, scanners and console video game systems, as well as an HDTV and an overhead projection unit. Students studying interface design also can take advantage of heads-up displays, wearable computing components and other futuristic technologies housed in this lab.

The usability testing laboratory consists of testing rooms and an observation area. Each testing room has a state-of-the-art networked PC and Mac with touch-screen monitors, along with several input devices such as joysticks, haptic mice, track balls, etc. The testing room has a video camcorder on a robotic arm that sends the video feed to the observation area. An intercom system is set up between the two areas to allow for communication. The observation side has a monitor for displaying the user's screen, headsets, a PC for note taking and video and audio recorders.

The networking, security and systems administration department's networking lab is designed to facilitate network exploration. The lab consists of individual workstations that include several PCs, three hubs, routers and a layer-2 switch. Each of the PCs can run "sniffer" software, making each a network analyzer. Additional equipment, such as cable testers, breakout boxes, more hubs, crimping tools and V.35 cables for serial routing, is available from an equipment cage as needed. In addition, each station is cabled to the lab infrastructure to allow it to be its own subnetwork in the lab network or directly connected to the lab network, which provides many topology options.

The networking, security and systems administration projects lab is designed to facilitate learning about hardware and wireless and wired networking topics that exceed those covered in the usability testing or the networking labs. Each station contains multiple PCs and an infrastructure similar to the usability testing and networking labs. A collection of roll-around racks with a variety of networking appliances make the construction of special projects possible and aids in the pursuit of graduate theses.

The networking, security and systems administration systems administration lab is designed to facilitate experimentation in network management and systems administration. The lab consists of computer stations with four PC-compatible computers each. Normally these are configured as a Windows Server, a Windows workstation and two UNIX platforms. However, students can reconfigure these machines as required and save their configurations using disk-imaging software on the lab image server, making this an extremely flexible lab. There are lab-wide servers and a networking infrastructure to enrich the computing environment. The main switch-router in this lab affords six sub-networks per station. Additional hardware and software are available from the equipment cage, to allow students to configure more complex topologies.

The networking, security and systems administration security lab is designed to facilitate student experimentation in the growing field of information security. Each student station consists of multiple PCs capable of running any number of operating systems. This lab is totally isolated from the rest of the campus to allow for in-depth exploration of viruses, firewalls and other security topics. Additional computer equipment such as routers, switches, hubs, testers, firewalls, IDS or IPS may be checked out from an equipment cage.

Our computing facilities are connected to the gigabit RIT campus backbone, which has OC3 connections to the Internet. Students have access to our computer facilities via an Ethernet connection from their residence halls or via dial-up PPP or other connections from off-campus locations. Institutional facilities provide a location for students to develop their own presence on the Web.

RIT's general and specialized information technology laboratories make our facilities one of the most up-to-date in the nation for undergraduate and graduate exploration of information technology concepts.

Master of Science in Computer Security and

Information Assurance

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Developers and practitioners need to understand the importance of building security and survivability into systems, rather than trying to add it once systems are installed. This curriculum addresses these concerns by drawing on the expertise of the faculty from the four departments that make up the Golisano College of Computing and Information Sciences.

The MS in computing security and information assurance includes a foundation of seven core courses designed to give students a better understanding of the technological and ethical roles of computer security in society. Students then develop a specialization in one of several areas by selecting four related elective courses under the guidance of a faculty adviser. Students conclude their program of study with a thesis, completed under the guidance of a faculty mentor. This cross-disciplinary program enables graduates to develop a strong foundation, preparing them for leadership positions in both the private and public sectors in the computer security industry or for an advanced degree. Students also can prepare for academic or research careers in computer security and information assurance, as well as further academic study.

Faculty members in the contributing department are actively engaged in consulting and research in the information assurance areas, including cryptography, databases, networking and software engineering. There are many opportunities for graduate students to participate in these research activities toward thesis or independent study work.

Computing facilities

The computing facilities of the Golisano College are driven by curricular- and research-based needs. The college computing facilities are connected to the gigabit RIT campus backbone with an OC3 connection to the Internet. Students have access to our facilities from off-campus locations, and university facilities provide a location for students to develop their own presence on the Web.

The following computing laboratories, equipped with the latest hardware and software technology, are available to support students pursuing the master's degree in computer security and information assurance:

- Sixteen studio laboratories designed to increase student-instructor interaction. These labs support formal, closed lecture/laboratory instruction and can accommodate 16 to 40 students in a class. Five of these are equipped with heavy-duty Sun Blade workstations while the rest are equipped with up-to-date, high-capacity PCs.
- A networking and distributing systems laboratory focuses on the study of data communications and networking strategies, utilizing a variety of Sun workstations and file servers as networking tools.
- A network laboratory focuses on the physical set-up, configuration and analysis of various internetworking devices, including the Internet. There are 60 computers organized into 20 work areas.
- A systems administration laboratory focuses on the installation, configuration and management of various network services and resources. It includes 80 computers organized into 20 work areas.
- Two security laboratories support all topics in networking and systems security. One is equipped with 48 PCs, organized into 25 work areas, and the other is equipped with a variety of minicomputer workstations, organized into 10 areas.
- A projects lab supports all wireless, network trouble-shooting and network management curriculum with a wide variety of equipment. There are 54 computers organized into 18 work areas.
- A network programming and scripting lab supports all programming and scripting requirements of the security and network curricula. The lab accommodates up to 32 students.
- Three general-purpose laboratories are open daily, including weekends, and are available to all of our majors, as well as those from other programs who are registered in one of our courses. One is a mini-computer Sun workstation lab with 28 stations while the other two are microcomputer laboratories, one with 40 stations and the other with 116.
- A graduate laboratory for use by students in graduate programs.
- Eleven student team rooms equipped with generous whiteboard space, a meeting table and comfortable seating for six. Each team room has one workstation plus six Ethernet connections. Six of the rooms are equipped with computer-ready, ceiling-mounted projectors that can be used to rehearse presentations or increase team productivity during meetings.
- A lab for real-time and embedded systems, with a capacity for 25 students. A $250,000 National Science Foundation grant was awarded to equip this lab with the latest technology. This lab
- Three research laboratories dedicated to the areas of artificial intelligence, computational vision and acoustics, data mining, robotics and wireless networks. They range in size from 12 to 15 stations.
- Three database studio laboratories are equipped with VMware and special database software and servers to support database curricula and research. The largest has 60 computers organized into 20 to 35 areas, depending on purpose. The other two laboratories have approximately 40 computers and can seat from 24 to 35 students.

Computer security and information assurance students also have

access to computers, relevant information technology labs (PCs and Macs) and RIT's main Information Technology Services facilities. Graduate networks are also available to support departmental research, theses, projects and course work. All students have full access to the Internet and the World Wide Web.

General information

The MS in computing security and information assurance is designed for students who have an undergraduate degree in computer science, information technology or software engineering, as well as those who have a strong background in a field in which computers are applied, such as computer or electrical engineering.

Computing security and information assurance graduate courses are generally offered in the afternoon and evening. Some of our graduate students are employed and are pursuing the degree on a part-time basis. A full-time student, one who takes three courses per quarter, may be able to complete the course work in five quarters; part-time students can finish in two to four years. The time required to complete a master's thesis varies according to the student and the scope of the thesis; two quarters is typical.

Admission requirements

Because the program encompasses a wide variety of technical disciplines, students with diverse backgrounds are encouraged to apply. Undergraduate preparation leading to a bachelor of science degree in computer science, software engineering, information technology, computer engineering, electrical engineering, applied mathematics or computer engineering technology usually is required. However, exceptional students from other fields may be admitted on a contingent basis. Applicants should have a minimum grade point average of 3.0.

Applicants must have a strong record of academic achievement from their undergraduate institution, as indicated by official transcripts, proficiency on the Graduate Record Examination and strong recommendations from at least two well-qualified individuals who are able to assess the student's potential for success in the program. It is expected that applicants will achieve minimum scores of 650 (quantitative), 500 (verbal) and 650 (analytical) on the GRE.

Applicants from foreign universities will be required to submit results of the Test of English as a Foreign Language. A minimum score of at least 570 (paper-based), 230 (computer-based) or 80 (Internet-based) is required.

Prerequisites

Applicants must satisfy prerequisite requirements in mathematics and computing:

Mathematics

Integral Calculus
Discrete Mathematics

Computing

Experience with a modern high-level language (e.g., C++, Java)
Operating Systems
OS Scripting
Software Engineering
Computer Networking

Bridge program

If an applicant lacks any of these prerequisites, bridge program courses are available to allow students to achieve the required knowledge and skills. Generally, formal acceptance into the master's program is deferred until the applicant has made significant progress through these necessary courses.

Students whose undergraduate preparation or industrial experience does not satisfy the prerequisites may make up these deficiencies through up to a year of study, taking one or more of the following RIT courses, as prescribed by the graduate coordinator.

Mathematics

1016-281, 282	Calculus
1016-265	Discrete Math I

Computing

4003-707	Advanced Programming
4003-713	Operating Systems
4002-402	OS Scripting
4010-361	Software Engineering
4055-746	Telecommunications Network Protocols

If any bridge courses are indicated in a student's plan of study, the student may be admitted on the condition that he or she successfully completes the bridge program courses with a grade of B or better. All remaining bridge program courses must be completed with a grade of at least "B"; courses with lower grades must be repeated. Bridge program courses are not part of the 49 credits required for the master's degree. These grades are not included in a student's graduate grade point average.

A bridge program can be designed in different ways. Often, other courses can be substituted, and courses at other colleges can be applied. (See the Computing Security and Information Assurance Graduate Studies Handbook for more details.) All programs must be approved in advance by the program chair.

Curriculum

The graduate program of study is composed of core courses, electives and a thesis, for a total of 49 credits. The thesis track consists of:

- Seven required "core" courses (26 credits)
- Electives (16 credits)
- Master's thesis (7 credits)

The computing security and information assurance core

consists of seven courses:

4005-755	Secure Wireless and Wired Data Networks
4002-780	Computer System Security
4005-705	Cryptography I
4005-774	Secure Database Systems
4055-726	Research Methods
4010-748	Secure Software Engineering: Requirements and Design
0110-745	Ethics in Technology
4005-690	Thesis

A subset of electives is shown below:

4002-760	Computer Viruses and Malicious Software
4002-841	Advanced Forensics
4002-877	Secure e-Commerce
4002-882	Enterprise Security
4005-740	Data Communications and Networks I
4005-741	Data Communication and Networks II
4005-743	Secure Operating Systems and Networks
4005-800	Theory of Computer Algorithms
4010-758	Secure Software Engineering: Verification and Validation Seminar
4005-774	Secure Database Systems
	Special Topics
4055-899	Independent Study

Students also may include elective courses from other RIT departments' graduate offerings. Other departments' courses are primarily for their own majors and may have prerequisites that will not be approved for degree credit.

Electives provide breadth of experience in security-related areas within computer science, information technology and software engineering. Students who wish to include courses from departments outside of the list of electives need prior approval of the graduate coordinator.

A program of study must be designed in cooperation with the graduate coordinator.

Master's thesis

A thesis paper forms the capstone of this MS program. In order to register, a student must complete Research Methods (4055-726) and submit an acceptable proposal to the computing security and information assurance faculty.

Requirements for the degree must be completed within seven years of the date of the oldest course counted toward the student's program. Bridge courses are excluded.

Master of Science in Game Design and Development

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The master of science in game design and development defines a program of study that allows students to explore the entertainment technology landscape, along with other related areas of software development. The program has its technical roots in the computing and information science disciplines, while simultaneously covering the breadth of the game development landscape through involvement in topics such as computer graphics design, human-computer interaction, interactive narrative and game world design. The degree is intended specifically for students that aspire to hold careers within the professional games industry or a related field such as simulation, edutainment or visualization.

This is a two-year, on-campus, cohort-based program in which students are admitted through a portfolio review process. Each student selects a major sequence of six courses, to guarantee depth within a specialization area relative to game development, and a minor of three courses in a game-related specialty area of interest. In addition, students complete a seminar track of five courses that brings all students together to explore the areas of overlap and interconnection within their work. This sequence also provides a framework for understanding the game industry as a whole.

Upon completion of their course work, students form development teams that construct a working game engine and software title as the program capstone experience. This capstone requirement includes both individual and group expectations. The capstone culminates in a private defense before program faculty, as well as a public exhibition. Together, the capstone project, the focus on team-based collaborative development, the seminar track on industry issues and the applied nature of the course work provide a unique and comprehensive educational experience for individuals who aspire to a career in the game development industry.

Admission requirements

Due to the cohort nature of the program, students are admitted in fall semesters only. Admission to the program is highly competitive, and applicants are selected in a manner that ensures balance among the various curricular tracks and specialties. Prospective students are expected to have an undergraduate degree in a relevant field, such as computer science, software engineering, information technology or computer graphics. Students with undergraduate degrees in related disciplines such as computer animation or human computer interaction also will be considered.

Admission is based on prior academic performance as well as portfolio examination. The portfolio can include both individual and group projects (clearly marked as such) relevant to the area that the individual wishes to study within the degree program. Prospective students are encouraged to include examples of game construction activities in their portfolios.

To be competitive, applicants should have at least a 3.25 grade point average or a first-class international degree with distinction. Students requesting consideration who have not achieved this level of academic performance should submit strong portfolios and GRE scores.

International applicants who have not received a degree within the United States are required to submit both Test of English as a Foreign Language and Graduate Record Examination scores. A minimum TOEFL score of 230 (computer-based), 570 (paper-based) or 88 (Internet-based) is required.

Prerequisites

Students are expected to have at least one year of significant programming experience in a current object-oriented language—preferably C++ or Java—and a solid working knowledge of web-site development and interactive multimedia concepts. Examples of appropriate prerequisite course work includes:

Object-Oriented Programming

4002-714	Java Programming (requires prior programming experience)
or	
4002-716	C++ Programming Workshop (requires prior programming experience)

Multimedia and Website Design

Website development skill equivalent to either of the following:	
4002-320	Introduction to Multimedia: the Internet and the Web
or	
4004-741	Fundamentals of Web-Based Multimedia

Curriculum

All students choose a major of six courses, for depth, in either game engine development or artificial intelligence and simulation:

Game Engine Development Major Sequence		Qtr. Cr. Hrs.
4005-761	Computer Graphics I	4
4005-762	Computer Graphics II	4
4002-734	2-D Graphics Programming	4
4002-735	3-D Graphics Programming	4
4005-763	Computer Animation: Algorithms and Techniques	4
4002-836	Game Engine Design and Development	4

Artificial Intelligence and Simulation Major Sequence		Qtr. Cr. Hrs.
4005-750	Introduction to Artificial Intelligence	4
4002-791	Artificial Life and Evolutionary Simulation	4
4005-752	Artificial Intelligence for Interactive Environments	4
4005-759	Topics in Artificial Intelligence	4
4005-756	Genetic Algorithms	4
4005-855	Neural Networks and Machine Learning	4

All students are required to complete a minor of three courses, for breadth, in one of the areas shown below. Students also may create a minor from three courses selected from the major area that they have not studied or request approval for a special topics minor.

Asset Creation and Management		Qtr. Cr. Hrs.
Students must take 3-D CG Modeling (2014-721) plus any two additional courses from those listed below:		4
2014-721	3-D CG Modeling	4
2014-722	3-D CG Interactive Animation	4
2014-732	3-D CG Shading	4
2014-747	3-D CG Rendering, Output and Prototyping	4
2014-731	3-D CG Lighting	4
2014-743	3-D CG Character Design	4
2014-787	3-D CG Production Pipeline	4

Content Authoring For Games		Qtr. Cr. Hrs.
4004-728	Interactive Narrative for Games	4
4004-732	Game World Design	4
4004-744	Building Online Communities	4

Human Computer Interaction		Qtr. Cr. Hrs.
4004-745	Foundations of HCI	4
4004-748	Usability Engineering	4
4004-749	Usability Testing	4

Database Architecture and Design		Qtr. Cr. Hrs.
4004-720	Data Object Development	4
4004-784	Multi-Client Database Implementation	4
4004-785	Fundamentals of DBMS Architecture and Implementation	4

All students are required to complete the game design and development seminar sequence, a series of five courses designed to bring students of various cohorts together to investigate industry issues:

Game Design and Development Seminar Sequence		Qtr. Cr. Hrs.
4004-731	History and Critical Analysis of Computer Games and Interactive Entertainment	4
4004-734	Online Identity, Social and Community Behavior	4
4002-790	Emerging Themes in Entertainment Technology	4
4002-792	Development Processes in the Games Industry	4
4002-793	Business and Legal Aspects of Game Development	4

During the winter and spring semesters of their second year in the program, students complete a 20-week, team-based capstone experience. At the end of the spring semester, students present and defend their work. This presentation should have a private faculty review, which constitutes the capstone defense, and a public presentation and demonstration.

Game Design and Development Capstone Experience		Qtr. Cr. Hrs.
4002-887	Capstone Design	4
4002-888	Capstone Development	2

Master of Science in Software Development and Management

http://www.it.rit.edu/it/grad/sdm/index.maml

The master of science degree in software development and management enables the matriculated student to study, develop and become proficient in the practices, methodologies and techniques at all levels in the software development process. The program is designed for students whose undergraduate majors are in a computing discipline. Students must have a background in software development before entering the program.

The underlying principle of this curriculum is that software development is a manageable process—that the problems encountered now and in the future will be amenable to solutions based on sound managerial methodology and reasoned application of technology. This program is delivered online and is designed for part-time study.

Admission requirements

Applicants should have a baccalaureate or equivalent degree from an accredited institution and a minimum cumulative grade point average of 3.0 (B). Applicants must submit two professional recommendations.

Applicants from foreign universities must submit Graduate Record Examination scores. The GRE is also recommended for those applicants whose undergraduate grade point average is

less than 3.0. Since this is a part-time program, visa forms cannot be issued by RIT.

Applicants whose native language is not English must take the Test of English as a Foreign Language examination. A minimum score of 570 (paper-based), 230 (computer-based) or 88 (Internet-based) is required.

Individuals wishing to enter the master's program must have at least two years of full-time employment experience in the software development process and a solid background in object-oriented programming (Java).

Bridge program

Students who do not have the necessary programming background may take bridge courses to help them meet this prerequisite. Formal acceptance into the master's program may be possible even though the applicant must complete bridge courses.

Students whose undergraduate preparation or industrial experience does not satisfy the Java prerequisite can make up this deficiency by completing one or more of the following RIT courses, as prescribed by the graduate program coordinator:

Java programming language	
4002-217	Programming for Information Technology I*
4002-218	Programming for Information Technology II*
or	
4002-414	Java for Programmers* (requires prior programming experience)
or	
4002-714	Java Programming (requires prior programming experience)

** These courses are not available through online learning. Please contact the graduate program coordinator for an appropriate substitution.*

Bridge program courses are not part of the 48 credits required for the master's degree. Grades for bridge courses are not included in a student's graduate grade point average if taken before matriculation; they are included if taken after matriculation.

A bridge program can be designed in a variety of ways. Other courses can be substituted or courses at other colleges can be applied. Contact the graduate program coordinator for approval.

The curriculum

The graduate program of study consists of 12 courses (48 quarter credit hours), which include a foundation course, a business elective, three course concentrations and the capstone experience. Two quarters of optional cooperative work experience are possible. Course numbers in parenthesis indicate required prerequisite(s).

The SD&M core:		**Qtr. Cr. Hrs.**
4002-752	Themes in Software Development and Management	4

The software development concentration consists of three courses:		**Qtr. Cr. Hrs.**
4002-710	Object Technologies	4
4002-720	Data Object Development	4
4002-725	Component Development (4002-710)	4

The project management concentration consists of three courses:		**Qtr. Cr. Hrs.**
4002-830	Project Management	4
4002-831	Process Management	4
4002-820	Economics of Software Development (4002-830 and 4002-831 recommended)	4

One business elective selected from:		**Qtr. Cr. Hrs.**
0102-740	Organizational Behavior	4
0102-763	Behavior Skill for Managers and Professionals	4

Upper-level concentration selected from the following options:

Enterprise Architecture		**Qtr. Cr. Hrs.**
4002-819	Integration Technologies (4002-725)	4
4002-821	Data Architectures and Management (4002-710 & 4002-720)	4
4002-825	System Architectures (4002-725; 4002-819 recommended)	4

E-Commerce Management		**Qtr. Cr. Hrs.**
4002-871	IT and Organizational Process	4
4002-872	Inter-enterprise Computing	4
4002-873	IT and Strategic Opportunity	4

Human Computer Interaction (HCI)		**Qtr. Cr. Hrs.**
4004-745	Foundations of HCI	4
4004-755	Advanced Topics in HCI (4004-745)	4
4002-892	CSCW and Groupware (4004-745)	4

Architecture Fundamentals		**Qtr. Cr. Hrs.**
4002-821	Data Architecture and Management (4002-710)	4
4004-745	Foundations of HCI	4
4002-872	Inter-enterprise Computing	4

Special Topics: Three courses on advanced topics related to software development, with prior approval of the software development and management faculty.

The capstone		**Qtr. Cr. Hrs.**
4002-895	Software Development and Management	4

Students with a business degree or prior academic study that includes the required business elective may replace that course with another graduate-level course, with the approval of the graduate program coordinator.

Master of Science in Information Technology

http://www.it.rit.edu/it/grad/msit.maml

The master of science degree in information technology is a unique and flexible program that allows the student to craft his or her own program of study within the broad range of the IT computing discipline. Students build upon a core requirement in current information technology themes. The specialty areas include website design and multimedia development, game programming, application development, software project management, electronic commerce, learning and performance technology, human-computer interaction, database theory and practice and computer networking. In addition, students have the option of choosing courses from among the wide variety of fields offered within RIT, such as computer animation, computer graphics design, telecommunications technology and business. The degree, with the core course and selected concentrations, is available in the distance delivery format.

Admission requirements

Applicants should have a baccalaureate or equivalent degree from an accredited institution and a minimum cumulative grade point average of 3.0 (B). Applicants must submit a resume and two professional recommendations.

Applicants from foreign universities must submit Graduate Record Examination scores. These scores may be required for applicants whose undergraduate grade point average is less than 3.0.

Applicants whose native language is not English must submit Test of English as a Foreign Language scores. A minimum score of 570 (paper-based), 230 (computer-based) or 88 (Internet-based) is required. Applicants with a lower TOEFL score may be admitted conditionally and will be required to complete a prescribed program in English, along with a reduced program course load.

Prerequisites

It is expected that students wishing to enter the program will have a background in fundamental information technology concepts, including object-oriented programming, computer hardware and software architecture, networking, website design and interactive multimedia concepts.

Students without the necessary background should complete the prerequisites before applying to the program. Bridge courses are available to satisfy the prerequisites.

Bridge program

Students whose undergraduate preparation or employment experience does not satisfy the prerequisites can make up these deficiencies through study, taking one or more of the following RIT bridge courses, as prescribed by the graduate program coordinator:

Object-Oriented Programming

4002-217	Programming for Information Technology I*, and
4002-218	Programming for Information Technology II*
or	
4002-414	Java for Programmers*(requires prior programming experience)
or	
4002-714	Java Programming (requires prior programming experience)
or	
4002-716	C++ Programming Workshop (requires prior programming experience)

Hardware

4050-350	Computer System Fundamentals (discrete math)

Networking

4050-351	Network Fundamentals (4050-0350)
or	
4055-746	Telecommunications Network Protocols

Multimedia and Website Design

4002-320	Introduction to Multimedia: Internet and Web*
or	
4004-741	Fundamentals of Web-Based Multimedia*

** These courses are not available through online learning. Please contact the graduate program coordinator for an appropriate substitution.*

With the possible exception of Java for Programmers (4002-714) or C++ Programming Workshop (4002-716), the bridge program's courses are not part of the 48 quarter credit hours required for the master's degree. Grades for bridge courses are not included in a student's graduate GPA if the courses are taken before matriculation; courses are included if they are taken after matriculation.

Bridge programs can be designed in a variety of ways. Other courses can be substituted, or courses at other colleges can be applied. Contact the graduate program coordinator for approval.

The curriculum

The master of science in information technology consists of 48 quarter credit hours of graduate study. The curriculum consists of a core course, a choice of concentrations and an elective.

Core course (available through online learning)	Qtr. Cr. Hrs.
4002-718 Current Themes in Information Technology	4

Concentrations (36 credits)

Prerequisites for concentrations are listed following the course chart for each concentration or group of concentrations.

Interactive Multimedia Development (on-campus only)		Qtr. Cr. Hrs.
4004-745	Foundations of Human-Computer Interaction	4
4004-737	Website Design and Technology (4004-741)	4
4004-730	Interactive Media Implementation (4004-741 and a two-course object-oriented programming sequence)	4

Prerequisites: Fundamentals of Web-Based Multimedia (4004-741) is the introductory/foundation concentration for

this curricular area. It is intended for students who do not have prior background in website design and interactive media development but would like to either do a three-course overview concentration or prepare for more in-depth study in this area in one of the other concentrations below.

Multimedia Application Development (on-campus only)		Qtr. Cr. Hrs.
4004-746	Programming for Interactive Multimedia (4004-730)	4
4004-729	Introduction to VRML (4004-737 and 4004-746)	4
4004-738	Multi-User Media Spaces (4004-746)	4

Prerequisites: Interactive Media Implementation (4004-730) and Website Design and Technology (4004-737) from the introductory concentration above.

Web Application Development (on-campus only)		Qtr. Cr. Hrs.
4004-739	Programming for the World Wide Web (4004-737 and a two-course programming sequence)	4
4004-751	Web-Database Integration (4004-739 and a database course)	4
	Advanced Web development elective	4

Prerequisite: Completion of a two-course programming sequence (program prerequisite); Website Design and Technology (4004-737), from the introductory concentration above; an introductory or higher database course; and any other prerequisites as appropriate for the chosen elective.

XML Data Management (on-campus only)		Qtr. Cr. Hrs.
4002-770	Introduction to XML (4004-737 and 4004-739)	4
4002-771	XML Programming (4002-770 and 4002-714)	4
4002-772	XML Transformation and Presentation (4002-770)	4

Prerequisites: Completion of a two-course programming sequence or Java for Programmers (4002-714), Website Design and Technology (4004-737) and Programming for the World Wide Web (4004-739).

Interface Architecture (on-campus only)		Qtr. Cr. Hrs.
4004-757	Graphical Elements of the User Experience (4004-730)	4
4004-802	Perspectives on Computer Mediation (4004-730, 745)	4
4004-804	Building Tools for Creative Practice (4004-730, 745)	4
4004-806	Innovation, Invention, and Computer-Mediated Experience (4004-730 and 4004-748 or 4004-775)	4

Prerequisites: Interactive Media Implementation (4004-730) and Foundations of HCI (4004-745). This concentration focuses on the visual perception, interaction style and sensory aspects of creating functional user interfaces for computer-mediated experiences.

Game Programming (on-campus only)		Qtr. Cr. Hrs.
Students without extensive formal multimedia programming must take:		
4004-746	Programming for Interactive Multimedia (4004-730)	4
The concentration consists of 4004-746, if needed, and two or all three of the following:		
4002-734	2D Graphics Programming (4002-714 or 4004-746)	4
4002-735	3D Graphics Programming (4002-734)	4
4002-836	Game Engine Design and Development (4002-734 and 4002-735)	4

Prerequisites: Completion of a two-course programming sequence and Interactive Media Implementation (4004-730) from the interactive multimedia development concentration, or equivalent programming experience.

Game Design (on-campus only)		Qtr. Cr. Hrs.
4004-731	History and Critical Analysis of Comp. Games and Interactive Entertainment (MSIT graduate student status in computer game content.)	4
4004-728	Interactive Narrative (4002-731 and (4004-737 or 4004-746))	4
4004-732	Game World Design (4002-728)	4

Prerequisites: Completion of Fundamentals of Web-Based Multimedia (4004-741)

Application Development (online and on-campus)		Qtr. Cr. Hrs.
4002-714	Java Programming (a two-course programming sequence in a language other than Java)	4
4002-710	Object Technologies (4002-714 or knowledge of Java)	4
4002-725	Component Development (4002-710)	4

Prerequisite: This concentration requires a minimum two-course, object-oriented programming sequence or equivalent preapproved background/experience. If the student has solid experience in Java programming (equivalent to 4002-714), then Integration Technologies (4002-819) may be substituted, with prior approval, as the third course.

Human-Computer Interaction		Qtr. Cr. Hrs.
4004-745*	Foundations of Human-Computer Interaction	4
And two of the following courses:		
4004-748	Usability Engineering (4004-745 and 4004-730)	4
4002-749	Usability Testing (4004-748 and a statistics course)	4
4004-755*	Advanced Topics in HCI (4002-745)	4
4002-765*	User-Centered Design Methods (4004-745)	4
4002-892*	CSCW and GroupWare (4004-745)	4

**These courses are offered online.*

Prerequisites: This concentration requires completion of Current Themes (4002-718) or equivalent preapproved background/experience. Students also need a solid background in Web technologies, including Interactive Media Implementation (4004-730) or equivalent preapproved background/experience.

Learning and Performance Technology (online and on-campus)		Qtr. Cr. Hrs.
4002-722	Fundamentals of Instructional Technology	4
4002-723	Interactive Courseware (4002-722)	4
4002-724	Performance Support Systems Design	4

Prerequisites: This concentration requires completion of all program bridge course work and Current Themes (4002-718), or equivalent preapproved background experience.

Project Management (online only)		Qtr. Cr. Hrs.
4002-830	Project Management	4
4002-831	Process Management	4
4002-820	Economics of Software Development	4

Prerequisites: This concentration requires at least two years of full-time employment in the software development process plus programming experience. The faculty recommends that 4002-820 be taken after the other two courses.

Electronic Commerce Management (online only)		Qtr. Cr. Hrs.
4002-871	Information Technology and Organizational Process	4
4002-872	Inter-Enterprise Computing	4
4002-87	IT and Strategic Opportunity	4

Technical E-Commerce (online only)		Qtr. Cr. Hrs.
4002-872	Inter-Enterprise Computing	4
4002-875	E-Commerce Implementation (4004-741, 4002-720)	4
4002-876	Secure E-Commerce (4002-875)	4

Prerequisites: These concentrations require completion of all prerequisites and Current Themes (4002-718), or equivalent pre-approved background experience. Students need a solid background in programming, Web technology and data communications as well as experience in issues relevant to the field of information technology.

Database		Qtr. Cr. Hrs.
4002-720*	Data Object Development (two-course object-oriented programming sequence)	4
4002-785	Fundamentals of DBMS Architecture and Implementation (4002-360/720)	4
4002-784	Fundamentals of Database Client/Server Connectivity (4002-360/720)	4
4002-787	Database Performance and Tuning (4002-784 and 4002-785)	4
4002-789	Data Warehousing (4002-785)	4

**Offered online and on-campus*

Prerequisites: This concentration requires a background in object-oriented programming. If an undergraduate theory course in database management systems, such as Introduction to Databases and Data Modeling (4002-360), has been taken, Data Object Development (4002-720) is not needed.

Bioinformatics (on-campus only)		Qtr. Cr. Hrs.
4002-762	Introduction to Bioinformatics Computing (4002-714 and a discrete math course)	4
4002-763	Advanced Bioinformatics Computing (4002-762)	4

Prerequisites: This concentration area is under development. It requires a background in discrete math (1016-265) and programming. A background in biology is helpful.

Networking		Qtr. Cr. Hrs.
4055-761*	Principles of System Admin (4055-746 and (4050-402 or 4055-721))	4
4055-815	Introduction to Routing and Switching (4050-342)	4
4055-755**	Secure Wireless and Wired Data Networks (4055-746)	4

**Offered online*
***Offered online and on-campus*

Prerequisites: This concentration requires Telecommunications Network Protocols (4055-746) as a prerequisite. Students without scripting background also will need to take OS Scripting (4050-402) or Perl for System Administration (4055-721). An additional course may be included to create a concentration of four courses. A maximum of four courses from the networking, security and system administration department can be included in the MS in information technology plan of study.

System Administration		Qtr. Cr. Hrs.
4055-721	Perl for System Administration (two-course OOP sequence)	4
4055-761*	Principles of System Admin (4055-746 and 4050-402 or 4055-721)	4
4055-780	Computer System Security (4055-761) or (4050-421) and (0501-507)	4

** Offered online*

Prerequisites: This concentration requires Telecommunications Network Protocols (4055-746) as a prerequisite. An additional course may be included to create a concentration of four courses. A maximum of four courses from the networking, security and system administration department can be included in the information technology MS program.

System Survivability		Qtr. Cr. Hrs.
4055-761*	Principles of System Administration (4055-746) and (4050-402) or (4055-721)	4
4055-780	Computer System Security (4055-761 or (4050-421 and 0501-507))	4
4055-755*	Secure Wireless and Wired Data Networks (4055-746)	4

**Offered online and on-campus*

Prerequisite: This concentration requires Telecommunications Network Protocols (4002-746) as a prerequisite. Students without scripting background also will need to take OS Scripting (4050-402) or Perl for System Administration (4055-721). An additional course may be included to create a concentration of four courses. A maximum of four courses from the networking, security and system administration department may be included in the MS in information technology program.

Concentrations offered by other RIT departments
With the permission of the graduate program coordinator, students are permitted to complete one concentration (a maximum of 12 graduate credits) from another department

at RIT. Concentrations are available in the following areas:

- Technology management (E. Philip Saunders College of Business)
- Information systems (E. Philip Saunders College of Business)
- Telecommunications technology (engineering technology department, College of Applied Science and Technology)
- Automated manufacturing (manufacturing and mechanical engineering technology department, College of Applied Science and Technology)
- Health systems administration (School of Hospitality and Service Management, College of Applied Science and Technology)
- Computer Graphics (interactive media design and animation department, College of Imaging Arts and Sciences)

Contact the information technology graduate coordinator for more information.

Special Topics
Students can use the special topics option to design a concentration with approval from the graduate program coordinator. Undergraduate information technology courses at the 400-level or above may be acceptable with prior approval.

Electives (up to 4 credits)
Electives may be chosen from information technology, computer science, computer engineering, electrical engineering or business. Graduate courses from other departments also may be appropriate, with the approval of the graduate program coordinator.

Capstone experience (4 or 8 credits)
A master's project or thesis is required to meet graduation requirements. The capstone experience should build upon the student's concentrations and electives. It is important that students plan their course work toward completing the project or thesis in their intended area of interest.

Each student will assemble a capstone experience committee consisting of two (project) or three (thesis) faculty members who will evaluate the project or thesis. Students will register for 4 or 8 credits for their capstone experience, depending on the scope of the work. Students who choose the 8-credit capstone will not take the elective. All requirements for the degree must be completed within seven years of the date of the oldest course counted toward the student's program. Bridge courses are excluded.

Master of Science in Learning and Knowledge Management Systems

http://www.it.rit.edu/it/grad/lkms.maml

The master of science degree program in learning and knowledge management systems addresses the knowledge and skills necessary for the planning, creation and implementation of innovative instructional, performance support and knowledge-sharing environments. Developing these environments requires an understanding of instruction, knowledge assets and human performance, along with skills in current and emerging networked multimedia technologies.

Students in this program investigate a variety of strategies for providing education, training and performance support to learning populations separated by distance, time or other constraints. Students learn how to capture, store, evaluate and distribute knowledge assets, as well as design technical and organizational systems for knowledge management. Students learn to select and implement the best tools and methods to allow their population to achieve its knowledge-based objectives.

The program integrates aspects of performance technology, instructional design and technology, information technology and knowledge management. The program is delivered completely through online learning, and attempts to practice what it preaches with a variety of online course formats and approaches.

Admission requirements
Applicants should have a baccalaureate or equivalent degree from an accredited four-year institution and a minimum cumulative grade point average of 3.0 (B). Applicants must submit two professional recommendations and a resume. Submission of either a portfolio of relevant work or Graduate Record Examination scores is strongly recommended. Applicants from foreign universities must submit GRE scores, as well as those applicants requesting consideration whose undergraduate grade point average is less than 3.0.

Applicants whose native language is not English must submit scores from the Test of English as a Foreign Language. A minimum score of 570 (paper-based), 230 (computer-based) or 88 (Internet-based) is required. Since this program is only offered for part-time online study, an I-20 for full-time study in the United States is not available to international students.

Prerequisites
It is expected that individuals wishing to enter the master's program will have previous experience in the field of instructional design, training or knowledge management. Individuals with this experience should submit a portfolio of their work that demonstrates their familiarity with Internet tools and educational technology. In lieu of this portfolio, GRE scores should be submitted. For detailed information on submitting a portfolio, contact the information technology graduate program coordinator.

Applicants must have at least introductory programming skills. This can be demonstrated through a standard two-course, object-oriented computer programming sequence or equivalent work experience. Any object-oriented programming language is acceptable. All prerequisite study must be completed with a grade of B or better.

The following introductory programming courses, in the C++ programming language, are available in distance-learning format from RIT (prerequisites are shown in parentheses):

4002-208	Introduction to Programming
4002-210	Programming with Classes (4002-208)

The curriculum

The program is a 45 quarter credit hour MS degree composed of 10 required courses plus a 5-credit MS capstone. The capstone is a single-term, course-based experience.

		Qtr. Cr. Hrs.
4002-722	Fundamentals of Instructional Technology	4
4002-723	Interactive Courseware	4
4002-724	Performance Support Systems	4
4002-728	Models of Human Performance	4
4002-729	Media Asset Creation	4
4002-731	LKM Application Development	4
4002-810	Simulations and Learning Environments	4
4002-812	Knowledge and Content Objects	4
4002-828	Intelligent Computer-Based Instruction	4
4002-845	Economics of Human Performance	4

The LKMS capstone

4002-865	Project and Program Evaluation	5

Advanced Certificate in Interactive Multimedia Development

http://www.it.rit.edu/it/grad/imdCert.maml

As interactive technologies advance, the forms and approaches to human communication change—and the importance of enhancing the communication experience within electronic environments increases. This certificate provides an opportunity for students to gain firsthand knowledge and expertise in the art and science of interactive multimedia design. In this program, students explore the theories of interactive computing, the fundamentals of interactive multimedia, programming in an authoring language, multimedia design and the impact of networked technologies in such areas as the Internet.

Admission requirements

Undergraduate degree applicants should have a baccalaureate or equivalent four-year degree from an accredited institution and a minimum cumulative grade point average of 3.0 (B). Two professional recommendations must be submitted.

Applicants whose native language is not English must submit scores from the Test of English as a Foreign Language. A minimum score of 570 (paper-based), 230 (computer-based) or 88 (Internet-based) is required. Applicants with a lower TOEFL score may be admitted conditionally and will take a prescribed program in English, along with a reduced program course load. Since this is a part-time online program, I20 forms cannot be issued by RIT.

Prerequisites

Due to continuing advances in the field of interactive multimedia, knowledge of programming has become necessary to complete all of the courses. Students must have object-oriented programming skills equivalent to one undergraduate course. Either of the following bridge courses is available to complete this requirement. Neither requires any prerequisites:

4002-217	Programming for Information Technology I (Java; on-campus only)
4002-208	Introduction to Programming (C++; on-campus and online)

The curriculum

Projects include the development of websites and interactive multimedia applications. The curriculum consists of six courses:

		Qtr. Cr. Hrs.
4004-741	Fundamentals of Web-based Multimedia	4
4004-730	Interactive Media Implementation	4
4004-737	Website Design and Technology	4
4004-745	Foundations of Human-Computer Interaction	4
	Two Web or multimedia electives	8

The curriculum can be completed in as few as three quarters. Students have at their disposal a variety of computer, video and digitizing equipment in our state-of-the-art interactive multimedia laboratory.

Advanced Certificate in Learning and Knowledge Management Systems

This innovative certificate program is designed with a strong social science emphasis and focuses on the growing need for business and industry to address corporate learning and knowledge management. The four courses that comprise the certificate develop knowledge and skills in the area of planning, creating and implementing media-based instructional systems. Creating these systems requires knowledge of instructional design and development, along with skills in current and emerging networked multimedia technologies. Students in this certificate learn a variety of techniques for providing media-based training to learning populations separated by distance, time or other constraints.

Graduates of the certificate program can work as instructional designers or educational multimedia specialists, among other job titles and responsibilities. The certificate is also an option for students enrolled in the master of science degree program in learning and knowledge management systems.

The curriculum is completely distance delivered and attempts to "practice what it preaches" with a variety of online course formats and approaches intended to support learning and build community.

Admission requirements

Applicants should have a baccalaureate or equivalent four-year degree from an accredited institution with a minimum cumulative grade point average of 3.0 (B). A resume and two professional recommendations must be submitted.

Applicants whose native language is not English must submit scores from the Test of English as a Foreign Language. A minimum score of 570 (paper-based), 230 (computer-based) or 88 (Internet-based) is required. Since this is a part-time online program, I20 forms cannot be issued by RIT.

Prerequisites

The program requires a mix of technical and social science skills. Students who have experience in the field are more likely to succeed. However, a student may use this certificate program to build a portfolio of work, which could be used for admission to the MS program in learning and knowledge management systems. Because computer programming is done in almost every course in the certificate, applicants must have a programming background equivalent to a two-course programming sequence in a current object-oriented programming language before admission. The following bridge courses are available to complete this requirement:

4002-217	Programming for Information Technology I (Java) (on-campus only) and
4002-218	Programming for Information Technology II (Java) (on-campus only)
or	
4002-208	Introduction to Programming (C++) (on-campus and online) and
4002-210	Programming with Classes (C++) (on-campus and online)

The curriculum

The advanced certificate in learning and knowledge management systems consists of four courses, which are a subset of the requirements for the master of science degree.

	Qtr. Cr. Hrs.
4002-722 Fundamentals of Instructional Technology	4
4002-729 Media Asset Creation	4
4002-723 Interactive Courseware	4
4002-731 LKM Application Development	4

With the appropriate background, the certificate can be completed in either two or four quarters, depending upon the number of courses taken.

Software Engineering Department

J. Fernando Naveda, Chair
(585) 475-5048, F.Naveda@rit.edu

The department of software engineering is developing a master of science degree in software engineering, which is currently awaiting final approval by the New York State Department of Education. It is projected that the program will be ready to accept students for admission in the fall of 2006. Please note that this is a projected date only, and is pending approval of the program by the New York State Department of Education. The information regarding this program is subject to change without notice.

Demand for quality software delivered on time and within budget has never been higher and, according to recent studies, it will continue to increase for years to come. In 1996, RIT became the first university in the United States, and one of the first in the world, to offer a baccalaureate degree in software engineering. Many schools are following our leadership, as undergraduate software engineering degrees are increasingly featured in university portfolios.

Laboratory facilities

The great majority of the courses offered by this department require team projects. In addition, an increasing number of courses are being taught using the studio format, which gives students the opportunity to capitalize on interactive instruction. The facilities that support the department's curriculum are:

- Three studio labs
- One real-time and embedded systems lab
- Eleven team rooms
- One open lab
- One mentoring lab (primarily designed in support of the undergraduate curriculum)
- One senior projects lab

Master of Science in Software Engineering

Mark Ardis, Graduate Program Corrdinator, Profesor
(585) 475-2949, maavse@rit.edu

Building on our leadership position in undergraduate software engineering education, the master of science in software engineering (MSSWE) is designed to attract software professionals with a formal undergraduate background in software engineering, computer science, or computer engineering and at least one year of professional experience. The program's core content ensures that graduates will possess both breadth and depth of knowledge in software engineering. Specialization tracks in software quality and software design provide the student with the opportunity to match their graduate education with their professional goals.

Admission requirements

There are two large groups of individuals who may be interested in an advanced software engineering degree. The first group comprises professionals without a formal baccalaureate degree in computing, but who may otherwise have sufficient experience developing software professionally. The second group includes recent graduates from accredited baccalaureate computing degree programs who have at least one year of software development experience. The program's admission requirements are as follows:

- Prospective students with a baccalaureate degree from an accredited institution must have a cumulative grade point average (GPA) of 3.0 or higher. Prospective students from institutions that do not use the GPA scale are expected to demonstrate an equivalent level of academic accomplishment. Formal academic background in software engineering, computer science, or computer engineering is a plus.
- Prospective students without a bachelor's degree in software engineering, computer science, or computer engineering are expected to submit evidence of professional experience developing software. For these individuals, a minimum of three years of professional experience developing software is required.
- GRE test scores are required from applicants whose undergraduate degrees are from foreign colleges. Applicants whose undergraduate GPA is under 3.0 are also encouraged to submit their GRE score to enhance their application.
- A Test of English as a Foreign Language (TOEFL) score of at least 570 (paper-based), 230 (computer-based), or 88 (Internet-based) is required for all applicants for whom English is not their native language.
- All applicants must submit a professional essay describing their current job (if applicable), relevant experience, and career plans.
- All applicants must submit a document describing significant software projects in which they have participated.

Prerequisites

Based on evaluation of academic and relevant experience, some applicants may be required to successfully complete (with a grade of "B" or better) some or all of the following bridge courses. Successful completion of bridge courses is necessary for registration in graduate-level courses.

Required courses

4010-361	Introduction to Software Engineering
4010-362	Engineering of Software Subsystems
4010-555	Software Requirements and Specification

Plus one of the following

4010-441	Principles of Concurrent Software Systems
4010-442	Principles of Distributed Software Systems
4010-443	Principles of Information Systems Design
4010-549	Software Design Seminar (topics may vary)

The curriculum

The program comprises 52 quarter credit hours, anchored by a three quarter (12 credit hour) practicum where students work with peers and faculty on a long-term, moderately complex software development project. Initially students will serve in basic support and developer roles, but as they progress through the practicum and accompanying coursework they will be assigned correspondingly greater responsibilities. As a consequence, the program combines fundamental and theoretical concepts taught in courses with their application in a constrained but realistic setting. This is in the best tradition of RIT's historic commitment to "learning through doing."

The MSSWE core

4011-720	Software Evolution and Re-engineering
4011-710	Research Methods
4011-730	Process Engineering and Environments
4011-700	Practicum I
4011-701	Practicum II
4011-702	Practicum III
4011-740	Empirical Software Engineering
4011-750	Software Modeling
4011-780	Experience and Research Report

Electives

Though significant learning specific to the student's specialization track will be learned through the three practicum courses, students in the quality and design tracks are required to take one of the following two courses depending in their choice of specialization track.

4011-760	Software Quality Engineering (quality track)
4011-770	Software Architectures and Product Lines (design track)

In addition to the specialization track elective, the curriculum includes three technical electives can be chosen from graduate offerings in computer science, computer engineering, and software development and management.

Graduate Faculty

Jorge L. Díaz-Herrera, BS, Venezuela; MS, Ph.D., University of Lancaster—Dean, Professor

Edith Lawson, BS, University of Wisconsin at Stevens Point; MS, Rochester Institute of Technology—Associate Dean, Professor

Evelyn Rozanski, BS, State University of New York at Brockport; MS, Syracuse University; Ph.D., State University of New York at Buffalo—Interim Associate Dean for Graduate Studies and Research; Professor

Department of Computer Science

Paul Tymann, BS, MS, Syracuse University—Department Chair, Professor

Ivona Bezakova, Ph.D., University of Chicago—Assistant Professor

Hans-Peter Bischof, BS, MS, University of Ulm; Ph.D., University of Osnabrück—Graduate Program Coordinator—Associate Professor

Zack Butler, BS, Alfred University; Ph.D., Carnegie Mellon University—Assistant Professor

Roxanne Canosa, Ph.D., Rochester Institute of Technology—Assistant Professor

Warren Carithers, BS, MS, University of Kansas—Associate Professor

Henry Etlinger, BS, University of Rochester; MS, Syracuse University—Undergraduate Program Coordinator; Associate Professor

Roger S. Gaborski, BS, MS, State University of New York at Buffalo; Ph.D., University of Maryland—Professor

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Leonid Reznik, Ph.D., St. Petersburg Polytechnic Institute—Professor

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Department of Information Technology

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Michelle Harris, MPS, New York University—Assistant Professor

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Peter Lutz, Ph.D., State University of New York at Buffalo—Professor

Sharon P. Mason, BS, Ithaca College; MS, Rochester Institute of Technology—Associate Professor

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Software Engineering

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Center for Advancing the Study of CyberInfrastructure

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Information Technology

4002-710 Object Technologies
This is a course in the principles and techniques of designing and implementing software objects. Current software environments are used to explore effective design methods and concepts. Topics include basic object design, class definition and syntax, object-oriented design, software quality and object evaluation. Software design and programming projects are required. (Completion of SD&M bridge or permission) **Class 4, Distance Format, Credit 4**

4002-714 Java for Programmers
An intensive survey of the Java programming language for experienced programmers. This course covers the creation of application programs. Topics include: basic language concepts (declaring and evaluation of data, statements, expressions, control flow, and input/output), object-oriented fundamentals, GUI interfaces, exception handling, debugging, threads, and the client/server environment. Programming projects will be required. (A two-course object-oriented programming sequence in a language other than Java) **Active Learning 5, Credit 4**

4002-716 C++ Programming Workshop
A workshop in the C++ programming language intended for students to gain programming experience. This course will focus on modern programming concepts such as reusability, data abstraction, information hiding, exception handling and object-oriented design. Programming projects will be required. (4002-710 or permission of instructor) **Class 4, Distance Format, Credit 4**

4002-718 Current Themes in Information Technology
This course provides entering graduate students in Information Technology with an overview of current theory and issues in the field. Topics covered would include social and cultural impacts of technology, virtuality digital communication, and online communities. Using reading from a variety of books and periodicals, students will be presented with views on information technology in a socioeconomic context. (MS-IT Bridge) **Class 4, Distance Format, Credit 4**

4002-720 Data Object Development
Introduction to analysis and design of data representations and data object implementation. Current software environments are used to explore effective database design and implementation concepts. Topics include conceptual modeling, methodologies, logical/physical database design, data query and manipulation, and transaction design. Database design and implementation projects are required. (Completion of SD&M Bridge) **Class 4, Distance Format, Credit 4**

4002-722 Fundamentals of Instructional Technology
The world of information technology offers the possibility of transforming the way that instruction is designed and delivered. However, few information technology professionals understand the methods and materials of instructional design. As a professional in information technology, a student may be responsible for designing instruction either in a business or an educational context. This course enables the student to be able to plan, organize, and systematically develop instructional materials. The course uses an Instructional Systems Design (ISD) model to analyze, design, deliver, and evaluate instruction. **Class 4, Credit 4**

4002-723 Interactive Courseware
Computer software that teaches is referred to as courseware. This course was designed to help you make the transition from "general" Instructional Design (4002-722/510) into the actual application of these principles in a computer-based environment. Although the basic principles of instructional design hold true in all media environment, using these teaching and learning principles is somewhat different when developing instruction that will be delivered by computer. This course teaches procedures that have already been successful in the design and development of courseware. (4002-722) **Class 4, Credit 4**

4002-724 Performance Support Systems Design
An electronic performance support system (EPSS) is a software technology, designed to give each user what he or she needs when he or she needs it. It is designed to enable skilled performance without training. An EPSS can be defined functionally, by what it does. The job of an EPSS is to help a worker perform his or her job better. Typical components of an EPSS encompass tutorials, drills, simulations, and hypertexts, but often include expert systems, help systems, and intelligent job aids. This course examines some of the relevant literature supporting EPSS and provides students with the opportunity to design and develop several different components of a performance support system. (4002-722 and a two course programming sequence) **Class 4, Credit 4**

4002-725 Component Development
A programming course focused on the use, design and implementation of reusable software components. Students create and test components based on current technology. Issues of reusable design, quality, component libraries, and interoperability are included. Design and programming project is required. (4002-710) **Class 4, Distance Format, Credit 4**

4002-726 Research Methods
This course will prepare students to conduct research and to design experiments and analyze data for empirical studies in Information Technology. Students will explore qualitative and quantitative research methods, experimental and non-experimental design, theoretical framework development, statistical data analysis, sampling and data collection methods within the context of information technology research. Case studies, mini-research projects and scholarly writing assignments will be required. (0307 712 or equivalent) **Class 4, Credit 4**

4002-727 Digital Audio and Computer Music
Technologies and techniques for producing and manipulating digital audio and computer music are explored. Topics include digital representation of sound, synthesis techniques, digital audio recording and processing, MIDI and real-time performance issues, algorithmic composition, and application of digital audio to multimedia and Web production. Students also are required to pursue a related research topic that could lead to a Masters project or thesis. (4002-730) **Class 4, Credit 4**

4002-728 Models of Human Performance
This course focuses on the theoretical underpinnings of effective distributed learning and knowledge management. The course focuses on surveying general models of distributed learning in both industry and education, then relates the design of these systems to relevant theory, from the fields of psychology, education, sociology and other areas. (4002-722) **Class 4, Distance Format, Credit 4**

4002-729 Media Asset Creation
Media assets are knowledge-based components that have broadband, multimedia elements. Students will learn how to create and work with broadband interactive media such as streamed audio and video, animation, and to program graphical user interfaces. This course is intended as a hands-on introduction to the creation and implementation of these components. **Distance Format, Credit 4**

4002-731 Learning, Knowledge and Management Application Development
This course is an introduction to the development of several client server technologies. Students will learn to create server-side scripts and programs that can process information. They will also use a variety of client-side scripting languages. The course will show students how to analyze the distributed programming needs for a given problem. (4002-217, 4002-218, or a two-course programming sequence) **Class 4, Credit 4**

4002-734 2D Graphics Programming
Use of an advanced graphics API to access hardware accelerated graphics. Discussion of scene graphs, optimizations, and integration with the API object structure. Advanced use of the API calls in production code, to construct environments capable of real-time performance. (4002-714 and 4004-746) **Class 4, Credit 4**

4002-735 3D Graphics Programming
Use of a graphics API to access hardware accelerated graphics. Discussion of the API scene graph, 3D optimizations, and integration between the 2D graphics mode and a 3D immediate mode implementation. This course builds upon students' previous work and extends it in the construction of a fully functional 3D Engine, with library construction for game development. (4002-734) **Class 4, Credit 4**

4002-752 Themes in Software Development and Management
This course will present prominent and emerging views of technologies, approaches, and issues in application development to entering graduate students in the Software Development and Management Program. The range of topics will encompass a broad spectrum of the software development lifecycle using readings from a variety of books and periodicals, independent research, and presentations by leading experts on application development. **Class 4, Distance Format, Credit 4**

4002-762 Introduction to Bioinformatics Computing
This course will provide a theoretical and practical (lab-based) study of computational genomics. Techniques will be studied for quickly and effectively commandeering computing resources to the solution of problems raised in biology. Course topics include an express tour of bioinformatics resources, exact and approximate pattern matching, sequence alignment, gene prediction, fragment assembly, multiple alignment, statistical and machine learning approaches. (Programming for IT 3 4002-219 or Computer Science 3 0603-233 or Java for Programmers 4002-318 or 4002-714, Discrete Math I 1016-265) **Class 3, Lab 2, Credit 4**

4002-763 Advanced Bioinformatics Computing
This course will provide an in-depth exposure to advanced techniques in computational genomics. Topics may include: gene finding, genetic algorithms, hidden markov models, neural networks, gene expression analysis, clustering algoithms, probabilistic models of evolution, phylogenetic trees, simple and complex diseases: gene mapping, SNP analysis, machine learning, molecular network analysis, probabilistic framework for modeling and interference, systems biology. (4002-762) **Class 3, Lab 3, Credit 4**

4002-765 User-Centered Design Methods
This course will focus on the major user centered design methodologies used in the development of applications and environments. Topics include: evolution of software design methods, emergence of user centered design, and key concepts and attributes of contextual, scenario-based, and performance-centered design. Case studies will be used to illustrate the different design methods. Software design projects will be required. (4004-745 or by instructor approval) **Class 4, Distance Format, Credit 4**

4002-770 Introduction to XML
This course will focus on the development and use of the extensible markup language (XML) to create structured data. Emphasis will be placed on the conceptual framework of XML, key components and practices of XML design, XML standards and methods of creating structured data and metadata, research issues in XML development and use. (4004-737 and 4004-739) **Class 4, Active Learning Format, Credit 4**

4002-771 XML Programming
Exchange of information between disparate programs is a significant problem in industry. Students will learn how to leverage XML to achieve interoperability between programs. Topics covered in this hands-on course include parsing and generating XML, and web services. (4002-770 and 4002-714) **Class 4, Active Learning Format, Credit 4**

4002-772 XML Transformation and Presentation
This course will explore techniques and technologies for transforming XML documents using XSLT and XSL-FO. The emphasis will be on transformation of XML data into human-readable documents, such as HTML pages and PDF files. Topics covered will include XSLT syntax and processing, XPath and XPointer. Students will implement projects to present XML data using a variety of transformation tools and technologies. (4002-770) **Class 4, Active Learning Format, Credit 4**

4002-784 Fundamentals of Database Client/Server Communication
Students will investigate strategies for client-server and server communication against single or multiple database servers. Specifically, students will configure, test, and demonstrate successful communication between multiple database servers and multiple clients. Similarities and differences between commercially available connectivity packages, and issues impacting performance will be explored. Programming exercises are required. (4002-360 or 4002-720 and 4002-219 or 4002-714) **Class 5, Active Learning Format, Credit 4**

4002-785 Fundamentals of DBMS Architecture and Implementation
Students will be introduced to issues in client/server database implementation and administration. Topics such as schema implementation, storage allocation and management, user creation and access security, transaction management, data backup and recovery, and performance measurement and enhancement will be presented in lecture and investigated laboratory environment. Students will configure and demonstrate successful management of a database server for client access. (4002-360 or 4002-720) **Class 3, Lab 2, Credit 4**

4002-787 Database Performance and Tuning
Students will explore database theory as it applies to the performance and tuning of database systems. Topics in database performance will be explored including: physical and logical design issues, the hardware and software environment, SQL statement execution and front end application issues. Techniques in performance monitoring and tuning will be investigated. (4002-484 and 4002-485 or 4002-784 and 4002-785) **Class 5, Active Learning Format, Credit 4**

4002-789 Data Warehousing
This course covers the purpose, scope, capabilities, and processes used in data warehousing technologies for the management and analysis of data. Students will be introduced to the theory of data warehousing, dimensional data modeling, the extract/transform/load process, warehouse implementation, dimensional-data modeling, and summary-data management. The basics of data mining and importance of data security will also be discussed. Hands-on exercises include implementing a data warehouse. (4002-485, 785) **Class 4, Credit 4**

4002-790 Emerging Themes in Entertainment Technology
This course examines current technologies as well as future trends that will impact the direction of technology development within the gaming industry. Topics of study may include, but are not limited to; graphics hardware, graphics algorithms, content creation tools, content organization tools, artificial intelligence techniques, machine learning techniques, game play networking, audio and video hardware and algorithms, user interface development, control and feedback systems, simulation systems, console game systems, as well as game engine technology and corresponding development API's. (Graduate standing in Information Technology and enrollment in the Game Programming Concentration or permission of the instructor) **Class 4, Credit 4**

4002-791 Artificial Life and Evolutionary Simulation
This course will provide students with theory and practical skills in Artificial Life (A-Life). Topic areas include the history and evolution of Artificial Life algorithms, uses of Artificial Life as a simulation tool, as well as applications of Artificial Life algorithms to applied domains such as game artificial intelligence, computer music, simulation and visualization. Software and toolsets that assist Artificial Life programmers will be examined. Students will be expected to design and implement a simulation in teams as well as properly document their designs and development strategy. (4004-746 Programming of Interactive Media or 4005-750 Introduction to Artificial Intelligence) **Class 4, Credit 4**

4002-792 Development Processes in the Game Industry
This course examines the individual and group roles of the development process model within game design and development industry. Students will transform design document specifications into software and hardware needs for developers, testers, and end users. Students will examine team dynamics and processes for programming, content development, testing, deployment, and maintenance. Students will explore design process through the deconstruction of the game industry's software cycle mode. (Enrollment in the Game Design and Development graduate program) **Class 4, Credit 4**

4002-793 Business & Legal Aspects of Game Development
This course will provide students with a practical background in business and legal practices specific to the gaming industry. Students will be introduced to entrepreneurship in the gaming industry, confidentiality rules, game developer rights and responsibilities, the developer/publisher/retailer relationship, contract development, intellectual property rules and regulations, royalties, licensing, and legal responsibilities for content and consumer impact. Projects may include individual and group research, examination of case studies, and written and oral reports on current industry practice. (Enrollment in the Game Design and Development Masters or permission of instructor) **Class 4, Credit 4**

4002-810 Simulations and Learning Environments
A learning environment is an electronic environment in which students are provided resources from which to learn. These resources may include tutorials, but are generally far more experimental in nature. A valuable component within a learning environment is an instructional simulation, which provides an opportunity for learners to interact with a safe, virtual world. Kolb's experiential learning theory is a theoretical framework that can be used for designing learning environments. This course provides theoretical background along with hands-on development. (4002-722 and 4002-216 or equivalent programming experience) **Class 4, Credit 4**

4002-812 Knowledge and Content Objects
Students will develop instructional content for reuse using current technologies. Learners study issues relating to current and emerging standards for reuse and interoperability. Activities include translating instructional material into standard design models, evaluating examples of knowledge representation, creating knowledge objects, and creating new content modules out of existing knowledge objects. (4002-723 and 4002-730) **Class 4, Distance Format, Credit 4**

4002-819 Integration Technologies
This course is an in-depth study of the major interoperability technologies. Exercises are used to illustrate how modern integration technologies address the economic and technical issues related to the development of integrated systems. Programming projects are required. (4002-710, 4002-725) **Class 4, Distance Format, Credit 4**

4002-820 Economics of Software Development
This course is an analysis of the factors that determine software cost, quality, and time to delivery. Topics include fundamentals of software development, identification of cost drivers, and analysis of productivity and quality data. Students use models to estimate software cost, delivery time, and operational reliability. (2+ years of software development experience and SD&M bridge) **Class 4, Distance Format, Credit 4**

4002-821 Data Architecture and Management
This course will focus on data architectures, issues, and strategies for managing enterprise data as an organizational information asset. The fundamental meaning and management of data is emphasized as an enabler to enterprise data integrity, enterprise data architecture, and satisfaction of enterprise business requirements. Topics include metadata management, business process integration, data and process governance, repository management, data quality, data architectures, and current technologies in information exchange. Data integration and programming projects are required. (4002-710, 4002-720) **Class 4, Distance Format, Credit 4**

4002-825 Systems Architectures
A programming course focused on the application of interoperability technologies. Students develop integrated systems based on software components, applications, databases, web sites, heterogeneous operating systems and networks. (4002-819) **Class 4, Distance Format, Credit 4**

4002-828 Intelligent Computer-Based Instruction
Intelligent Computer Based Instruction (ICBI) uses the ideas of individualization and adaptation in the process of computer-based instruction. As such, ICBI pushes the limit of computer-based instruction. Using the computer as an intelligent system requires the computer to have a more sophisticated student model and content model, and a set of rules for resolving gaps between the two. Students will use emerging ICBI shells and will design and implement web-based components and modules that adjust to learner's skills and abilities. (4002-723) **Class 4, Distance Format, Credit 4**

4002-830 Project Management
This is a course in the methods and techniques of managing a software development project. Topics include defining project goals, work breakdown structure, defining tasks, project plans, estimation and scheduling techniques, work monitoring and measurements. (2+ years of software development experience and SD&M bridge) **Class 4, Distance Format, Credit 4**

4002-831 Process Management
This is a course in the methods and techniques of managing a software development environment. Topics include development organization structure, team management, staff development, project selection and prioritization, cost/benefit analysis, role of standards, and organization communication. (2+ years of software development experience and SD&M bridge) **Class 4, Distance Format, Credit 4**

4002-836 Game Engine Design and Development
This course will provide students with theory and practical skills in game engine design topic areas such as understanding the graphics pipeline as it influences engine design, hardware principles and the relationship to game engine design construction, mathematical principles, scene graph construction and maintenance, advanced scenegraph manipulation, textures, materials, and lighting, collision systems, physics, particle systems, and control systems. Furthermore, this course will examine software and toolsets that assist game engine designers in their tasks. Students will be expected to design and implement a game engine in teams as well as properly document their design and development strategy. **Class 4, Credit 4**

4002-845 Economics of Human Performance
This course studies the economics of human performance within organizations. Topics include community costs in information work, productivity measurement of knowledge related work, long-term value of service, and related economic topics. **Class 4, Distance Format, Credit 4**

4002-871 IT and Organizational Process
The topic of process reengineering has become an intriguing issue as it places information technology as a key enabler within organizations. Information Technology offers new opportunities to integrate and improve the effectiveness of an organization's processes; both internal and customer facing. It also places a new value on information. This course will explore the importance of information, the importance of sound digital processes to the organization, and the design of a digital business (MSIT core or equivalent background/experience) **Class 4, Distance Format, Credit 4**

4002-872 Inter-enterprise Computing
Managers and technologists both need to be aware of the variety of new means of doing business. Information Technology has made it possible for multiple businesses to work together as an extended enterprise, sharing full access to vital information that enables them to do business more effectively. This course presents an in-depth study of alternative ways for organizations to conduct business electronically. Additionally, business can take advantage of current means of sharing information, via Internet and functioning as extended enterprises, and ways in which they are using Internet for commercial advantage. (MSIT core or equivalent background/experience) **Class 4, Distance Format, Credit 4**

4002-873 IT and Strategic Opportunities
Using a variety of futuring techniques and exercises, this course prepares students to identify new strategic opportunities created by advances in information technology. The course looks at service organizations, manufacturing organizations, and also information organizations as described by Drucker. The course attempts to predict trends in technology within these types of environments, by looking for parallels in history, by mapping trends, and by examining the characteristics of new technologies according to their innovative characteristics. (MSIT core or equivalent background/experience) **Class 4, Distance Format, Credit 4**

4002-875 eCommerce Implementation
This course focuses on building and integrating the back-end components required to build a scalable e-commerce site. The course will address the concepts, issues, and programming skills specific to building components for enterprise-level e-commerce systems. Topics include search engines and inventory, ordering, and profile management systems. Programming projects required. (4004-741, 4002 720, 4002-872) **Class 4, Distance Format, Credit 4**

4002-876 Secure eCommerce
This course covers the concepts required to implement a secure e commerce site. Topics include the assessment of security in a proposed or an existing site, the implications of decisions impacting security and the implementation considerations needed to establish a secure site. (4002-875) **Class 4, Distance Format, Credit 4**

4002-887 Capstone Design—MSGDD
This course allows students within the Game Design and Development program to develop a capstone proposal and design document. The capstone design document specifies the scope and depth of the capstone project as well as defines the group and individual responsibilities for the cohort capstone project experience. (Permission of MS Game Design and Development faculty) **Credit 4**

4002-888 Capstone Development—MSGDD
This course provides Master of Science in Game Design and Development students with capstone project experiences. Students are expected to work in cohorts towards the implementation of a game system that properly illustrates proficiency in the application of theory and practice towards a large-scale project. For each student, individual responsibilities for the group project will be defined in consultation with both the group and the faculty. Students must successfully complete the Capstone Design course and present a satisfactory capstone project proposal to the faculty before enrolling in this course. (4002-887 Capstone Design-MS Game Design and Development and permission of MS Game Design and Development faculty advisor) **Credit 2**

4002-890 Graduate Seminar in IT
This is the IT seminar course to allow for special one-time offerings of graduate topics or to allow faculty to pilot new graduate offerings. Specific course details (such as the course topics, format, resource needs, and credit hours) will be determined by the faculty member(s) who propose a given special-topics offering. (As appropriate for topic proposed. Corequisites: as appropriate for topic proposed) **Credit 2–8**

4002-892 CSCW and Groupware
This course will examine the role of information technology in collaborative work settings. An overview of relevant theory, technologies, and standards will provide the context for examining the integration and strategic use of e-mail distributed networking, the World Wide Web, conferencing and enhanced messaging. (4004-745) **Class 4, Distance Format, Credit 4**

4002-893 Seminar in Thesis and Project Preparation
This course provides a structure, methodology and forum for the capstone experience proposal development and committee selection. (Two-thirds of graduate course work not including prerequisite courses) **Class 2, Distance Format, Credit 2**

4002-895 Software Development and Management Capstone
A presentation demonstrating current awareness and understanding of trends impacting the software development and management field. Students prepare a portfolio summarizing their course work in the SD&M program and discuss the relationship of their course work to advances in software development technology and practice. (Enrollment in last quarter of study) **Class 4, Distance Format, Credit 4**

4002-897 MS Thesis
Capstone experience for the master of science in information technology degree program. Students must submit an accepted thesis proposal in order to enroll. (Permission of Graduate Studies Committee) **Credit 0-8**

4002-898 MS Project
Capstone experience for the master of science in information technology. Student must submit an accepted proposal in order to enroll. (Permission of the graduate studies committee) **Credit 0-8**

4002-899 Independent Study
The student will work independently under the supervision of a faculty adviser on a topic not covered in other courses.

4002-999 Graduate Co-op Education
An optional cooperative educational experience is available for those students who wish to participate in order to gain industrial experience. (Completion of bridge program and 5 core courses) **Credit 0**

Computer Science

4003-703 Advanced C++ and Program Design
The course covers design techniques and advanced programming. Topics include the software development life cycle; analysis and design using the Unified Modeling Language (UML); advanced programming in the C++ programming language will be used; and implementation strategies for external data structures. Individual and group programming projects will be required. Homework assignments are an integral part of the course. **Credit 4**

4003-705 Discrete Mathematics
The fundamental concepts of discrete mathematics which are necessary for understanding further mathematical foundations of computer science. Topics include: structures defined on finite sets, elementary symbolic logic, patterns of mathematical proof, vectors and matrics, graphs, combinatorics, formal languages, abstract mathematical systems. The relevance of the chosen topics to computer science and the applications of computers to these topics will be stressed. (College algebra, computer literacy) **Class 4, Credit 4**

4003-707 Advanced Programming
The goal of this course is to introduce the language Java. Topics include class design and implementation, inheritance, exceptions, files, threads, swing, network programming, and remote method invocation. We will use object-oriented technology as a means to an end to design and implement software solutions. Programming assignments are an integral part of the course. (Object-oriented Programming + C) **Credit 4**

4003-709 Programming Language Concepts
A study of the syntax and semantics of a diverse set of high-level programming languages. The languages chosen are compared and contrasted in order to demonstrate general principles of programming language design. This course emphasizes the concepts underpinning modern languages rather than the mastery of particular language details. Programming projects will be required. Alternative RIT offering: 4003-450 (Computer Science 4 and 1016-265 Discrete Math 1) **Credit 4**

4003-710 Computer Organization
An introduction to computer architecture and assembly language programming concepts and techniques. Topics include Boolean algebra, combinational and sequential circuit design, storage mechanisms and their organization, the instruction cycle in a simple CPU, assembly language programming, programming at the device level, and the role of assembly language in understanding the hardware/software interface. Digital logic and software projects will be required. (1016-351, 4003-334) **Class 4, Credit 4**

4003-713 Operating Systems
A general survey of operating system concepts. Topics include process synchronization, interprocess communication, deadlock, multiprogramming and multiprocessing, processor scheduling and resource management, memory management, overlays, static and dynamic relocation, virtual memory file systems, logical and physical I/O, device allocation, I/O processor scheduling, process and resource protection. Programming projects will be required. Alternative RIT offering: 4003-440. (4003-334 Computer Science 4 and 4003-345 Computer Organization) **Class 4, Credit 4**

Interactive Media

4004-728 Interactive Narrative
This course will examine elements of narrative and storytelling within computer games. Students will learn how narrative works within these environments and how it differs from standard narrative whether the digital creation is original or derived from a traditional narrative source. Students will learn to apply different theories of Ludology (theory and critical analysis of computer games) to analysis and critique of computer games. Students will write treatments, flowcharts, storyboards and scripts for their own games and then implement prototypes based on those documents. Students will complete written assignments. (4004-731 and either 4004-737 or 4004 746 or equivalent) **Class 4, Active Learning Format, Credit 4**

4004-729 Introduction to VRML
This course will focus on basic and advanced concepts of 3D environment creation and implementation within the Virtual Reality Markup Language (VRML) specification implemented on the World Wide Web. Students will work individually in groups to create VRML environments on their own home pages and in a larger scale group environment. (4004-737 and 4004-742) **Class 4, Credit 4**

4004-730 Interactive Media Development
Students will build on their understanding of basic media types to develop interactive user interfaces to rich-media content, such as video, audio, graphics, and text. They will learn to control and synchronize multiple media assets in a variety of environments utilizing authoring tools such as Macromedia Director. Students will design and implement applications that support a high level of interactivity and develop strategies for delivering these programs via CD-ROM and the World Wide Web. Programming will be required. (4004-741 or equivalent, and 4002-231 or 4002-218, or a two-course programming sequence) **Class 4, Active Learning Format, Credit 4**

4004-731 History and Critical Analysis of Computer Games and Interactive Entertainment
This course provides a historical perspective on the evolution of computer and video game design, development and production. Related interactive digital entertainment will also be investigated to provide an understanding of historical issues related to games, computer games, and interactive media. Topics include analysis and critique of analog and interactive television technology, the application of computing and technology to the arts and literature, the business of computer games and cultural responses to computer games. Students will critique computer games and other interactive entertainment products in the context of these topics, the trade press, and personal experience. **Class 4, Active Learning Format, Credit 4**

4004-732 Game World Design
In this course, students will examine technical requirements for the creation of computer games based on previously developed design artifacts. They will create a design document consistent with current industry practices, building upon a written script, related materials and prototype and will present the draft design documents for critique. (4004-728) **Class 4, Active Learning Format, Credit 4**

4004-734 Online Identity, Social and Community Behavior
This course introduces students to the expanding body of research and popular writing on online identity, social and community behavior and its application to the development of new online communities and social software tools. Students will create their own prototypes for online communities and/or software tools, will participate in and evaluate existing online environments. **Class 4, Active Learning Format, Credit 4**

4004-737 Website Design and Technologies
Assuming a basic knowledge of HTML coding and web page design, this class moves into large-scale site development, and an introduction to advanced web technologies. Building on the web page design concepts introduced in 4004-741, this course focuses on site design issues, including scalability, maintenance, and integration of web technologies into the business or organizational context. Technologies introduced include cascading style sheets, dynamic HTML, basic JavaScript, and streaming media. (4004-741) **Class 4, Active Learning Format, Credit 4**

4004-738 Multi-User Media Spaces
This course will focus on the development of interactive applications that use network connectivity to allow multiple users to interact with each other in real time and in a persistent virtual community. The course will integrate multiple technologies dealing with connectivity, database access, server-side logic and object-oriented programming environments. Important human-computer interaction issues will be raised around the design and processing of messages and the traffic patterns generated by multi-user messaging. (4004 746) **Class 4, Active Learning Format, Credit 4**

4004-739 Programming for the World Wide Web
The World-wide Web is no longer just linked as static HTML documents. Web pages can be generated dynamically and can interact with a user to modify pages on-the-fly, validate user inputs and entertain. This course is an overview of several forms of programming that are used in the creation of interactive and dynamic web content. This course provides a practical overview of programming in the context of the World-wide Web. It will enable students to develop web pages and web sites that incorporate both client-side and server-side programming by installing and modifying existing scripts as well as writing new scripts. (4004-737 and a two-course programming sequence) **Class 4, Credit 4**

4004-741 Fundamentals of Web-Based Multimedia
This class provides an introduction to web-based multimedia development and implementation. Topics covered include uses of web based multimedia in business and historical contexts, differences between web-based and stand-alone multimedia, basic HTML and web page design, digital image creation and manipulation, and the incorporation of audio, video, and animated components in web-based multimedia. Students will learn to use computer-mediated communication and internet utilities in support of multimedia development. (Computer literacy) **Class 4, Credit 4**

4004-742 Interactive Multimedia Development
The development of interactive multimedia requires principles garnered from a variety of disciplines. Through readings, critiques, exercises and discussions, students will explore what makes an interactive multimedia application (or component of an application) successful and what types of applications are best suited to interactive multimedia. This course provides an introduction to the design of interactive multimedia drawing upon user interface design, task analysis, analysis of audience characteristics, and usability testing as well as design and editing principles from animation and video production. Using the hardware and software tools learned in the Fundamentals course, students will implement and test designs as individual components and as integrated elements of interactive multimedia for interactive and instructional applications. (4004-741 and 4004-745) **Class 4, Credit 4**

4004-743 Interactive Multimedia Project
This project-based course provides a culminating multimedia experience. Having achieved some proficiency with the tools and concepts of interactive multimedia, students are expected to produce significant work that can be used as a portfolio piece. Examples of interactive multimedia are examined and discussed. As CD-ROM is increasingly the medium of choice for distribution of interactive multimedia, design constraints for using read-only media are discussed. Techniques and principles for managing larger and more complex projects involving teams are examined. (4004-746) **Class 4, Credit 4**

4004-744 Building Online Communities
Students design and then work in teams to implement fully-functional on-line communities and/or social software tools to support on-line communities. This includes attracting members, promoting and managing their communities. Students will also evaluate the performance of their designs, their community members and their own management skills. (4004-737 and either 4004-734 or 4002-892) **Credit 4, Active Learning Format, Credit 4**

4004-745 Foundations of Human-Computer Interaction
Human-computer interaction (HCI) is a field of study concerned with the design, evaluation and implementation of interactive computing systems for effective human use and with the study of major phenomena surrounding them. This course surveys the foundation concepts and major issues of the HCI field including: cognitive psychology, human factors, interaction styles, user analysis, task analysis, interaction design methods and techniques, and evaluation. The primary focus of this course will be on the users and their tasks. **Class 4, Distance Format, Credit 4**

4004-746 Programming for Interactive Multimedia
The goal of this course is to advance the student's programming skills for implementing multimedia. This course will include programming the computer to control graphics, text, audio and video images as well as implement navigational strategies, indexing of information, import and export of data. This course will look at both event-driven and time-driven models of interaction. Upon completion of the course, students will achieve an understanding of basic programming concepts such as control structures, variables and procedures as well as design strategies such as defining requirements, top-down and bottom up design using applicable software engineering principles and interactive design involving users. Learning will be project-based and, whenever possible, directly related to ongoing projects. (4004 730) **Class 4, Credit 4**

4004-747 Topics in Interactive Multimedia
Interactive multimedia is a rapidly evolving field that is significantly influenced by changes in theory, storage media, computing hardware, authoring/presentation software and communication capabilities such as local and wide-area networks. In this course, students will be exposed to recent trends by hands-on development of interactive media projects. These will include development of interactive multimedia for use on multiple platforms, developing multimedia that can be accessed via the internet, real-time interaction between users using networked multimedia and development of interactive CD-ROM-based multimedia. (4004-746) **Class 4, Credit 4**

4004-748 Usability Engineering
This team project oriented course stresses the importance of good software interfaces and the relationship of user interface design to human computer interaction. Topics include: the usability engineering lifecycle, effective system design and development, usability heuristics, testing, assessment methods, and international user interfaces. This course focuses on the design, testing, and development of effective user interfaces. (4004-745 and 4004-730) **Class 4, Credit 4**

4004-749 Usability Testing
This project-based course will focus on the formal evaluation of user interfaces. Topics include: usability test goal setting, recruitment of appropriate users, design of test tasks, design of the test environment, test plan development and implementation, analysis and interpretation of the results, and documentation and presentation of results and recommendations. (4004-748 and a statistics course) **Class 4, Credit 4**

4004-751 Web-Database Integration
An introduction to technologies, techniques, and contexts for developing dynamic web sites that are driven by back-end databases. Builds on the concepts of web programming and multi-user relational databases introduced in prerequisite classes. (4004-737, 4004-739 and 4002-360 or 4002-720) **Class 4, Credit 4**

4004-755 Advanced Topics in HCI
Human-computer interface is an evolving field. This course is designed to study the current themes and advanced issues of HCI. Topics will vary depending upon current research and developments in the field. (4004-745) **Class 4, Distance Format, Credit 4**

4004-757 Graphical Elements of the User Experience
This course provides a theoretical framework covering principles of GUI and its effect upon the user experience. Emphasis will be upon principles that guide the user toward certain behaviors and elicit a sense of identity. This course is designed to articulate methods used to manipulate visual perceptions of space and surface. Students will apply these methods to create user interfaces that reflect the utility and character appropriate for specific projects. (4004-730) **Class 4, Credit 4**

4004-774 Eye Tracking: Theory, Methodology, and Applications
This course will provide a theoretical and practical study of eye movements and eye tracking, and will focus on the application of eye tracking to usability testing. Course topics include: eye movements and visual perception; types of eye trackers and theory of operations; data analysis; and the application of eye tracking to various domains. Laboratory projects will be required. (4004-745 and Statistics) **Class 4, Credit 4**

4004-775 Remote Usability Development and Testing
This course will discuss the tools and procedures of remote usability testing and apply them to the development of an effective user interface. Topics include: the software development lifecycle, design and development of effective interfaces, heuristic evaluations, assessment methods, usability testing procedures and protocols, remote testing tools and procedures, and analyze testing results and propose recommendations. (4004-745, 4002-730 and statistics, not intended for students taking 4004-748 and 4004-749) **Class 4, Credit 4**

4004-780 Application Domains in HCI
This course will provide a theoretical and case-based study of several areas of HCI, all considered within an application domain of information technology. Application domains may include medical informatics, bioinformatics, game design, and entertainment. Course topics include: A Scientific Approach to UI Design (Usability Engineering), Domain-Specific User Analysis and User Profiles, Social and Cultural Influences, General and Domain-Specific Design Issues, Information Visualization, Data Integration, Mobile Devices, Security, Privacy and Ethics. (4004-745) **Class 4, Credit 4**

4004-781 Usability Economics
User-centered design methodologies are proven enablers for developing successful systems and are important to realizing enterprise benefits. An understanding of usability economics is needed to effectively integrate usability engineering into the systems development process. This course provides students with the necessary background and methods to prepare cost-benefit analysis of applying usability engineering in a variety of system development domains. Other topics include: strategies for introducing usability engineering lifecycle into an organization; developing a usability culture; and developing enterprise usability standards. (4004-745, and 4004-748 or 4004-775) **Class 4, Credit 4**

4004-802 Perspectives on Computer Mediation
This course examines the design and implementation of software for computer mediation from several perspectives: the computer support for cooperative work (CSCW) perspective addresses activity and organization management, the computer-mediated collaboration (CMC) perspective addresses social systems for computing, and the computer supported collaborative learning (CSCL) perspective addresses collaborative and constructivist learning systems. Students will investigate the design and implementation of computer mediated experiences across several domains, including, but not limited to: social computing, pervasive and ubiquitous computing, computer-based learning environments, entertainment and gaming systems, as well as visualization and simulation systems. Students will be required to work in teams to create a large-scale computer mediated project. (4004-730 and 4004-745) **Class 4, Active Learning Format, Credit 4**

4004-804 Building Tools for Creative Practice
Students will be introduced to many of the patterns defining modern computer interfaces and will use them to implement a novel interface of their own design. Students will develop implementation skills for prototyping traditional and experimental interfaces for computing devices. Design patterns and classes will be used to implement components of a typical graphical user interface. Students will then apply these programming strategies to build a toolkit for a new, less conventional interaction style of their own design. Programming projects will be required. (4004-730 and 4004-745) **Class 4, Active Learning Format, Credit 4**

4004-806 Innovation, Invention and Computer Mediated Experience
This course considers the process and products of invention in Information Technology, past, present, and future. Each term we will conceive and develop a different "outside the box" project in a "tinkerer's lab". Readings, lectures, student presentations and discussions will deal with the interplay of technology, human nature and a human environment in which information technology is pervasive, ubiquitous, and (perhaps) implanted. The instructor will also guide students through a series of collaborative experiences inventing, designing, implementing and studying past and future IT. Presentations and projects are required. (4004-730 and 4004-748 or 4004-775) **Class 4, Credit 4**

4004-897 MS HCI Thesis
Capstone experience for the Master of Science in Human-Computer Interaction. Student must submit an accepted proposal in order to enroll. (Permission of the HCI Graduate Studies Committee) **Credit 4**

4004-898 MS HCI Project
Capstone experience for the Master of Science in Human-Computer Interaction. Student must submit an accepted proposal in order to enroll. (Permission of the HCI Graduate Studies Committee) **Credit 4**

Computer Science

4005-700 Foundations of Computer Theory
Introduction to the classical and contemporary theory of computation covering regular, context-free, and computable (recursive) languages with finite state machines, pushdown automata, and Turing machines. Basic concepts of computability theory. (Algorithms and Data Structures, 1016-265, 4003-709 Programming Language Concepts) **Class 4, Credit 4**

4005-701 Computability
Computability is the heart of theoretical computer science for it is the theory which attempts to formalize the notion of computation. Topics include computation by while-programs, Turing machines, recursive function theory, symbol manipulation systems, program methodology, the limitation of the concept of effective computability. (4005-700) **Credit 4**

4005-702 Computational Complexity
This course is concerned with the mathematical analysis of computer algorithms. Topics include matrix operations, combinatorial algorithms, integer and polynomial arithmetic, NP-completeness, and lower bounds on algorithms involving arithmetic operations. (4005-700) **Credit 4**

4005-704 Complexity and Computability
This course provides an introduction to complexity theory and computability theory. It starts with an overview of basic complexity classes, with special focus on NP-theory. This is followed by a study of problems complete for NP and PSPACE, the Church-Turing thesis, and undecidability of a selection of classical problems. Some advanced topics in computability, like degrees of unsolvability, the recursion theorem, or Godel's incompleteness theorem will be discussed. (4005-700) **Class 4, Credit 4**

4005-705 Cryptography
The course is devoted to the review of basic cryptographic algorithms, their implementation and usage. Classical encryption techniques and those of Rivest-Shamir-Adleman and EL Gamal will be seen in depth, and an overview of several others will be presented. This course also presents authentication schemes and interactive proof protocols. Students will write a term paper, either theoretical based on literature or reporting a student's own implementation or experiments with a chosen cryptographic scheme. Depending on the size of the group, some or all students will give a presentation to the class. (4003-263 or 4003-334; 1016-265; set by instructor) **Class 4, Credit 4**

4005-706 Cryptography II
This course investigates advanced topics in cryptography. Topics include an overview of necessary background in algebra and number theory, private and public key cryptosystems, and basic signature schemes. Additional topics include number theory and basic theory of Galois fields used in cryptography; history of primality algorithms and the polynomial time test of primality; discrete logarithm based cryptosystems including those based on elliptic curves; interactive protocols including the role of zero-knowledge proofs in authentication; construction of untraceable electronic cash on the net; and quantum cryptography. Other topics may include digital watermarking, fingerprinting, and steganography. Programming will be required. (4005-705 Cryptography I or 4003-482 and permission of instructor) **Credit 4**

4005-709 Topics in Computer Science Theory
Current topics in the field. The format of this course is a combination lecture and seminar. Students may register for this course more than once. Topics covered in the past include: arithmetic algorithms, data encryption, the Fast Frontier Transform, combinatorial optimization, logic. Programming projects may be required. (Set by instructor) **Credit 1–4**

4005-710 Programming Language Theory
An introduction to the basic concepts of programming language design. It begins with a survey of the issues that are involved in the design and implementation of languages. Specific tools for the description of syntactic and semantic structure are introduced. The balance of the course is an analysis of programming language structure, using these descriptive tools to give precise form to the discussion. Programming assignments will be required. (1016-265, 4003-709) **Class 4, Credit 4**

4005-711 Compiler Construction
This course discusses design and implementation of language processors and translators. Topics include lexical, syntactic, and semantic descriptions, algorithms for analysis tools, and programming techniques, as well as environment-, stack-, and heap-based interpreters and at least the principles of code generation for typical computer architectures. Teams of students will be required to design and implement a programming language with nested block structure and data aggregates. (4003-707 and 4003-709 or permission of instructor;) **Class 4, Credit 4**

4005-713 XML-Architectures, Tools and Techniques
This course is a critical review of the XML standard and its major applications for data description, transformation, storage, and transport, and in its role as a meta language for little languages used within software development and network communication. XML as a tool for language design is compared to a parser-generator based approach. The implementation of XML parsing is compared to other forms of language recognition. Students are expected to complete programming assignments, some involving Java, and give a team presentation (which includes a demonstration and online presence) about an XML-based technology available from the internet. (4003-707 or permission of instructor) **Class 4, Credit 4**

4005-714 Paradigms and Programming Skills
The goal of this course is to introduce the student to a programming paradigm and an appropriate programming language chosen from those that are currently important in industry or that show high promise of becoming important. A significant portion of the learning curve occurs through programming assignments with exemplary solutions discussed later in class. Students must complete a separate term project which will require some skills not discussed in class. The instructor will post specifics prior to registration. With the approval of the program coordinator, this course can be taken for credit more than once, provided each instance deals with a different paradigm and language. (4003-707 or 4003-233 or permission of instructor) **Credit 4**

4005-715 Language Based Security
This course explores the two major roles played by programming language-based mechanisms in developing secure systems that share mobile data or code. First, the course covers principles and practice of secure coding including topics such as good versus bad code, design, and implementation; security principles and architectures; and automation and testing. Second, the course examines techniques based on language design and implementation including topics such as secure operating system structures; software based fault isolation; reference monitors; type-safe languages; certifying compilers; proof-carrying code; automated program analysis and program rewriting. Computing projects are required. (4003-440, 713 and 4003-709 or permission of instructor) **Class 4, Credit 4**

4005-719 Topics in Programming Languages
Current topics in the field. The format of this course is a combination lecture and seminar. Students may register for this course more than once. Topics covered in the past include: logic programming, data flow, functional or applicative, and object oriented languages, programming language semantics, formal verification. Programming projects will be required. (Permission of the instructor, completion of the bridge program) **Class 1–4, Credit 1–4**

4005-720 Computer Architecture
Review of commercially available computer systems, including classical CPU and control unit design, register organization, primary memory organization and access, internal and external bus structures, and virtual memory schemes. Alternatives to classical machine architecture such as the stack machine and the associative processor are defined and compared. Parallel processors and distributed systems are also presented, along with an analysis of their performance relative to nonparallel machines. Programming projects are required. (4003-707, 4003-713) **Class 4, Credit 4**

4005-729 Topics in Computer Architecture
Current topics in the field. The format of this course is a combination lecture and seminar. Students may register for this course more than once. Programming projects will be required. (Permission of the instructor, completion of the bridge program) **Class 1–4, Credit 1–4**

4005-730 Distributed Operating Systems I
An introduction to the study of the hardware and software issues affecting the design of a distributed operating system. This course begins with an overview of processor networks and network protocols. It continues with a discussion of the issues that must be addressed in the design of a distributed operating system. The remainder of the course focuses on protocols and algorithms for handling process communication, synchronization, and coordination. (4003-709 and 4003 713) **Class 4, Credit 4**

4005-731 Distributed Operating Systems II
This course addresses the practical issues involved in the design of a distributed operating system. The following topics are discussed: implementations of the process environment, processor scheduling, file systems, and the management of distributed memory. Examples of specific implementations will be discussed. Other topics (e.g., security) may be covered, at the discretion of the instructor. A group or individual project, involving the design and implementation of one or more components of a distributed operating system, will be a major component of this course. (4005-730) **Class 4, Credit 4**

4005-735 Parallel Computing I
A study of the hardware and software issues in parallel computing. Topics include an introduction to the basic concepts, parallel architectures and network topologies, parallel algorithms, parallel metrics, parallel languages, network topology, granularity, applications, parallel programming design and debugging. Programming projects will be required. (4003-713) **Class 4, Credit 4**

4005-736 Parallel Computing II
Parallel Computing II is a collaborative learning course. Students will agree on the topics for the course, will prepare and present one of the agreed upon topics, and will lead the discussion for another lecture. In addition, parallelism will be applied to real-world interdisciplinary projects. (4005-735 Parallel Computing I) **Class 4, Credit 4**

4005-739 Topics in Operating Systems
Current topics in the field. The format of this course is a combination lecture and seminar. Students may register for this course more than once. Topics covered in the past include: Unix internals, concurrency methods, Petri Nets, parallel programming and algorithms, security, operating systems performance, software environments, communicating sequential processes ("CSP"). Programming projects will be required. (Permission of the instructor, completion of the bridge program) **Credit 1–4**

4005-740 Data Communication and Networks I
This course is an introduction to the concepts and principles of computer networks. Students will design and implement projects using application protocols, and will study transport, network, and data link protocols and algorithms. This course also includes an introduction to local area networks, data transmission fundamentals, and network security. Programming projects will be required. (1016-351 and either 4003-334 or 4003-263 or 4003-707) **Class 4, Credit 4**

4005-741 Data Communication and Networks II
This course continues the study of computer networks begun in 4005-740 Data Communications and Networks I, emphasizing design principles and theoretical aspects of networks. Topics include the nature of communications media and signaling methods, analog and digital transmission, data link protocols, protocol proof techniques, routing, broadcasting, and multicasting, connection, disconnection and crash recovery protocols, internetworking and security, network analysis and design using graph theory and queueing theory. (4005- 740, 4003-707) **Class 4, Credit 4**

4005-742 Ad-Hoc Networks
This course explores serverless ad-hoc networks. Topics include authentication, confidentiality, routing, service discovery, middleware and key generation and key distribution. Programming projects are required. (CSI-CS3 or 4003-707, 4003-420 Data Communications and Networking) **Class 4, Credit 4**

4005-743 Secure Operating Systems Network
This course provides students with an introduction to the issues surrounding security aspects in operating systems and networks. Case studies will be used to illustrate security issues in operating systems and networks. Topics include but are not limited to the orange book, access control, firewalls, and an evaluation of the security aspects in a distributed system. Where appropriate, programming exercises will be used to improve understanding of security issues. Exercises may involve group as well as individual projects. It is expected that student presentations will be given during the quarter. (4005-740 and 4003-440 or permission of the instructor) **Class 4, Credit 4**

4005-749 Topics in Data Communication
Current topics in the field. The format of this course is a combination lecture and seminar. Students may register for this course more than once. Topics covered in the past include: network reliability, special-purpose protocols, error-correcting codes. Programming projects will be required. (Permission of the instructor, completion of the bridge program) **Class 1–4, Credit 1–4**

4005-750 Introduction to Artificial Intelligence
An introduction to the field of artificial intelligence, including both theory and applications. A programming language that allows effective symbolic manipulation (PROLOG) is used to demonstrate the capabilities and limitations of the material presented in class. Topics include search strategies and their implementation, logic, networks, frames and scripts, production, symbolic manipulation and list processing, problem-solving methods, expert systems, natural language understanding, and selections from vision, robotics, planning and learning. Programming assignments are an integral part of the course. (4003-709) **Class 4, Credit 4**

4005-751 Knowledge Based Systems
An introduction to the issues and techniques of building knowledge based systems. Topics will include a survey of existing expert system architectures and implementations, knowledge representation techniques, expert system building tools, and knowledge acquisition. In addition to examining existing expert systems, students will implement expert systems. Programming projects will be required. (4005-750) **Class 4, Credit 4**

4005-752 Artificial Intelligence for Interactive Environments
This course delves into the use of artificial intelligence in interactive environments. These environments range from the entertaining nature of role-playing games to more serious military simulations. In all these environments, agents and groups of agents must interact in an intelligent manner. Topics will include advanced pathfinding algorithms, sensory systems, group tactical strategies, and learning algorithms. Projects are an inherent part of the course. (4003-455, 4005-750 or permission of instructor) **Class 4, Credit 4, Lab 1**

4005-753 Biologically Inspired Intelligent Systems
This course examines contemporary topics in artificial intelligence in neuroscience, cognitive science and physiology. Students will focus on developing computer models that are biologically inspired and leverage current knowledge in these areas with the goal to develop systems that understand their environment. An in-depth research paper on a relevant topic, a programming project, and a presentation will be required. A background in biology is not required. (Graduate standing in CS or permission of instructor) **Credit 4**

4005-755 Neural Networks and Machine Learning
Neural networks, systems with massively connected parallel primitive computing elements, are, metaphorically, computers structured after natural brains. Such systems promise much better performance than classical computers at pattern recognition and related areas. In this seminar, we will present several neural network models, introduce the current research activity, and develop some underlying mathematics. Students will have the opportunity to develop and present models, both paper and software simulated, and to utilize canned simulators. Students will be exposed to the current research literature. Programming projects will be required. (4005-700 and completion of bridge) **Class 4, Credit 4**

4005-756 Genetic Algorithms
Genetic algorithms provide a powerful approach for searching large, ill-behaved problem spaces. In this course, we will study the theoretical foundations of genetic algorithms as well as their application to a variety of search and optimization problems. This course will cover topics from the current research literature, and students will be expected to do a library research review and perform an experimental project. Programming projects will be required. (4005 700, 4005-710) **Class 4, Credit 4**

4005-757 Introduction to Computer Vision
An introduction to the underlying concepts of computer vision and image understanding. The course will consider fundamental topics, including image formation, edge detection, texture analysis, color, segmentation, shape analysis, detection of objects in images and high level image representation. Depending on the interest of the class, more advanced topics will be covered, such as image database retrieval or robotic vision. Programming assignments are an integral part of the course. (Completion of bridge) **Class 4, Credit 4**

4005-758 Advanced Computer Vision
This course examines advanced topics of current research interest in computer vision including motion analysis, video processing and model based object recognition. The topics will be studied with reference to specific applications, for example video interpretation, robot control, road traffic monitoring, and industrial inspection. A research paper, an advanced programming project, and a presentation will be required. (4005-757 or permission of instructor) **Credit 4**

4005-759 Topics in Artificial Intelligence
Current topics in the field. The format of this course is a combination lecture and seminar. Students may register for this course more than once. Topics covered in the past include: logic programming, natural language processing, pattern recognition, specialized AI languages and programming paradigms, robotics. Programming projects will be required. (Permission of the instructor, completion of the bridge program) **Class 1–4, Credit 1–4**

4005-761 Computer Graphics I
Computer Graphics I is a study of the hardware and software principles of interactive raster graphics. Topics include an introduction to the basic concepts: 2-D and 3-D modeling and transformations, viewing transformations, projections, rendering techniques, graphical software packages and graphic systems. Students will use a standard computer graphics API to reinforce concepts and study fundamental computer graphics algorithms. (Completion of the graduate bridge program) **Class 4, Credit 4**

4005-762 Computer Graphics II
This course will investigate the theory of computer image synthesis. Seminal computer graphics will be used to describe the various components of the image synthesis pipeline and explain, just as in photography, how the path of lights in a virtual scene can be simulated and used to create photorealistic imagery. The course will emphasize the theory behind various rendering tools and libraries available for image synthesis. The student will put theory into practice via programming assignments and a capstone project. Topics will include light and color, three-dimensional scene specifications, camera models, surface materials and textures, rendering (local, ray tracing, radiosity), procedural shading and modeling, tone reproduction, and advanced rendering techniques. (4005-761 Computer Graphics I or 4002-735 3D Graphics Programming) **Class 4, Credit 4**

4005-763 Computer Animation-Algorithms and Techniques
This course takes a look at Computer Animation from a programmer's perspective. It will investigate the theory, algorithms and techniques for describing and programming motion for virtual 3D worlds. Approaches that will be explored include keyframing systems; kinematics, motion of articulated figures, procedural and behavioral systems, and the use of motion capture data. This course is a programming-oriented course with major deliverables including the implementation of techniques presented in lecture as well as a final project concentrating on an area of a student's choice. Students enrolling in this course are expected to have proficiency in the use of a 3D API (e.g. OpenGL, DirectX, Java3D). The course will additionally prepare graduate students to do research in this area through reading, summary, and survey of papers from the animation literature. (4005-761 or 4002-735 or permission of instructor) **Credit 4**

4005-769 Topics in Computer Graphics
This project-oriented course builds on topics developed in 4005-761, Computer Graphics I. Expanded topics include standard graphics software, animation techniques, 3-D modeling methods, hidden surface and line algorithms, shading, antialiasing, color models and design of the user interface. Students will be required to design and implement an interactive system for an application that incorporates several of the above areas. Programming projects will be required. (4005-761 or permission of the instructor) **Class 4, Credit 4**

4005-771 Database Systems
Broad introduction to database management systems (DBMS) and the design, implementation, and applications of databases. Topics include an overview of DBMS architectures, concepts and implementations of the relational model, SQL, database design and modeling techniques, and issues such as recovery, concurrency, physical implementation concerns and performance and management aspects. Optimal topics include: alternative approaches to designing database systems (for example, object-oriented or extended relational systems), distributed databases, database machines, and database interfaces and languages. A programming project is required. (4003-334 or 4003-707) **Class 4, Credit 4**

4005-772 Database Systems Implementation
This course covers data structures and algorithms used to implement database management systems. Topics include physical data organizations, indexing and hashing, query processing and optimization, database recovery techniques, transaction management, concurrency control, and database performance evaluation. Current research topics in database system implementation are explored. Programming projects will be required. (4003-771) **Class 4, Credit 4**

4005-774 Secure Database Systems
This course explores policies, methods and mechanisms for protecting enterprise data. Topics include data reliability, integrity, and confidentiality; discretionary and mandatory access controls; secure database architectures; secure transaction processing; information flow, aggregations, and inference controls, and auditing; security models for relational, object-oriented, statistical, XML, and real time database systems. Programming projects are required. (4002-484, or 4003-485, or 4010-443 or equivalent) **Class 4, Credit 4**

4005-775 Introduction to Data Mining
This course provides an introduction to the concepts and techniques used in the field of data mining. The course covers the knowledge discovery process that includes data selection, cleaning, coding; different statistical, pattern recognition and machine learning techniques; and reporting and visualization of generated structures. Computing projects, a term paper, and presentations are required. (4005-771) **Class 4, Credit 4**

4005-779 Computer Science Seminar
This course explores policies, methods and mechanisms for protecting enterprise data. Topics include data reliability, integrity, and confidentiality; discretionary and mandatory access controls; secure database architectures; secure transaction processing; information flow, aggregation and inference controls, auditing; security models for relational, object-oriented, statistical, XML, and real-time database systems. Programming projects are required. (4002-484 or 4003-485 or 4010-443 or 4005-771 or permission of instructor). **Credit 4**

4005-784 Privacy and Security
This course provides students with an introduction to the issues surrounding security of computer systems and privacy concerns in an increasingly information-based society. This class will consider numerous social issues in computing, including risks and liability involved in using information as well as ethical concerns. Case studies will be used to illustrate both common and historic problems in computer security. Group and individual programming projects will be used to improve understanding of security issues. Students will research specific areas of interest and report their results to the class. (4003-420 and 4003-713) **Class 4, Credit 4**

4005-800 Theory of Computer Algorithms
This course provides an introduction to the design and analysis of algorithms. It covers a large number of classical algorithms and their complexity and will equip students with the intellectual tools to design, analyze, implement, and evaluate their own algorithms. (1016-265 Discrete Math I, 4003-334-CS 4) **Class 4, Credit 4**

4005-890 MS Thesis
Capstone of the master's degree program. Students must submit an acceptable thesis proposal in order to enroll. (Permission of the graduate studies committee; 4005-893) **Credit 0–9**

4005-891 MS Project
Alternative capstone of the Master's Degree Program. Student must submit an acceptable project proposal in order to enroll. (Permission of the graduate studies committee; 4005-893) **Variable credit 2–5**

4005-893 MS Project/Thesis Seminar
In this course the student will develop a master's project or thesis topic. It will be necessary for the student to make presentations in the class, form a committee and write a master's proposal. This course must be completed prior to registering for 4005-891. (Complete 16 graduate hours with a minimum 3.0 GPA) **Class 2, Credit 2**

4005-898 Independent Study
A supervised investigation of selected topics within computer science. Consent of the sponsor and department approval are required.

4005-899 Seminar
Current advances in computer science (set by instructor). **Credit 4**

4005-999 Graduate Co-op Education
Six months of full-time, paid employment in the computing field. See the CS graduate program coordinator or RIT's Office of Cooperative Education and Career Services for further details. (Good standing, completion of bridge and 16 graduate credits) **Credit 0**

Software Engineering

4010-748 Secure Software Engineering: Requirements
Overview of the secure software issues and principles that should be addressed during requirements engineering and design. Topics include: risk management and software requirement specification. Designing for security and security in implementation. (4010-361) **Credit 4, Class 0, Lab 0**

4010-758 Secure Software Engineering: Verification
Overview of the secure software issues and principles that should be addressed during testing. Topics include: test planning, security goal test planning, testing tools, testing security requirements, testing the security of a design, grey box testing techniques, acceptance testing techniques, and contemporary issues regarding testing for security. (4010-361) **Credit 4, Class 0, Lab 0**

4011-700 Software Engineering Practicum I
A project course where students practice what they have learned or are learning in class, through directed study. The practicum is an ongoing project in which students register to participate as engineers in a specific role in accordance to individual levels of expertise and profile. (Enrollment in the MS in software engineering program) **Credit 4, Class 0, Lab 4**

4011-701 Software Engineering Practicum II
A project course where students practice what they have learned or are learning in class through directed study. The practicum is an ongoing project in which students register to participate as engineers in a specific role in accordance to individual levels of expertise and profile. (4011 700) **Credit 4, Class 0, Lab 4**

4011-702 Software Engineering Practicum III
A project course where students practice what they have learned or are learning in class through directed study. The practicum is an ongoing project in which students register to participate as engineers in a specific role in accordance to individual levels of expertise and profile. (4011-701) **Credit 4, Class 0, Lab 4**

4011-710 Research Methods
Overview of the academic research methodologies used in graduate level work. Topics include; writing style, audience analysis, research planning, experimental design, document structure, research validation, and the process for submission and review to conferences and journals. (Admission to the MSSWE program. Students from graduate programs other than software engineering require departmental approval). **Credit 4, Class 4, Lab 0**

4011-720 Software Evolution and Reengineering
This course explores the concepts of software evolution and reengineering and introduces approaches and support tools used to extract the information needed to assess existing software systems. Major maintenance activities are presented including estimating maintenance costs, managing change and predicting maintainability with software quality metrics. Organizational issues relative to product maintenance are discussed. Principles of software reuse and reverse engineering techniques are demonstrated through the use of class activities, team projects and case studies. (Enrollment in the MSSWE program. Graduate students from programs other than software engineering require departmental approval). **Credit 4, Class 0, Lab 4**

4011-730 Process Engineering and Environments
In this course, students will study the Software Process Engineering Metamodel (SPEM) standard as a tool for modeling and analyzing engineering processes. Students will use SPEM to characterize various process and organization models and patterns, and they will align these process characteristics to categories of needs for various organizations and projects. The students will study process engineering frameworks and the configuration and assembly of reusable process components into processes. Students will also study how tools and methods support the process and will identify issues in tool/artifact integration across the software development lifecycle. They will apply their learning to engineer software engineering processes, tools, and methods appropriate for their graduate projects and course projects. (4011-720 – Students from graduate programs other than software engineering require departmental approval.) **Credit 4, Class 0, Lab 4**

4011-740 Empirical Software Engineering
This course focuses on the application and analysis of software engineering (SE) experimentation as a means of improving both the technical and process-oriented aspects of SE; includes software quality and testing, software design, maintenance, and software development techniques. Topics of interest include, but are not limited to: the analysis of empirical studies of software processes and products, evaluation and comparison of techniques and models (e.g., cost estimation, analysis and design methods, testing), analysis of reports on benefits derived from using studied technologies, examination of predictive models, and the characterization of research methods (measurement theory, experimental design, qualitative modeling, analysis approaches, grounded theory, protocol studies, families of experiments). (4011-710-Students from graduate programs other than software engineering require departmental approval. **Credit 4, Class 0, Lab 4**

4011-750 Software Modeling
Modeling plays a pivotal role during the pre-construction and post-construction activities of the software lifecycle. During the pre-construction stage models help software engineers understand, specify, and analyze software requirements and design. During the post-construction stage models can be used to analyze software systems while in operation. This kind of analysis includes reliability and safety issues as well as timing constraint analysis. (4011-700 and one of 4011-720 or 4011-730. Students from graduate programs other than software engineering require departmental approval). **Credit 4, Class 0, Lab 4**

4011-760 **Software Quality Engineering**
This course begins with an exploration of the concepts underlying quality systems and the use of metrics. Students are encouraged to discuss the advantages as well as the limitations of systems and quantitative approaches, with a view to understanding the importance of interpretation in metrics usage and of matching quality systems choices to organizational objectives and culture. They learn the use of modern metrics such as DRE, PCE, COQ/COPQ, reliability objectives and SUMI scores through exercises in analyzing and interpreting charts. This is complemented with a project where they work in teams to design an appropriate quality system for a specific project/organizational situation. (4011-701, 4011-730; students from graduate programs other than software engineering require departmental approval). **Credit 4, Class 0, Lab 4**

4011-770 **Software Architecture & Product Lines**
A system's software architecture is the first technical artifact that illustrates a proposed solution to a stated problem. For all but the simplest system, the achievement of qualities such as flexibility, modifiability, security and reliability is critically dependent on the components and interactions defined by the architecture. The course focuses on the definition of architectural structures, the analysis of architectures in terms of tradeoffs among conflicting restraints, the documentation of architecture for use over a product's life cycle, and the role of architecture in defining product lines based on reusable components. (4011-701, 4011-750; students from graduate programs other than software engineering require departmental approval.) **Credit 4, Class 0, Lab 4**

4011-780 **Software Engineering Experience Research**
This course provides the student with an opportunity to reflect on his/her experience throughout this program and to relate that experience to his/her professional goals. The student builds a professional document during the last academic quarter of study. The report must include an in-depth research report on a topic selected by the student and in agreement with the student's experience report advisor. The report must be structured as a conference paper, and must be submitted to a conference selected by the student and his/her advisor. (Department authorization) **Credit 4, Class 0, Lab 4**

Computing and Information Sciences

4080-801 **Ph.D. Research Seminar I**
This course is one of a series of six required research seminar courses for Ph.D. in Computing and Information Sciences students. This series of courses is designed to foster development of critical thinking, clear communication, peer-mentoring, and collaboration in an interdisciplinary research environment. Supported by faculty, students in this course are charged with identifying, researching, interviewing, and reporting on potential research areas and collaborators for future research in cyberinfrastructure. The courses will introduce students to their Ph.D. study and research at RIT and help them to prepare themselves for future study, research and career development. **Credit 1**

4080-802 **Ph.D. Research Seminar II**
This course is one of a series of six required research seminar courses for Ph.D. in Computing and Information Sciences students. This series of courses is designed to foster development of critical thinking, clear communication, peer-mentoring, and collaboration in an interdisciplinary research environment. Supported by faculty, students in this course are charged with identifying, researching, interviewing, and reporting on potential research areas and collaborators for future research in cyberinfrastructure. The course will focus on establishing patterns and setting up collaborations with other students, faculty and researchers for future research. **Credit 1**

4080-803 **Ph.D. Research Seminar IIII**
This course is one of a series of six required research seminar courses for Ph.D. in Computing and Information Sciences students. This series of courses is designed to foster development of critical thinking, clear communication, peer-mentoring, and collaboration in an interdisciplinary research environment. Supported by faculty, students in this course are charged with identifying, researching, interviewing, and reporting on potential research areas and collaborators for future research in cyberinfrastructure. The course will concentrate on best practices in research and developing research skills necessary for achieving research results, their presentation and publication. **Credit 1**

4080-804 **Ph.D. Research Seminar IV**
This course is one of a series of six required research seminar courses for Ph.D. in Computing and Information Sciences students. This series of courses is designed to foster development of critical thinking, clear communication, peer-mentoring, and collaboration in an interdisciplinary research environment. Supported by faculty, students in this course are charged with identifying, researching, interviewing, and reporting on potential research areas and collaborators for future research in cyberinfrastructure. While promoting wide collaboration, this course will concentrate on developing specific knowledge and research skills for conduction further study and research in an Interaction domain. **Credit 1**

4080-805 **Ph.D. Research Seminar V**
This course is one of a series of six required research seminar courses for Ph.D. in Computing and Information Sciences students. This series of courses is designed to foster development of critical thinking, clear communication, peer-mentoring, and collaboration in an interdisciplinary research environment. Supported by faculty, students in this course are charged with identifying, researching, interviewing, and reporting on potential research areas and collaborators for future research in cyberinfrastructure. While promoting wide collaboration, this course will concentrate on developing specific knowledge and research skills for conduction further study and research in an Informatics domain. **Credit 1**

4080-806 **Ph.D. Research Seminar VI**
This course is one of a series of six required research seminar courses for Ph.D. in Computing and Information Sciences students. This series of courses is designed to foster development of critical thinking, clear communication, peer-mentoring, and collaboration in an interdisciplinary research environment. Supported by faculty, students in this course are charged with identifying, researching, interviewing, and reporting on potential research areas and collaborators for future research in cyberinfrastructure. While promoting wide collaboration, this course will concentrate on developing specific knowledge and research skills for conduction further study and research in an Infrastructure domain. **Credit 1**

4040-807 **Teaching Skills Workshop I**
Teaching is a valuable and desirable skill for PhD students. This first of a series of workshops provides an introduction to the concepts and skills needed for quality teaching in higher education. Students will be provided with lecture, reading, and class activities centered on building skills in educational analysis, design, and assessment. **Credit 2**

4040-808 **Teaching Skills Workshop II**
This second of a series of workshops provides students with an opportunity to practice with a variety of instructional delivery formats, including lectures, professional presentations, in-class activities, tutoring, active learning, media support, and seminars. Students will be provided with examples and class activities centered on building skills in educational delivery. (4040-807) **Credit 2**

4040-809 **Teaching Skills Apprenticeship**
This is the third course in a series of workshops that provides students with an opportunity to work with an experienced faculty member as an assistant. Students will be provided with an opportunity to observe and discuss teaching techniques with an experienced faculty "mentor." Students will be provided with opportunities to contribute to the teaching of a course, and will receive feedback on their teaching techniques and materials. (404-808) **Credit 1**

4040-810 **Research Methods**
This is a core course of the Ph.D. in computing and information sciences program. This course provides students with the theoretical background and practical application of various research methods that can be used in computing and information sciences. The course provides an overview of the research process and the literature review, and provides initial study in correlational and experimental research methods and design. Students will analyze several existing research studies, and design and conduct studies. **Class 4, Credit 4**

4040-820 **Discovery**
This is a core course of the Ph.D. in computing and information sciences program. This course explores the theory and practice of discovering information from large data sets. Topics include data informatics, knowledge discovery, data visualization, information sharing and presentation, and ethical issues underlying access and interpretation of large data sets. **Class 4, Credit 4**

4040-830 Connectivity
This is a core course of the Ph.D. in computing and information sciences program. This course provides coverage of connectivity in communication, computing, and naturally-occurring networks. Topics include fundamental and emerging concepts in networking, and the analytical and heuristic tools that people use to develop and analyze networks. **Class 4, Credit 4**

4040-840 Security and Trust
This is a core course of the Ph.D. in computing and information sciences program. This course discusses theoretical, social, policy and procedural, and human factors aspects that effect general security in a computing environment. Course topics are: cryptography, network security, policies and procedures, access control, secure software engineering, and human factors of security. **Class 4, Credit 4**

4040-849 Ph.D. Seminar
Current advances in computing and information sciences. (Prerequisite courses set by instructor) **Credit 1–4**

4040-850 Design
This is a core course of the Ph.D. in computing and information sciences program. This team and project oriented course stresses the systems approach to problem solving in the context of "use-inspired basic research." The course provides an overview of design processes, methods and tools. Topics include various types of systems and their lifecycles and process frameworks; effective system design representations and development methods; usability heuristics, testing, and assessment methods, product line domain engineering concepts; project planning and oversight tools. **Class 4, Credit 4**

4040-899 Independent Study
Ph.D. students will work with supervising faculty on a project or research study of mutual interest. The design and evaluation will be determined through discussion with the supervising faculty and documented through completion of an independent study form. The independent study must be approved by the Ph.D. program director.

Networking, Security and Systems Administration

4055-721 Perl for System Administration
This course will provide students with an introduction to the Perl programming language, with examples and problems drawn from the system administration arena. In addition to the essentials of the language, students will be taught how to locate and install Perl Modules for use on a computing system. Toward the end of the course, OOPerl (Object Oriented Perl) will be introduced, as an extension to Modules. Application areas discussed will include programs for walking the files system, user account creation and manipulation, and the processing of log files. (Completion of a two-course object oriented programming sequence) Co-listing: 4050-521 **Class 4, Credit 4**

4055-726 Research Methods in NSSA
This seminar introduces students to the MS in networking, and system administration by providing an opportunity to meet the faculty involved in the program and their fellow students. Students will learn about current areas of research in networking, security, and system administration and the areas of research interest of the faculty. To encourage students to begin thinking about their final project or thesis, students will develop a research proposal that may serve as the basis for their later thesis proposal. In addition, this course provides an overview of the academic research methodologies used in graduate level work. Topics include: experimental research, correlation, experiment observation, surveys, and case studies. Also included will be document structure, validation, and the process for submission and review to conferences and journals. **Class 4, Credit 4**

4055-746 Telecommunications Network Protocols
Network topologies are discussed, with coverage of layers, 1, 2, 3, and 4. Access control, framing, network protocols, (IP) transport protocols (TCP and UDP), session initiation protocols (SIP), subnetting, port numbers, hubs, switches, routers, and other topics are covered. Prerequisites: None **Class 4, Credit 4**

4055-755 Secure Wireless and Wired Data Networks
Providing security in today's complex networks is a complicated subject and requires network managers to be well versed in the many aspects comprising network security. In order to accommodate the rapid expansion of networks and the alarming rate in which network security is breached, there is a need for more and better educated people who understand the basics of security in a networked world. This course is designed to provide students with the foundation needed to understand the problems of network security, perform a risk analysis to ascertain the threats and cost of an attack, and design and implement security strategies to effectively build a defense to minimize the effects of these attacks. (4055-746 or equivalent knowledge) **Class 4, Credit 4**

4055-760 Computer Viruses and Malicious Software
This course involves the study of malicious software (Malware) including computer viruses, worms, and Trojan horses. Topics include the various mechanisms used in the construction of malicious software; existing commercial anti-virus software; preventative and reactive means for dealing with malicious software on workstations, servers and in networks; training and education of users; and reliable sources to monitor for alerts as well as the prevention of hoaxes. (4055-716 C++ for Programmers or equivalent) **Class 3, Lab 2, Credit 4**

4055-761 Principles of System Administration
Students are introduced to fundamental system administration topics and technologies that serve as the basis for later course work in system administration. Topics covered include; ethics and system administration, the law and system administration, and the role of the system administrator in organizations. Technologies covered include: computing resource management, the TCP/IP protocol suite, the Domain name Service (DNS), the Dynamic Host Configuration Protocol (DHCP), and the Lightweight Directory Access Protocol (LDAP). Students will use the Remote Laboratory Emulation System (RLES) to complete laboratory exercises. (4050-3504 and 4050-3514 or equivalent) **Class 4, Credit 4**

4055-780 Computer System Security
This course provides an introduction to computer network security. The areas covered will include the liability, exposure, opportunity, and ability to exploit various weaknesses in a networked computer environment. The forms of the attacks and the detection and defense of the attacks will be discussed. The issues and facilities available to both the intruder and administrator will be examined and evaluated with illustrative laboratory exercises. (4055 761 or equivalent, corequisite: 4055-780 lab) **Class 3, Lab 2, Credit 4**

4055-782 Wireless Adhoc/Sensor Networks
This course will introduce students to the diverse literature on ad hoc/sensor networks, and expose them to the fundamental issues in designing and analyzing ad-hoc/sensor network systems. Students will study related technologies and standards ranging from networking, OS support and algorithms, to security. Of primary concern will be protocol design, communication and computational challenges posed by these systems. Activities will include constructing ad-hoc/sensor networks, programming on the sensor hardware, and studying the performance of various protocols. (4055-746 and a two-course sequence in object-oriented programming) **Class 3, Lab 2, Credit 4**

4055-815 Introduction to Routing and Switching
This is a laboratory-based course that focuses on the standards and technologies used to establish internetwork structures that will support a TCP/IP data stream for higher level services to operate over. It is primarily concerned with the network layer and below. Although the course focuses on the TCP/IP protocol suite and the Ethernet LAN protocol other protocols may be studied. Students will use their knowledge of how to connect computers (PCs) in a LAN and learn how to connect separate networks together to form an internetwork.. Bridging and switching concepts are investigated (such as the resolution of bridging loops through the appropriate algorithms). Routed and routing protocols and algorithms are studied and implemented. (4050-351; corequisite: 4050-815 lab) **Class 3, Lab 2, Credit 4**

4055-817 Emerging Network Technologies
The internet has experienced profound growing pains in the last several years that have called into question the adequacy of some of the underlying technologies upon which it has been based. In response to this there are a substantial number of emerging network technologies that if widely adopted may allow the internet to continue to grow and develop. This course is designed to provide students with an overview of several of these emerging network technologies. The course will consist of a combination of lectures, independent labs and simulation and modeling exercises. **Class 4, Credit 4**

4055-818 Network Management
This course will introduce students to the advanced concepts related to the development and implementation of network management tools utilizing a scripting language and the simple network management protocol (SNMP). Theoretical concepts related to network management and tool development will be discussed as well as the requirements of tool use in an enterprise scale network environment. Scripting and programming projects required. (4055-817) **Class 3, Lab 2, Credit 4**

4055-841 Advanced Computer Forensics
This course provides students with knowledge and understanding of computer forensics. It will also provide a theoretical foundation for the techniques and methods needed for the extraction of information from digital devices. Students will gain exposure to the spectrum of available computer forensics tools along with developing their own tools for "special needs" situations. The core forensics procedures necessary for ensuring the admissibility of evidence in court, as well as the legal and ethical implications of the process, will be covered on both Unix and Windows under multiple file systems. (4055-716 or equivalent and 4055-761 or equivalent) **Class 4, Credit 4**

4055-850 Network Design and Performance
This course will examine the design and performance of networks. Students will learn to design networks based on identified needs, analyze the performance of that network. The designs include site, campus, and enterprise. WAN technologies will be combined with LAN technologies in the design of enterprise networks. Students will learn to assess the business goals and their application to the network goals. Students will learn to evaluate the security goals of the network and to integrate these goals in the design. (4002-455, 4055-746, 4055-761) **Class 4, Credit 4**

4055-862 Advanced Routing Protocols
Managing complex network environments requires an understanding of the sophisticated routing protocols necessary for controlling information flow. This course will examine the routing protocols in standard use and their application in typical enterprise and large internet service provider (ISP) environments. The advantages and disadvantages of each protocol will be investigated. In addition, emerging networking technologies and the protocols needed to facilitate their implementation will also be discussed. (4055-746 or equivalent) **Class 4, Credit 4**

4055-863 Protocol Design and Implementation
Students will use a package that provides them access to the lowest layers of the OSI model available to software. Employing this package, students will write programs to interact with established protocols, and to implement their own protocols. What a protocol is will be discussed and what makes a protocol good or bad will also be explored. (4055-746 and 4002-716) **Class 5, Credit 4**

4055-882 Enterprise Security
This course is designed to provide students with the advanced concepts needed to establish network security strategies to ensure adequate protection for the corporate environment and yet provide accessibility for the corporate community. (4055-761 and (4055-815 or 4055-746).) **Class 4, Credit 4**

4055-883 Enterprise Networking
This course will provide students with the knowledge and understanding to apply modeling and simulation techniques to predict throughput in large-scale enterprise networks. Theoretical concepts of large-scale networks will be discussed and students will create software models based on this theory. This course will provide students with the knowledge needed to apply available tools for modeling network functionality to determine the impact of network infrastructure modification, device reconfiguration, and the impact of new application rollout. Modeling/simulation project required. (4055 850 Network Design and Performance.) **Class 4, Credit 4**

4055-884 Enterprise Service Provisioning
Advances in server software and hardware have made it possible for large organizations to consolidate software services onto fewer, higher powered servers while at the same time enhancing reliability and availability. This course will explore available technologies such as cluster computing and server virtualization as they can be used to deploy software services in enterprise environments. (4055-818, Corequisite: 0101-703) **Class 4, Credit 4**

4055-885 Advanced Networking Concepts
This course introduces a range of advanced topics in the design and implementation of modern computer and telecommunication networks. The course provides students with theoretical and working knowledge of various networking technologies. The state-of-the-art hardware and software networking technologies are introduced. These include, for example, Fiber-optic and Mobile communications; Wavelength Division and Time Division Multiple Access Protocols; New technologies for TCP/IP, GMPLS, Mobile IP, Ad-Hoc/sensor networks, Multicasting, QoS; and Next Generation Internet technologies (All-Optical networks). (4055-746) **Class 4, Credit 4**

4055-886 Security Audits of Web Servers and Applications
This course will provide students with an introduction to processes and procedures for performing a technical security auditing of web servers and web based applications. Students will not only explore the existing XML/WebServices threats, but also learn to apply appropriate auditing tools to identify new vulnerabilities existing in or stemming from web servers and applications. Students will write and present their audit reports on web servers and applications' vulnerabilities. (4055-780 Computer System Security or equivalent) **Class 4, Lab 0, Credit 4**

4055-890 Graduate Seminar in NSSA
This is the NSSA seminar course to allow for special one-time offerings of graduate topics or to allow faculty to pilot new graduate offerings. Specific course details (such as the course topics, format, resource needs, and credit hours) will be determined by the faculty member(s) who propose a given special-topics offering. (Prerequisites as appropriate for topic proposed) **Credit 2–8**

4055-896 Proposal Development
This course will guide students in the development of a proposal for the completion of a thesis in networking and system administration. As part of this course, students will learn about the different parts of a proposal and the relationship of a proposal to a completed thesis. As part of this course, students will meet with potential thesis advisers in their area of concentration and discuss with them potential thesis topics. **Credit 1**

4055-897 MS NSSA Thesis
This is the capstone experience for the master of science in networking and system administration. Student must submit an accepted proposal in order to enroll. (Permission of instructor) **Credit 4**

4055-899 Graduate Independent Study in NSSA
Graduate students will work with a supervising faculty member on a project of mutual interest. Project design and evaluation will be determined through discussion with the supervising faculty member and documented through completion of an independent study form to be filed with the Department of NSSA. **Variable credit 1–6**

Kate Gleason College of Engineering

www.rit.edu/~630www

Programs

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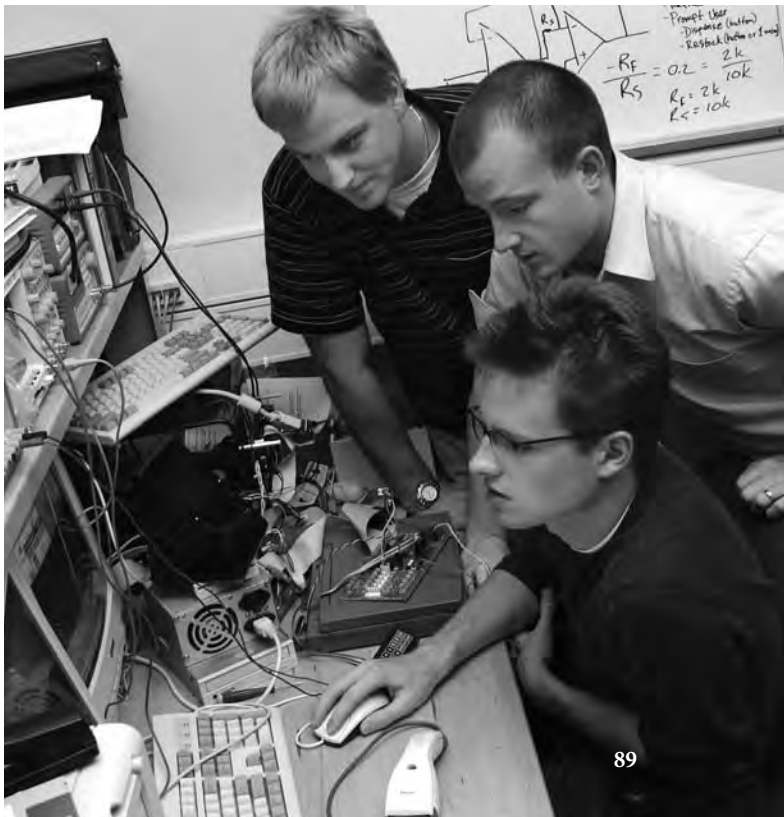
⇆ *Online learning option available*

Harvey J. Palmer,
Dean

The Kate Gleason College of Engineering offers comprehensive, innovative graduate programs in a range of engineering disciplines. Programs include traditional master of science degrees, master of engineering degrees and a broad-based, cross-disciplinary Ph.D. in microsystems engineering. The College of Engineering, in conjunction with the College of Science, also offers an interdisciplinary MS degree in materials science and engineering.

The master of science degree is research-based and leads to either employment in an industrial environment or graduate study at the doctoral level. The master of engineering degree is primarily a terminal master's program leading to industrial employment. An industrial internship, engineering case study or opportunity for substantial cross-disciplinary studies replaces the traditional thesis requirement. Day, late afternoon and evening classes are designed to meet the needs of both working professionals and full-time students.

Details on specific programs, including courses, research activities, thesis requirements and assistantships, are outlined in this Graduate Bulletin. For additional information about the interdisciplinary master of science degree in materials science and engineering, offered jointly with the College of Science, please visit the department website at www.rit.edu/~670www/CMSE/.



Study options

Full-time study

The variety of graduate programs in engineering allows students to matriculate on either a full- or part-time basis. A full-time student will generally take between 12 and 18 credits per quarter, depending upon their research or graduate project activity. A full-time student in a master of engineering degree program may choose to alternate academic quarters with an internship. A full-time student normally can complete the degree requirements in one calendar year.

Part-time study

The College of Engineering encourages practicing engineers in the greater Rochester industrial community to pursue a program of study leading to the master of science or master of engineering degree without interrupting their employment. Consequently, many of the courses in the graduate programs in engineering are normally scheduled in the late afternoon or early evening.

Students employed full time in industry are limited to a maximum of two courses or 8 credits each quarter. A student who wishes to register for more than 8 credits while employed full time must obtain the approval of his or her adviser and the department head.

Admission requirements

Any student who wishes to become a candidate for the master's degree must first be formally admitted to the appropriate graduate program. Formal admission to a graduate program gives matriculated status to a student.

An applicant may be considered for admission as a graduate student if he or she has received a bachelor's degree in engineering, or a closely related field, from an approved undergraduate school. Graduate applicants who do not fully satisfy all admission criteria, such as appropriate baccalaureate degree, grades and other credentials, may be considered for admission with the condition that they take the appropriate bridge courses to make up their deficiencies. Such courses will not normally count toward the graduate credits required for the master's degree. All applicants who are admitted prior to the conclusion of their baccalaureate program are required to submit their final transcript by the end of the first quarter of graduate work.

To be considered for admission, it is necessary to file an Application for Admission to Graduate Study, accompanied by the appropriate transcripts of previous undergraduate and graduate study and two letters of recommendation.

Nonmatriculated status

An individual may take graduate courses as a nonmatriculated student if he or she has a bachelor's degree from an approved undergraduate school and the necessary background for the specific courses in which he or she wishes to enroll. The courses taken for credit usually can be applied toward the master's degree when the student is formally admitted to the graduate program at a later date. However, the number of credits that will be transferred to the degree program from courses taken at RIT as a nonmatriculated student is normally limited to a maximum of 12 credits.

Those who wish to enroll in a graduate course as a nonmatriculated student must obtain permission from the graduate program coordinator in the department and the course instructor.

In general, applicants are required to submit scores from the Graduate Record Examination for admission into the master's degree programs. Please contact each individual department for more information. The exam also is required for admission into the Ph.D. program in microsystems engineering.

Plan of study

The programs are flexible and afford students an opportunity to plan a course of study suited to their interests and educational objectives. Each graduate student should submit a plan of study to the department office within the first year after admission as a graduate student. To assure a coherent program, and one which reflects the student's maturing capacities and aims, the plan may be revised on request.

Transfer credits

A maximum of 9 quarter credits in a 45 credit hour program or 12 quarter credits in a 48 credit hour program may be transferred from graduate courses taken outside the university. To be considered for transfer credit, the courses must have been taken within a five-year period prior to the date of the student's initial entry into a graduate program in engineering at RIT. Courses taken at another institution after the student's initial entry into a graduate engineering program at RIT are eligible for transfer credit as well. However, to ensure transferability, prior approval should be obtained. The student should contact the individual department office about the procedure for obtaining transfer credits.

Faculty adviser

A member of the faculty is appointed as a faculty adviser for each graduate student. The faculty adviser supervises the progress of the student toward the master's degree. For master of engineering programs that include an internship, a second adviser (for the internship) will be assigned once an internship proposal is submitted. This adviser will monitor and evaluate the student's internship experience (in cooperation with the student's industrial supervisor) and recommend to the department head the number of academic credits to be awarded for the experience.

Grade requirements

The average of grades for all courses taken at the university and credited toward the master's degree must be at least a "B" (3.0). Transfer credits from other institutions and internship credits are not included in the computation of the cumulative grade point average. The policy on probation and suspension is

explained in the Registration and Degree Requirements section of this bulletin. The student must pay careful attention to that policy. If a student fails any required examination, the student's adviser may recommend to the dean that the student's performance be reviewed and appropriate action taken.

Thesis
For the MS student, the thesis requirements vary among the different departments. The requirements of an individual department are stated in the sections describing each department's programs.

Three copies of the thesis must be submitted to the departmental office before the certification date of the quarter in question. These copies are for transmittal to the university library, the departmental office and the student's thesis adviser. For detailed instructions about the organization of the thesis, the student should consult the brochure "Thesis Format," available at the departmental office.

Internship
For master of engineering programs in which an industrial internship is an integral part of the program, a minimum of 4 and a maximum of 16 credits may be earned through the student's internship experience in a full-time engineering position. The internship is selected to reflect each student's primary professional interest and is integrated into his or her curriculum.

Maximum limit on time
The required credits for the master's degree must be completed within seven years after the student's initial registration in graduate courses at the university as a regular or nonmatriculated student.

Courses of instruction
Information about the courses that will be offered in a particular quarter will be available from the department office prior to registration. The university reserves the right to withdraw any course for which enrollment is insufficient or to make any changes in the schedule of courses, if necessary.

Financial aid
A limited number of teaching assistantships, research assistantships and tuition scholarships are available for graduate students. Detailed information is available from the appropriate department head.

For information
For specific questions on the individual department programs, please contact the department chair. For questions on course schedules and registration, please contact the following appropriate department:
Applied Statistics (585) 475-2033
Computer Engineering (585) 475-5873
Electrical Engineering (585) 475-2164
Industrial and Systems Engineering (585) 475-2598
Mechanical Engineering (585) 475-5788
Microelectronic Engineering (585) 475-6065
Microsystems Engineering (585) 475-2145
Product Development and Manufacturing Leadership (585) 475-7102

Computer Engineering Department

Andreas Savakis, Department Head
(585) 475-2987, andreas.savakis@rit.edu

The college offers a master of science degree in computer engineering intended to build upon a bachelor of science degree in computer engineering or a related discipline. The objectives of the MS degree are to provide graduates with a higher level of specialized knowledge in the area of computer engineering, strengthen their ability to successfully formulate solutions to current technical problems in computer engineering and offer a significant independent learning experience in preparation for further graduate study or for continuing professional development at the leading edge of the computer engineering discipline. The MS program is expected to accommodate recipients of BS degrees in other majors, such as electrical engineering or computer science, after some additional bridge courses.

Curriculum
The degree requires 45 quarter credits and includes a core curriculum of four courses. The requirements also include three courses within an area of concentration, two graduate electives, subject to a faculty adviser's approval, and 9 quarter credits of thesis research. Core courses and graduate electives are meant to provide breadth of knowledge. The concentration allows students to pursue an area of specialization in the field of computer engineering by completing a cohesive set of three courses beyond the core degree requirements. This provides students with enough depth to conduct meaningful thesis research. The graduate committee must approve a student's chosen thesis research topic. The committee consists of at least three faculty members, the majority of whom are computer engineering faculty. The committee chairperson normally serves as the student's faculty adviser.

Master of Science in Computer Engineering

www.ce.rit.edu/academics/msce.htm

The curriculum for the MS degree in computer engineering includes 45 quarter credit hours and includes the following requirements. These courses build on the knowledge a student has previously gained through a BS degree in computer engineering.

Four core courses (16 quarter credits)
Two graduate electives (8 quarter credits)

Three courses in a concentration chosen by the student (12 quarter credits)
Nine credits in master's thesis research

Core courses

0306-730	VLSI Design
0306-740	Analytical Topics for Computer Engineers
0306-756	Multiple Processor Systems
0306-720	Electronic Design Automation

Thesis research

One critically important aspect of graduate study is the student's preparation to lead challenging, state-of-the-art technical projects. To do this effectively, it is essential that the student obtain experience in reviewing related work of others in the field, as well as conduct meaningful independent research under a faculty mentorship. The graduate thesis is the degree component that addresses these issues.

Thesis work begins by selecting a faculty adviser, identifying a topic, forming a committee and submitting a proposal. The thesis topic, formulated by working closely with a faculty adviser, is related to recent technical developments in the field of computer engineering. Upon completion of the research outlined in the thesis proposal, the work is reported in a document submitted to the faculty committee and a thesis defense presentation. A technical paper resulting from the thesis research is submitted to a refereed conference or journal for publication.

Areas of concentration

The following areas of concentration are available in computer engineering:

VLSI and Digital Systems Design

0306-720	Electronic Design Automation
0306-730	VLSI Design
0306-731	VLSI Design Projects
0306-741	Design for Testability
0306-758	Fault Tolerant Digital Systems
0306-759	Principles of Digital Interfacing

Computer Architecture

0306-722	Advanced Computer Architecture
0306-724	High Performance Architectures
0306-756	Multiple Processor Systems
0306-772	Special Topics in Computer Architecture

Digital Image Processing and Computer Vision

0306-784	Digital Image Processing Algorithms
0306-785	Computer Vision
0306-772	Special Topics: Computational Intelligence

Computer Networking

0306-710	Network Modeling, Design and Simulation
0306-715	Wireless Networks
0306-795	Networking Security
0306-772	Special Topics: Wireless Communications

Embedded Systems and Control

0306-763	Embedded and Real-time Systems
0306-775	Robotics
0306-764	Modeling of Real-Time Systems
0306-772	Special Topics: Real-Time Operating Systems
0306-776	Robust Control

Admission requirements

Admission into the MS program in computer engineering requires a BS degree in computer engineering or a related discipline. For students lacking sufficient background in computer engineering, bridge courses may be required in addition to the regular degree requirements. The evaluation process is based primarily on the student's academic background, undergraduate academic performance and letters of reference. The Graduate Record Exam is required for all applicants, and international students are required to submit scores from the Test of English as a Foreign Language.

Transfer credits

Transfer of graduate course credit from other RIT departments or other appropriate institutions of higher learning is based on the graduate committee recommendation and may not exceed 9 quarter credits. A grade of "B" or better is required for all transfer courses. The total of 600-level courses applicable to the program may not exceed 4 quarter credits, and no graduate credit will be considered for courses below the 600 level.

Graduation requirements

RIT requires graduate students to maintain a grade point average of 3.0 or higher during all quarters of study, a grade of "B" or better for all transfer courses and the completion of all degree requirements within seven years.

Electrical Engineering Department

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www.ee.rit.edu

Focus areas

Within electrical engineering, a student can specialize in one of six areas for the MS degree: control systems, communications, digital systems, integrated electronics, signal and image processing, and microelectromechanical systems (MEMS). The boundaries between some of the areas are not as sharp as they have been in the past. Students are urged to discuss the significance of their choices with graduate advisers in the department.

Master of Science in Electrical Engineering

www.ee.rit.edu/academics/ms.htm

Admission requirements

Admission into graduate studies leading to the MS degree in electrical engineering requires a bachelor of science degree in electrical engineering from an accredited program.

An applicant with a strong undergraduate record and a bachelor of science degree in another branch of engineering

(mechanical, chemical, industrial, etc.) may be considered for admission. In this case, the student must complete a certain number of undergraduate courses in order to bridge over to electrical engineering. Additional information is available from the department.

Plan of study

At the beginning of the program, every matriculated student must prepare a plan of study in consultation with his or her adviser.

Policies

The following general rules apply:

- All students seeking the master of science in electrical engineering degree must satisfactorily complete the core course Matrix Methods in Electrical Engineering (0301-703). Students are expected to take the course immediately after entering the program, since it is a prerequisite for many of the other graduate courses.
- Those students who have selected focus areas in control systems, communications or signal and image processing must also take Random Signals and Noise (0301-702). Students who want to develop concentrations in the above areas also are encouraged to take Random Signals and Noise.
- Each student must take at least four courses from the electrical engineering department in the chosen focus area.
- All course selections must be approved by one of the graduate advisers. All courses must be at 700-level or above with one exception: a student is allowed to take a maximum of two 600-level courses for full credit in the graduate program.
- All students must satisfy a research component through one of the following activities:

1. Graduate thesis (nine credit hours)
   The inclusion of a thesis (0301-890) as a formal part of the MS degree program in electrical engineering is optional but strongly encouraged. Thesis work is done under the supervision of a faculty adviser and presented and defended before a thesis committee when complete.
2. Graduate research paper (five credit hours)
   A student may choose to write a "graduate paper" in lieu of a thesis. The graduate paper is an extensive term paper on a topic of professional interest. The objective of the graduate paper is to enable the student to undertake an independent and in-depth literature search and write a report summarizing the findings. A faculty member interested in the paper's topic will serve as the student's supervisor and direct the scope and depth of the paper as well as the format of the final written version. The student must first consult a faculty member about a suitable topic for the paper and obtain consent. The course 0301-800, Graduate Paper, is used to register for the paper. The student should plan to take at least five credit hours in 0301-800. The student choosing this option also is required to take a minimum of 10 courses for 40 credits.

- All graduate work must be completed within a seven-year period starting from the first course applied toward the MSEE degree. Also, a student who is pursuing thesis/project options may be required to register for continuation of thesis/project credits if he or she is not enrolled for any credits in a given quarter. For complete details, please consult the continuation of thesis/project/dissertation policies.

Transfer credits

A maximum of 8 quarter credit hours may be earned from courses available from other departments within RIT with the prior approval of the faculty/department adviser. Students may transfer a maximum of 8 quarter credit hours, or two classes, from another university. The total number of transfer credits from all sources outside the electrical engineering department cannot exceed 8 quarter credit hours. Under certain extraordinary circumstances, a resident full-time student may appeal to the electrical engineering department and the Graduate Council for additional transfer credits.

Those electrical engineering students who have an interest in computer science as a concentration area are encouraged to pay special attention to certain policies. The bridge courses—0602-701, 0602-702, 0602-703, 0602-704 and 0602-705—will be treated as advanced undergraduate courses. Therefore, the total number of credit hours generated from these cannot exceed eight. Also, electrical engineers with an interest in computer science are encouraged to complete certain sequences of appropriate courses (within the limits of allowable transfer credits) rather than take one or two courses at random. Please consult the department for more details.

Graduate student advising

All new students will be assigned a graduate adviser. The student generates a plan of study in consultation with his or her faculty adviser. That faculty member will continue to be the student's adviser until a research topic has been chosen. From that time, the thesis/paper adviser assumes the role of academic adviser as well.

Graduation requirements

The master of science degree in electrical engineering is awarded upon the successful completion of an approved graduate program consisting of a minimum of 45 quarter credit hours. Under certain circumstances, a student chooses or is required to complete more than the minimum number of credits. RIT graduate school requirements will apply, such as grade of "B" or better for all transfer courses, as well as the maintenance of a grade point average of 3.0 or better.

Scheduled Course Offerings 2007-08

Focus Area	Fall 2007-1	Winter 2007-2	Spring 2007-3
Core Courses	0301-702 Random Signal and Noise 0301-703 Matrix Methods in Electrical Engineering	0301-702 Random Signal and Noise 0301-703 Matrix Methods in Electrical Engineering	
Communication	0301-729 Antenna Theory and Design	0301-717 Microwave Circuit Design 0301-794 Information Theory	0301-768 Adaptive Signal Processing
Control Systems	0301-769 Fuzzy Logic and Applications	0301-761 Modern Control Theory 0301-815 Multivariable Modeling and Control	0301-733 Robust Control 0301-764 Digital Control Systems 0301-765 Optimal Control
Signal and Image Processing	0301-887 Digital Signal Processing	0301-770 Pattern Recognition 0301-779 Digital Image Processing	0301-749 Speech and Image Compression 0301-768 Adaptive Signal Processing 0301-803 Digital Video Processing
Integrated Electronics	0301-711 Advanced Carrier Injector Transistors 0301-821 High-Performance Semiconductor Devices	0301-712 Advanced Field Effect Devices 0301-726 Mixed Signal IC Design	0301-713 Solid State Physics 0301-730 Advanced Analog IC Design 0301-820 Modeling and Simulation of Semiconductor Devices
Digital Systems		0301-732 Advanced Topics in Digital System Design 0301-742 Advanced Topics in Embedded System Software Design	0301-741 Design for Testability 0301-810 Advanced Computer Architecture
MEMS	0301-789 Fundamentals of MEMS		0301-798 Microfluidic MEMS 0301-804 MEMS Evaluation

Courses other than those listed in this bulletin are developed and offered periodically by the department of electrical engineering. Information will be available from the department office the month before the beginning of each academic quarter. Course offerings are subject to minimum enrollment requirements.

Schedule of all electrical engineering graduate courses, 700- and 800-level courses

Fall Quarter

0301-702	Random Signals and Noise
0301-703	Matrix Methods in Electrical Engineering
0301-711	Advanced Carrier Injector Transistors
0301-729	Antenna Theory and Design
0301-769	Fuzzy Logic and Applications
0301-789	Fundamentals of MEMS
0301-799	Nano and Microengineering
0301-821	High-Performance Semiconductor Devices
0301-887	Digital Signal Processing

Winter Quarter

0301-702	Random Signal and Noise
0301-703	Matrix Methods in Electrical Engineering
0301-712	Advanced Field Effect Devices
0301-717	Microwave Circuit Design
0301-726	Mixed Signal IC Design
0301-732	Advanced Topics in Digital Systems Design
0301-742	Advanced Topics in Embedded Systems SW Design
0301-761	Modern Control Theory
0301-770	Pattern Recognition
0301-779	Digital Image Processing
0301-794	Information Theory
0301-815	Multivariable Modeling and Control

Spring Quarter

0301-713	Solid State Physics
0301-730	Advanced Analog IC Design
0301-733	Robust Control
0301-741	Design for Testability
0301-749	Speech and Image Compression
0301-765	Optimal Control
0301-768	Adaptive Signal Processing
0301-798	Microfluidic MEMS
0301-803	Digital Video Processing
0301-804	MEMS Evaluation
0301-810	Advanced Computer Architecture
0301-820	Modeling and Simulation of Semiconductor Devices

Summer Quarter

A select number of 600- and 700-level courses and will be available during the summer quarter. Consult the department for details.

600-level courses

These courses are senior-level undergraduate professional electives. A maximum of two courses from the following list may be taken by a graduate student and counted toward the MS degree.

0301-601	Modern Optics for Engineers
0301-610	Analog Electronic Design
0301-612	Semiconductor Devices III
0301-615	State Space Control
0301-621	Microwave Engineering
0301-630	Biomedical Instrumentation
0301-631	Biomedical Sensors and Transducers I
0301-632	Fundamentals of Electrophysiology
0301-633	Biomedical Signal Processing
0301-636	Biorobotics/Cybernetics
0301-646	Power Electronics
0301-647	Artificial Intelligence Systems
0301-650	Design of Digital Systems
0301-651	Physical Implementation
0301-655	Microcomputer Software I
0301-662	Neural Networks
0301-664	Embedded Microcontroller Systems
0301-677	Digital Filters and Signal Processing
0301-679	Analog Filter Design
0301-685	Principle of Robotics
0301-686	Microelectromechanical Devices
0301-688	MEMS System Evaluation
0301-692	Communication Networks
0301-693	Digital Data Communications

Courses other than those listed in this bulletin are developed and offered periodically by the department of electrical engineering. Information will be available from the department

office the month before the beginning of each academic quarter. Course offerings are subject to minimum enrollment requirements.

Industrial Engineering Department

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The industrial engineering department offers four degree options to meet the diverse interests of students seeking to continue their engineering education. These options include:

- master of science in industrial engineering
- master of engineering in industrial engineering
- master of engineering in systems engineering
- master of engineering in engineering management

There also are dual degree programs, which combine the undergraduate degree in industrial and systems engineering with each master's degree program listed above. In addition, the department offers a combined BS degree in industrial engineering with an MS in applied statistics from the College of Engineering's John D. Hromi Center for Quality and Applied Statistics. Additionally, there is an accelerated BS/MBS program offered jointly with the E. Philip Saunders College of Business. These programs have different credit hour/degree requirements and are described in detail on the department website, www.rit.edu/ise. The student, in conjunction with an adviser, formulates a program of study based on the individual's academic background, professional goals and degree requirements.

Department of Industrial and Systems Engineering: Typical Scheduled Course Offerings

Fall	0303-620	Engineering Economy
	0303-701	Linear Programming
	0303-703	Logistics Management
	0303-726	Contemporary Production Systems
	0303-727	Advanced Manufacturing Engineering
	0303-760	Product/Process Development and Design
	0303-765	Databases for IS
	0303-790	Fundamentals of Sustainable Design
Winter	0303-702	Integer and Nonlinear Programming
	0303-710	Systems Simulation
	0303-729	Advanced Systems Integration
	0303-731	Advanced Topics in Ergonomics and Human Factors
	0303-734	System Safety Engineering
	0303-758	Design of Experiments
	0303-784	Project Management
	0303-791	Lifecycle Assessment and Costing
Spring	0303-704	Logistics Management
	0303-711	Advanced Simulation Techniques
	0303-720	Production Control
	0303-732	Biomechanics
	0303-750	Management of Quality Systems
	0303-766	Manufacturing Systems
	0303-792	Design for the Environment
	0303-801	Design for Manufacture

Master of Science in Industrial Engineering

www.rit.edu/~633www/grad/index.htm

The master of science degree in industrial engineering allows students to customize their course work while working closely with industrial engineering faculty in a contemporary, applied research area. Faculty members are currently conducting applied project and research work in the areas of contemporary manufacturing processes/systems, ergonomic/biomechanical analysis, optimization, sustainable design and development, systems engineering/product development, systems integration/information systems and systems simulation modeling. The MS degree in industrial engineering will be awarded upon the successful completion of a minimum of 45 quarter credit hours, the equivalent of nine courses and a 9-credit-hour thesis.

Master of Engineering Degrees

www.rit.edu/~633www/grad/me.html

The master of engineering degrees in industrial engineering, systems engineering and engineering management allow graduate students to align their course work with their professional goals. These programs provide applied, practical degrees that allow students to gain breadth across several different areas or focus on one area. Close cooperation with other engineering departments and the E. Philip Saunders College of Business assures the student a wide selection of courses, as well as a unique opportunity to build a program that supports his or her professional interests. The master of engineering degrees will be awarded upon successful completion of a minimum of 48 quarter credit hours that is equivalent to 12 courses and an engineering capstone experience.

Master of Engineering in Industrial Engineering

The master of engineering in industrial engineering focuses on the design, improvement and installation of integrated systems of people, material, information, equipment and energy. The program emphasizes specialized knowledge and skills in the mathematical, physical, computer and social sciences together with the principles and methods of engineering analysis and design. The overarching goal of industrial engineering is the optimization of the system, regardless of whether the activity engaged in is a manufacturing or a service-related capacity. The student graduates with a variety of skills in the areas of applied statistics/quality, ergonomics/human factors, operations research/simulation, manufacturing and systems engineering.

Master of Engineering in Systems Engineering

This program concentrates on the industrial engineering courses that cover the science and technologies of decision making in a complex world in order to optimize the overall system rather than any one subsystem. Systems engineering is concerned with

improving the decision-making process by utilizing statistics, simulation, optimization and computer science skills to enhance the design, control, operation and understanding of systems. This discipline has shown rapid growth in both its development and recognition as a distinct field of engineering.

Master of Engineering in Engineering Management

This program blends courses from the industrial and systems engineering program and the E. Philip Saunders College of Business to focus on the management of the engineering and technological enterprise. It combines technological expertise with managerial skills. Engineering management is concerned with understanding the technology involved in an engineering project and the management process through which the technology is applied. The object is to provide a background in areas commonly needed in this role, such as organizational behavior, finance and accounting, in addition to industrial engineering expertise.

Facilities

The industrial and systems engineering department is located in the James E. Gleason building, within the College of Engineering. The department houses several state-of-the-art laboratories in support of the college's graduate programs, including the Brinkman Machine Tools and Manufacturing Lab, the Human Performance Lab, the Advanced Systems Integration Lab, the Product and Process Development Lab and a general computer lab. All of these labs are fully accessible to all ISE students.

There are ample computing facilities within these specialized labs, as well as a dedicated PC computer lab. These labs offer an extensive library of software to support industrial engineering research and project work, including conventional word processing, spreadsheet and presentation applications (e.g., Microsoft Office), database management (e.g., Microsoft ACCESS, FoxPro), data acquisition (e.g., Lab View), statistical analysis (e.g., Minitab, SAS), facilities layout (e.g., AutoCAD, Factory Flow, Factory Plan), manufacturing (e.g., MasterCam, material selection software), optimization and systems simulation software (e.g., CPLEX, Solver, ProModel, Arena) and lifecycle assessment and costing tools.

Admission requirements

Admission into the graduate programs within industrial engineering requires a BS degree in an engineering discipline and a 3.0 grade point average. Exceptions are made for the related fields of math and physics. Students with other backgrounds are considered for admission only after completing significant undergraduate course work in the engineering sciences. All applicants should have a fundamental knowledge of computers and probability/statistics.

Mechanical Engineering Department

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The graduate program faculty of the mechanical engineering department is dynamic and committed to professional growth. Current thermal science research activity includes microscale transport phenomena and microchannel heat transfer, water management in PEM fuel cells, micro air vehicles, particulate flow in biological systems and computational fluid dynamics. Materials science and engineering interests include fracture mechanisms in materials, characterization of materials by scanning probe microscopy and high-resolution X-ray diffractometry and reflectometry novel materials for thermal protection, and composites. Energy systems research includes second law analysis of thermal systems, environmental impacts of energy intensive systems, micro-power energy harvesters and alternative power generation technologies. The department houses several laboratories, which support vibration and modal analysis, robotics, industrial fluids applications, thermal analysis and microfluidics, biomedical systems analysis and materials science.

Extensive computing facilities include a large network of workstations, personal computers and laboratories equipped with Windows-based personal computers. Students have access to a vast array of software packages, including most programming languages and utilities, various word processing software, analytical and statistical data analysis, graph generation and spreadsheet packages. Software specifically used for mechanical engineering applications includes ALGOR, ANSYS and Mechanica (finite element analysis); Working Model (mechanical modeling and analysis); FLUENT, FLOW3D, PMARC and TODOR (fluid/thermal analysis); MATLAB/Simulink and LabVIEW (data acquisition and control system analysis); OptdesX (optimization); DFMA by Boothroyd/Dewhurst (designing for manufacturing assembly); and ProEngineer and IDEAS (CAD/CAE software).

Master of Science in Mechanical Engineering

www.rit.edu/~mecheng0/grad/msme.htm

The master of science degree in mechanical engineering is awarded upon successful completion of an approved graduate program consisting of a minimum of 45 quarter credit hours. A minimum of 36 credits are to be earned in course work and 9 credits of thesis. A maximum of 9 quarter credits may be transferred from graduate courses taken outside the university, provided such courses complement a student's proposed graduate program in the mechanical engineering department. Upon matriculation into the MS program, the student should formulate a plan of study in consultation with his or her adviser.

Admission requirements

A bachelor of science degree in engineering or science is required. If an applicant has a BS degree in an area other than mechanical engineering, the graduate admissions adviser will recommend which undergraduate courses must be taken in order to acquire an acceptable background. At least a 3.0 grade point average in the recommended undergraduate courses is required before admission is granted to the mechanical engineering graduate program.

Program requirements

The four elements of study within the MS in mechanical engineering program include core courses, courses required within an elected focus area, selected elective courses and a thesis. A minimum of 45 credits are required for the MS degree. At least 28 credit hours of graduate-level course work, including the core and focus area courses, must be taken in the mechanical engineering department. All full-time MS students are required to attend the weekly graduate seminar each quarter they are on campus. A minimum of 45 credits is required for the MS degree. Eight credits may be upper-level undergraduate electives (a course number beginning with 0304-6xx) or as technical courses outside of the department, with prior approval. Typical out-of-department courses include advanced engineering, mathematics and science courses. The credits for this program are distributed as follows:

Core Courses	**8 credits**
Focus Area Courses	12 credits
Elective Courses	16 credits
Graduate Thesis	9 credits
Graduate Seminar	0 credits

Core courses

All graduate students in the MS program are required to complete:

0304-870	Mathematics for Engineers I
0304-871	Mathematics for Engineers II (or an alternative course approved by the adviser and department head)

Focus area courses

All graduate students in the MS program must develop a graduate focus area of study, with prior approval from their adviser and the department head. The focus area should consist of at least 12 credits of graduate study in mechanical engineering, (0304-7xx or higher) and be related to the student's technical and professional development interests. Examples of focus areas include controls, materials science, thermo/fluids and mechanics/design.

Elective courses

All graduate students in the MS in mechanical engineering program must complete a minimum of 16 credits of elective courses.

Graduate mechanical engineering focus area and elective courses

0304-701	Research Methods
0304-710	Fuel Cell Technology
0304-730	Design Project Management
0304-743	Intermediate Control Systems
0304-745	Micro and Nano Characterization of Materials
0304-746	Engineering Properties of Materials
0304-752	Fundamentals of Tribology
0304-754	Fundamentals of Fatigue and Fracture Mechanics
0304-756	Aerosols in the Respiratory Tract
0304-758	Intermediate Engineering Vibrations
0304-810	Introduction to Continuum Mechanics
0304-811	Theory of Elasticity and Plasticity
0304-816	Finite Elements
0304-820	Advanced Optimal Design
0304-821	Advanced Vibrations
0304-823	Systems Modeling
0304-828	Special Topics in Applied Mechanics
0304-830	Introduction to Computational Fluid Dynamic Analysis
0304-831	Computational Fluid Dynamics Applications
0304-833	Heat Exchanger Design
0304-834	Boiling and Condensation
0304-835	Grid Generation
0304-838	Ideal Flows
0304-840	Signal Processing
0304-842	System Identification
0304-843	Advanced Control Systems
0304-847	Microscale Transport Phenomena
0304-848	Special Topics in Thermo Fluid Systems
0304-851	Convective Phenomena
0304-852	Advanced Turbomachinery
0304-864	Production Tool Design
0304-865	Computer Implementation of Finite Elements
0304-872	Analytical Mechanics
0304-875	Advanced Aerodynamics
0304-885	Advanced Mechanics of Solids
1028-705	Experimental Techniques
1028-710	Materials Properties and Selection
0307-712	Fundamentals of Statistics II
0307-770	Design of Experiments for Engineers

Graduate students are allowed to take a maximum of two upper-level undergraduate electives (course numbers beginning with 0304-6xx) in mechanical engineering. However, if students choose to take upper-level undergraduate electives in mechanical engineering, they may be limited regarding the number of out-of-department electives. Some examples are:

0304-610	Topics in Mechanical Engineering Design
0304-615	Robotics
0304-618	Computer-Aided Design
0304-620	Introduction to Optimal Design
0304-624	Vehicle Dynamics
0304-635	Heat Transfer II
0304-638	Design of Machine Systems
0304-640	Internal Combustion Engines
0304-642	Air Pollution Dispersion Modeling
0304-643	Control Systems
0304-644	Introduction to Composite Materials
0304-652	Fluid Mechanics of Turbomachinery
0304-658	Engineering Vibrations
0304-660	Refrigeration and Air Conditioning
0304-671	Aerostructures
0304-672	Dynamics of Machinery
0304-678	Propulsion
0304-680	Advanced Thermodynamics
0304-682	Flight Dynamics

A student also may earn a limited number of credits by doing an independent study with guidance from a member of the graduate faculty. Some of the areas for independent study are selected topics in applied mathematics, analytical mechanics, nonlinear mechanics, fracture mechanics, heat transfer, fluid mechanics, thermodynamics, control systems, optimal control,

thermal stresses, composite materials and biomechanics.

Course calendar
Graduate courses are generally offered every other year, with the most common graduate courses offered every year. For further information on current-quarter course offerings, students should review the open and closed courses at http://infocenter.rit.edu. For information on long-term course planning and proposed course offerings, students should review the Schedule of Courses at http://infocenter.rit.edu.

Thesis
Prior to completing 20 quarter credit hours of graduate work, the student should prepare a formal thesis proposal and discuss it with the faculty adviser. An acceptable proposal (including a statement of work, extensive literature search and proposed timeline), signed by the student and approved by his or her faculty adviser and department head, is required prior to registering for thesis credits. Students must form a graduate thesis committee in coordination with their adviser and present their proposal to their committee for review and approval during the first quarter in which they have registered for thesis credit. Requirements for the degree must be completed within seven years of the date of the oldest course counted towards the MS program. Students are required to deliver a successful written and oral presentation of their thesis.

Master of Engineering in Mechanical Engineering

www.rit.edu/~633www/grad/me.html#meie

This is a post-baccalaureate internship program leading to the professional degree of master of engineering. The objective of the program is to provide the engineering BS graduate the means for earning a terminal master's degree. The capstone experience for the master of engineering degree may be a course design project, a well-organized and carefully chosen industrial internship or an independent study project in place of the conventional thesis requirement of an MS degree. This master's degree is particularly well-suited to students who wish to study part time, those interested in updating their technical skills and those not focused on a research-oriented master of science thesis.

Core courses (12 credits)
All graduate students in the mechanical engineering program are required to complete:

0304-870	Mathematics for Engineers I
0304-823	Systems Modeling
0304-865	Computer Implementation of FEM

The program, although rooted in engineering, is significantly interdisciplinary, by design. The program may range over several colleges in the university, assembling courses that will best help students meet their professional objectives. The credits for this program are distributed as follows:

Core Courses (12 credits)
Concentration Courses	16 credits
Elective Courses	20 credits

At least 32 credit hours of graduate-level course work, including core courses, must be taken in the mechanical engineering department. Some possible concentration areas are business, print media, controls, manufacturing, materials science, thermo/fluids and design engineering. A minimum of 48 credits are required for the master of engineering degree. Students may complete the program as a course-only program of study, with a capstone design project in a graduate elective course. Students may choose to complete a three-month industrial internship or a project that includes a paper (both worth 4 elective credits) as one of their elective courses.

Admission requirements
The admission requirements, general standards and selection procedures for admission to the engineering program are similar to those for the MS degree program.

Master of Engineering in Manufacturing Engineering

www.rit.edu/~633www/grad/me.html#meie

The department of mechanical engineering and the department of industrial and systems engineering jointly offer this program. In the master of engineering in manufacturing engineering program, the student is required to take one course from each of four different groups: computer-aided design, manufacturing systems, computer-aided manufacturing and probability and statistics. In addition, the student is required to take the core course Design for Manufacture (0303-801). The balance of the course work can be completed by selecting appropriate courses from the course offerings in industrial and mechanical engineering.

A student seeking admission to the master of engineering in manufacturing engineering program is expected to have an undergraduate background in programming, engineering materials, manufacturing processes and probability and statistics.

Admission requirements
The admission requirements, general standards and selection procedures for admission to the manufacturing engineering program are similar to those for the MS degree program.

Assistantships and scholarships
Some assistantships and scholarships may be available for full-time students. Some faculty members have funded projects and may be able to provide research assistantships. Appointment as a teaching assistant carries a 20 hours a week commitment to a teaching function, and usually permits a student to take

graduate work for 8 credits per quarter. The remaining time is devoted to research efforts. Information on tuition scholarships may be obtained by contacting the Office of Part-time and Graduate Enrollment Services at (585) 475-2229.

Advanced Certificate in Vibrations Engineering

Engineers interested in continuing their professional development may wish to pursue graduate study without making a commitment to a masters' degree program. The advanced certificate is a means by which practicing engineers can enhance their career opportunities and professional knowledge. Advanced certificates require a minimum of 16 credits of study at the graduate level.

The advanced certificate in vibrations engineering provides students with specialized skills that are sought after in a variety of industrial settings. Engineers with skills in vibration engineering contribute to manufacturing production systems, aerospace systems, automotive engineering, medical product development, building mechanical and plumbing systems, consumer product development, and a host of industrial equipment and process systems. This program takes students beyond the normal preparation in vibrations engineering that students typically complete during their undergraduate program of study. Students learn to use sophisticated software tools, analytical techniques and experimental methods to design, develop and implement solutions for problems of vibration control and minimization in engineering systems. Students are exposed to modern technologies used in industry to insure that they are prepared for their specialized job market.

The advanced certificate in vibrations engineering requires each student to successfully complete three required courses and one graduate elective. The program answers a need for graduate level instruction for practicing engineers in the greater Rochester area, in a field of importance for the 21st century. Students seeking to earn a Master's degree can apply the courses within this program towards a Master's degree.

Three required courses:

0304-658	Engineering Vibrations
0304-758	Intermediate Engineering Vibrations
0304-840	Signal Processing

Plus, at least one elective course from the following list*:

0304-870	Mathematics for Engineers I
0304-871	Mathematics for Engineers II
0304-643	Control Systems
0304-743	Intermediate Control Systems
0304-843	Advanced Control Systems

**An alternative elective may be approved by the student's adviser and department head.*

Microelectronic Engineering Department

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The worldwide semiconductor industry is expected to grow from $226 billion to $308 billion over the next five years. The technology is advancing at an astounding pace that requires a specially educated workforce. The College of Engineering is proud to offer two master's programs in microelectronic engineering. The master of engineering in microelectronics manufacturing engineering is a full-time intensive classroom and laboratory-oriented program culminating with an internship. The master of science in microelectronic engineering is a research-oriented program that includes a master's thesis. Both programs are intended to prepare students for careers in the semiconductor industry.

Integrated circuit technology makes use of many diverse fields of science and engineering. Optical lithography tools, which print microscopic patterns on wafers, represent one of the most advanced applications of the principles of Fourier optics. Plasma etching involves some of the most complex applications of chemistry used in manufacturing today. Ion implantation draws upon understanding from research in high-energy physics and ion solid interactions. Thin films on semiconductor surfaces exhibit complex mechanical and electrical behavior that stretches our understanding of basic materials properties. Computing skills are necessary to design, model, simulate and predict processes and device behavior, extremely vital to manufacturing. Statistics is required to manipulate data and process control. Manufacturing concepts are extremely important in maintaining high yields and cost effectiveness.

One of the great challenges in integrated circuit manufacturing is the need to draw on scientific principles and engineering developments from such an extraordinarily wide range of disciplines not adequately provided by traditional engineering or science programs. Scientists and engineers who work in this field need broad understanding and the ability to seek out, integrate and use ideas from many fields. These programs are tailored to meet the demands of the semiconductor industry for a suitably educated workforce.

Students in these programs have hands-on experience in the design and processing of integrated circuits the vital component in almost every advanced electronic product manufactured today. RIT's laboratories are designed for the microelectronic engineering programs. They are among the best in the nation. The microelectronics engineering programs offer an unparalleled opportunity for students to prepare for professional challenges and successes in one of the leading areas of engineering.

Master of Science in Microelectronic Engineering

The objective of the master of science program in microelectronic engineering is to provide an opportunity for students to perform graduate-level research as they prepare for entry into the semiconductor industry or a doctorate program. The program requires strong preparation in the area of microelectronics, takes two years to complete and requires a thesis.

Program outcomes
The MS program in microelectronic engineering has a number of outcomes for its students:

1. Understand the fundamental scientific principles governing solid-state devices and their incorporation into modern integrated circuits
2. Understand the relevance of a process or device, either proposed or existing, to current manufacturing practices
3. Develop in-depth knowledge in existing or emerging areasof the field of microelectronics, such as device engineering, circuit design, lithography, materials and processes, and yield and manufacturing
4. Apply microelectronic processing techniques to the creation/investigation of new process/device structures
5. Communicate technical material effectively through oral presentations, written reports and publications

The prerequisites include a bachelor of science degree in engineering (such as electrical or microelectronic engineering), including an introductory course in device physics and an introductory course in fabrication technology. Students from RIT's BS program in microelectronic engineering will meet these prerequisites. Students who do not have these prerequisites can take these courses during their first quarter of study and still complete the MS program in two years. The prerequisite courses will not count toward the 36 credits of graduate courses required for the MS degree.

The program consists of eight graduate courses (700-level or higher), including seven core courses and one elective course for students with a BS degree in a discipline other than microelectronic engineering. Five core courses and three elective courses are required for students with a BS in microelectronic engineering. In addition, all students in this program are required to take a variable-credit (1 or 0 credit) seminar/research course each quarter they are at RIT. Up to 4 credits will be allowed toward the required 36 credit hours. A 9-credit thesis, which includes an oral defense, is required of all students in this program. The total number of credits needed for the MS in microelectronic engineering is 45.

Core courses:

0305-702	Microelectronics II, Lab
0305-703	Microelectronics III, Lab
0305-704	Semiconductor Process and Device Modeling
0305-705	Quantum and Solid State Physics for Nanostructures
0301-712	Physics and Scaling of CMOS
0305-721	Microlithography Materials, Lab
0305-731, 732*	Microelectronics Manufacturing I, II, Lab

** cannot be taken for graduate degree credit by students with a BS in microelectronic engineering.*

Elective courses:
The following elective courses are offered by the department of microelectronic engineering for graduate credits:

0305-706	SiGe and SOI Devices and Technology
0305-707	Nanoscale CMOS and Beyond
0305-714	Micro- and Nano-Characterization
0305-722	Microlithography Systems, Lab
0305-732	Microelectronics Manufacturing II, Lab
0305-830	Metrology for Yield and Failure Analysis
0305-870	Microelectromechanical Systems
0305-890	Special Topics

Based on the student's particular needs, he or she may, with departmental approval, choose electives from other programs at the university.

Fall		Qtr. Cr. Hrs.
0305-701	Transition Microelectronics I, Lab	4
0305-560	Transition Semiconductor Devices II	4
0305-721	Microlithography Materials and Processes, Lab	4
0305-801	Seminar/Research	1
Winter		
0305-702	Microelectronics II, Lab	4
0305-731	Microelectronics Manufacturing I, Lab	4
0305-801	Seminar/Research	1
	Full Time Equivalency*	3
Spring		
0305-703	Microelectronics III, Lab	4
0305-7XX	Elective	4
0305-801	Seminar/Research	1
	Full Time Equivalency	3
Summer		
	Research	
Fall		
0305-705	Quantum and Solid State Physics for Nanostructures	4
0305-801	Seminar/Research	1
0305-889	Thesis	3
	Full-time Equivalency*	
Winter		
0305-704	Semiconductor Process and Device Modeling	4
0301-712	Physics and Scaling of CMOS	4
0305-801	Seminar/Research	1
0305-899	Thesis	3
Spring		
0305-801	Seminar/Research	1
0305-899	Thesis	3
	Full-time Equivalency*	8

BS in microelectronic engineering sample schedule:

Fall

0301-705	Quantum and Solid State Physics for Nanostructures	4
0305-801	Seminar/Research	1
0305-xxx	Elective 1	4
	Full-time Equivalency*	3

Winter

0301-712	Physics and Scaling of CMOS	4
0305-704	Semiconductor Process and Device Modeling	4
0305-801	Seminar/Research	1
	Full-time Equivalency*	3

Spring

0305-732	Microelectronic Manufacturing II	4
0305-801	Seminar/Research	1
0305-xxx	Elective 1	4
	Full-time Equivalency*	3

Summer

	Research	

Fall

0305-xxx	Elective 2	4
0305-801	Seminar/Research	1
0305-899	Thesis	3
	Full-time Equivalency*	4

Winter

0305-xxx	Elective 3	4
0305-801	Seminar/Research	1
0305-899	Thesis	3
	Full-time Equivalency	4

Spring

0305-xxx	Elective 4	4
0305-801	Seminar/Research	1
0305-899	Thesis	3
	Full-time Equivalency*	4

**A full-time equivalency form must be completed for each quarter of the academic year for which the form is requested. The form can be accessed at the department website: http://www.microe.rit.edu/pdf/grad%20Student%FTE%20Equiv.pdf*

Thesis

A thesis is required for completion of the MS degree in microelectronic engineering. Normally, the thesis is undertaken once the student has completed all course requirements. Planning for the thesis, however, should begin as early as possible. Generally, full-time students should complete their degree requirements, including thesis defense, within two years (six academic quarters and one summer quarter) from the date of entry. A detailed description of the thesis process and previous MS thesis topics are provided on the department website at: http://www.microe.rit.edu/thesisguidelines.pjp?page=1

Admission requirements

Applicants must hold a baccalaureate degree in electrical engineering, chemical engineering, materials science and engineering, physics or the equivalent from an accredited college or university. An undergraduate grade point average of 3.0 or better on a 4.0 scale or strong academic/supervisor endorsements are required. Graduate Record Exam scores are not mandatory but may strengthen the student's candidacy.

Plan of study

In consultation with their adviser, students formulate a plan of study based on the their academic background, program objectives, degree requirements and course offerings. The plan of study is submitted to the department office within the first year. If necessary, a revision of the plan of study may be recommended by the adviser. Plan of study forms are available on the department website at: http://www.microe.rit.edu/pdf/Graduate%20Plan%20of%20Study.doc

Assistantships and fellowships

A limited number of assistantships and fellowships may be available for full-time students. Appointment as a teaching assistant carries a 12-hour-per-week commitment to a teaching function and permits a student to take graduate work at the rate of 12 credits per quarter. The remaining time is devoted to a research effort, which often serves as a thesis subject. Students in the MS program are eligible for research fellowships. Appointments provide full or partial tuition and a stipend. Applicants for financial aid should write directly to the department head for details.

Master of Engineering in Microelectronics Manufacturing Engineering

www.microe.rit.edu/me.php

The department of microelectronic engineering offers the master of engineering degree in microelectronics manufacturing engineering. The program provides a broad-based education to students with a bachelor's degree in traditional engineering or science disciplines who are interested in a career in the semiconductor industry.

The ME degree is awarded upon successful completion of an approved graduate program consisting of a minimum of 45 credit hours. The program consists of one transition course, seven core courses, two elective courses and a minimum of 5 credits of internship. Under certain circumstances, a student may be required to complete more than the minimum number of credits. The transition course is in an area other than that in which the BS degree was earned. For example, chemistry majors may be required to take a two-course sequence in circuits and electronics.

Program outcomes

The MS program in microelectronics manufacturing engineering has a number of outcomes for its students:

1. Design and understand a sequence of processing steps to fabricate a solid state device to meet a set of geometric, electrical and/or processing parameters
2. Analyze experimental electrical data from a solid state device to extract performance parameters for comparison to modeling parameters used in the device design

3. Understand current lithographic materials, processes and systems to meet imaging and/or device patterning requirements
4. Understand the relevance of a process or device, either proposed or existing, to current manufacturing practices
5. Perform in a microelectronic engineering environment, as evidenced by a three-month internship
6. Appreciate the areas of specialty in the field of microelectronics, such as device engineering, circuit design, lithography, materials and processes, and yield and manufacturing

The core courses are Microelectronics Processing I, II and III; Microelectronics Manufacturing I, II and III; and Microlithography Materials and Processes and Microlithography Systems. Two elective graduate-level courses in a microelectronic-related field are required. Elective courses may be selected from a list that includes courses such as metrology and failure analysis, semiconductor process and device modeling, and nanoscale CMOS. The program requires an internship, which is at least three months of full-time, successful employment in the semiconductor industry or at RIT in the SMFL Lab. It will involve an investigation or a study of a problem or process directly related to microelectronics manufacturing engineering. Though no thesis is required, a written report and oral presentation are made at the end of the project.

Microelectronics

The Microelectronics I, II and III sequence covers major aspects of integrated circuit manufacturing technology such as oxidation, diffusion, ion implantation, chemical vapor deposition, metalization, plasma etching, etc. These courses emphasize modeling and simulation techniques as well as hands-on laboratory verification of these processes. Students use special software tools for these processes. In the laboratory, students design and fabricate silicon MOS and bipolar integrated circuits, learn how to utilize most of the semiconductor processing equipment, develop and create a process and manufacture and test their own integrated circuits.

Microlithography

The microlithography courses are advanced courses in the chemistry, physics and processing involved in microlithography. Optical lithography will be studied through diffraction, Fourier and image-assessment techniques. Scalar diffraction models will be utilized to simulate aerial image formation and influences of imaging parameters. Positive and negative resist systems, as well as processes for IC application, will be studied. Advanced topics will include chemically amplified resists; multiple-layer resist systems; phase-shift masks; and electron beam, X-ray and deep UV lithography.

Laboratory exercises include projection-system design, resist-materials characterization, process optimization, electron-beam lithography and excimer laser lithography.

Manufacturing

The manufacturing courses include topics such as scheduling, work-in-progress tracking, costing, inventory control, capital budgeting, productivity measures and personnel management. Concepts of quality and statistical process control are introduced, and the laboratory for this course is the student-run factory functioning within the department. Important issues such as measurement of yield, defect density, wafer mapping, control charts and other manufacturing measurement tools, are examined in lectures and through laboratory work. Computer-integrated manufacturing also is studied in detail. Process modeling, simulation, direct control, computer networking, database systems, linking application programs, facility monitoring, expert systems applications for diagnosis and training, and robotics are supported by laboratory experiences in the integrated circuit factory. An online (distance delivery) version of this program exists for engineers employed in the semiconductor industry. Please refer to RIT's Online Guide for details.

Internship

The program requires a 5 credit internship, which is equivalent to at least three months of full-time successful employment in the semiconductor industry. The purpose of the internship is to provide a structured and supervised work experience that enables students to gain job-related skills that will assist them in achieving their desired career goals.

Students with prior engineering-related job experience may request "credit by experience." This request must be made with the department head and supported by a letter from the appropriate authority substantiating the student's job responsibility, duration and performance quality. Upon approval, the student is advised to deposit the incurred fee to the bursar after the transfer of credit is granted.

For students who are not working in the semiconductor industry while enrolled in this program, the internship can be completed at RIT. It will involve an investigation or study of a subject or process directly related to microelectronic engineering under the supervision of a faculty adviser. An internship may be taken any time after the completion of the first quarter, must total at least 5 credits and may be designed in a number of ways. For example, one 5-credit internship (typically a three-month, full-time work experience), five 1-credit experiences or any combination of separate credits interspersed throughout the graduate program may be used, as long as the total is the equivalent of three months of work. In these cases, full graduate tuition is charged. At the conclusion of the internship, submission of a final internship report to the faculty adviser is required.

Fall	Qtr. Cr. Hrs.
0305-701 Microelectronics I, Lab	4
0305-721 Microlithography Materials and Processes, Lab	4
Transition	4

Winter

0305-702 Microelectronics II, Lab	4
0305-731 Microelectronics Manufacturing I, Lab	4
Transition	4
0305-xxx Elective 1	4

Spring

0305-703 Microelectronics III, Lab	4
0305-722 Microlithography Systems, Lab	4
0305-732 Microelectronics Manufacturing II, Lab	4
0305-xxx Elective 2	4

Summer

Internship	5

The John D. Hromi Center for Quality and Applied Statistics

Donald D. Baker, Director
(585) 475-5070, ddbcqa@rit.edu
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www.rit.edu/~636www/

Statistics is the science of making decisions in the face of uncertainty. Statistical thinking and methods are used over a broad spectrum of industrial, research, educational, business and government activities. The College of Engineering, through the John D. Hromi Center for Quality and Applied Statistics, offers a master of science degree in applied statistics that provides state-of-the-art statistical thinking and methods. The college also offers two advanced certificates, in statistical quality and statistical methods for product and process improvement.

Many of our students are full-time professionals who want to learn cutting edge statistical techniques to enhance their careers and their value to companies. Others want to change careers and become statistical consultants. Those who do not fit the full-time professional category typically use the degree or advanced certificate to gain employment either as statisticians or quality engineers.

Faculty

The center's distinguished faculty members include fellows of the American Society for Quality and the American Statistical Association, and winners of the American Society for Quality's Shewhart Medal, as well as the Grant, Brumbaugh and Shewell awards. Both full-time and adjunct faculty members teach in the program. All instructors have real-world experience in the subjects they teach, evident in their approach to the subject matter. As part of their contracts with RIT, many of the full-time faculty work outside the MS program, through consulting and both public and contract-basis seminars. The faculty also are engaged in professional activities, present talks at professional society meetings and publish research or application papers.

Full- or part-time study

Full-time students will normally take three courses per quarter and can complete the MS degree in slightly over one year. (Exceptionally strong students may be able to complete the program in four quarters.) Students pursuing the MS on a part-time basis (one or two courses per quarter) typically complete the degree in two to four years. Part-time students pursuing an advanced certificate typically complete the requirements in four to six quarters of study.

BS/MS programs

The center has agreements with the department of mathematics and statistics and the department of industrial and systems engineering that allow students to earn both BS and MS degrees in less time and with fewer courses than would be needed if both programs were pursued separately. The undergraduate departments handle entry into these programs.

Cooperative education

Cooperative education allows qualified graduate students to attend school on a full-time basis during certain quarters and to earn a substantial salary during other quarters, typically as employees in a corporation. To qualify for cooperative education, students must complete at least one quarter of appropriate course work and receive departmental approval. Reverse cooperative education is also available, in which full-time employees get approval to study on a full-time basis, typically by alternating one or two quarters of work and study.

Online learning

Since 1979, when the university offered its first online learning course, RIT has been a leader in the use of electronic forms of communication for course interaction. Our online courses have the same objectives, workload and academic credit as our on-campus courses. Both the MS degree and the advanced certificates are available through online learning. No distinction is made between taking courses on campus or through online learning. In particular, programs earned partly or entirely through online learning are registered by the New York State Department of Education and are accredited by the Middle States Association of the Council for Higher Education. Each online course typically features either CDs or streaming video, professionally prepared for online learners. Courses also include live chat sessions or asynchronous discussion groups, using an electronic medium that allows students and the instructor to interact.

Because online courses are designed for the motivated professional who is not able to attend on-campus classes, we recommend enrollment to those over 25 years of age with at least three years of professional employment.

Admission requirements

Admission to the MS degree program in quality and applied statistics will be granted to qualified students who hold a baccalaureate degree from an accredited college or university and who have the following credentials: an acceptable GPA and mathematics credits, including acceptable grades in university-

level calculus and acceptable probability and statistics college credits equivalent to Fundamentals of Statistics I (0307-711), Fundamentals of Statistics II (0307-712) and Principles of Applied Statistics (0307-714). Admission to the certificate program in statistical quality requires a baccalaureate degree with the 0307-711 and 0307-712 probability and statistics requirements, but not calculus. Admission to the certificate program in statistical methods for product and process improvement also requires a course in calculus.

Entrance exams are not required. However, international students whose native language is not English must have a TOEFL score of at least 550 (paper-based) or 213 (computer-based). Courses are offered on an open-enrollment basis. Full-time students must begin their studies in the fall quarter. Part-time students may begin their studies based on our schedule of courses.

Transfer and interdisciplinary credits

Credit for courses of graduate stature from other universities in statistics, mathematics, operations research and other quantitative fields related to statistics may be accepted toward fulfillment of degree requirements at the discretion of the department with due regard to the candidate's objectives. A maximum of 9 graduate credits can be accepted toward the MS degree, while 3 credits may be accepted toward the certificate. A course used toward fulfillment of another degree can be credited only if it corresponds to one of the core courses described below. Transfer credits for the certificate must be from a course covering the same subject matter as the course being credited.

To ensure credit toward the degree, the candidate should write the department indicating courses for which he or she would like transfer credit. Prior approval of such courses is required.

Advising

In consultation with a departmental adviser, each student works out a total program structured to achieve individual professional objectives. Matriculated students will be assigned an adviser whom they should contact on a regular basis to review their progress toward meeting program requirements. Nonmatriculated students seeking advisement should contact the department.

Nonmatriculated students

It is not necessary to be formally admitted or matriculated into the MS program to register for course offerings. However, students who desire to enter the MS program will be allowed to apply only four courses taken prior to matriculation into the program. This is done to encourage proper selection of courses and adequate administrative time for transcript review. Students who desire to enter an advanced certificate program will be allowed to apply only two courses taken prior to matriculation into the program.

Financial assistance

The department awards financial assistance on a competitive basis to qualified applicants. Assistance in the MS program is offered in several forms, including scholarships and graduate assistantships. Awards are generally given to full-time students, with some exceptions for qualified part-time students. For information on other sources of financial assistance, applicants should review the appropriate section of this bulletin.

Master of Science in Applied Statistics

www.rit.edu/~636www/academics/msappliedstatistics.htm

The MS program in applied statistics, which requires 45 quarter credit hours (equivalent to 15 courses), is available to both part-time and full-time students. Those working toward their baccalaureate degree in certain RIT departments are eligible to apply for a joint BS/MS program. Cooperative education options are available also. The MS degree is available in an online learning format, which is especially appealing to students who are unable to attend classes on campus.

The MS program is primarily intended for students who do not wish to pursue a degree beyond the MS. However, a number of our former students are either working on, or have attained, a Ph.D. at other universities.

Requirements

The MS degree in applied statistics includes seven core curses, plus four courses from a career option.

Seven core courses

0307-742	Statistical Computing
0307-717	Design and Analysis of Experiments I
0307-818	Design and Analysis of Experiments II
0307-821	Theory of Statistics I
0307-822	Theory of Statistics II
0307-841	Regression Analysis I
0307-842	Regression Analysis II

Students, in conjunction with their advisers' recommendations, should take the core courses early in the program. In any event, they must be taken within the first 30 credit hours of the degree.

Four courses from a career option

There are three standard career options, each of which is designed to allow students to specialize within their career endeavors. A personalized career option is also available. The three standard career options are:

Quality Engineering

0307-721	Statistical Process Control
0307-731	Statistical Acceptance Control
0307-781	Quality Management
0307-782	Quality Engineering

Industrial Statistics

0307-803	Design and Analysis of Experiments III
0307-856	Interpretation of Data
0307-862	Reliability Statistics I
0307-883	Quality Engineering by Design

Statistical Theory and Methods

0307-824	Probability Models
0307-830	Multivariate-Analysis Theory
0307-831	Multivariate-Analysis Applications
0307-862	Reliability Statistics I

Advisers can help identify an appropriate career option and develop a total program structured to meet individual professional objectives.

Three additional courses are chosen by students with the help of their adviser. These courses are usually department courses but may include (along with the transfer credits explained previously) up to 9 credits from other courses related to the program that are consistent with students' professional objectives.

Students, with adviser approval, may choose to write a research thesis or research project instead of taking the full three electives. Theses are usually for 6 credits, and projects are usually for 3 credits.

A capstone course is designed to ensure that students can integrate the knowledge from their courses to solve more complex problems.

Full-time students must register for and attend Statistics Seminar (0307-895) in the fall, winter and spring quarters. This is a 0-credit course that is graded on a pass-fail basis.

Other requirements

The MS candidate must attain an overall program grade point average of 3.0 (B), with no more than two grades of C, for graduation. A minimum of 24 credits in 800-level courses is required in the degree program. Course work must be completed within seven years. Contact the department for more details on these requirements.

Students are strongly encouraged to further develop their writing, speaking, presentation and computer skills as they progress through the program.

Admission procedures

To be considered for admission, prospective students must complete a graduate application, submit transcripts of all previous undergraduate and graduate work, obtain two letters of recommendation and pay an application fee. RIT graduates do not have to pay this fee. Forms and instructions, including quarterly offerings and registration forms, may be obtained online or by writing to:

Office of Graduate Enrollment Services
Rochester Institute of Technology
Bausch and Lomb Center
58 Lomb Memorial Drive
Rochester, NY 14623-5604

Advanced certificate programs

Two advanced certificate programs in statistical quality and statistical methods for product and process improvement also are available. Each requires 18 quarter credit hours (equivalent to six courses) and both are available to part-time students. In both programs, the courses are a subset of the MS program courses and are offered on campus and in the online learning format. The advanced certificate in statistical quality is aimed primarily at quality managers, quality engineers or those who aspire to such positions. The advanced certificate in statistical methods for product and process improvement is designed for engineers, scientists and other professionals who want a solid education in the statistical methods that are most closely related to their work, but who wish to finish a program in a shorter time period than the MS program.

Advanced Certificate in Statistical Quality

Requirements

Students should have basic familiarity with MINITAB statistical software. This may be obtained by self-study; completion of Data Analysis Using MINITAB, a three-day, noncredit course in data analysis and statistical computing; through similar MINITAB short courses; or through Statistical Computing (0307-742), which covers both SAS and MINITAB software.

Six courses are required:

0307-721	Statistical Process Control
0307-731	Statistical Acceptance Control
0307-772	Applied Survey Design and Analysis
0307-781	Quality Management
0307-782	Quality Engineering
0307-717	Design and Analysis of Experiments I
0307-818	Design and Analysis of Experiments II

Students who wish to earn a Six-Sigma black belt after obtaining their advanced certificate should ensure an appropriate course selection by looking at the black belt requirements on the center's website.

Students must attain an overall program grade point average of 3.0 (B) for graduation. Please contact the department for more details.

Advanced Certificate in Statistical Methods for Product and Process Improvement

Requirements

Students should have basic familiarity with MINITAB statistical software. This may be obtained by self-study; by completion of Data Analysis Using MINITAB, a three-day, noncredit course in data analysis and statistical computing; through similar MINITAB short courses; or through Statistical Computing (0307-742), which covers both SAS and MINITAB software.

Six courses are required. There are three core courses:

0307-717	Design and Analysis of Experiments I
0307-818	Design and Analysis of Experiments II
0307-841	Regression Analysis I

Students, with the help of their adviser, choose three courses from the following list of electives:

0307-803	Design and Analysis of Experiments III
0307-842	Regression Analysis II
0307-883	Quality Engineering by Design
0307-873	Time Series Analysis
0307-862	Reliability Statistics I
0307-831	Multivariate Analysis Applications
0307-856	Interpretation of Data

The reliability course also requires calculus with integration as a prerequisite.

Students must attain an overall average program grade point average of 3.0 (B) for graduation. Please contact the department for more details.

More information

Course schedules, including interim updates, and additional information are available from the center's website, www.rit.edu/eng/cqas.

Design Development and Manufacturing Department

Master of Science in Product Development

Mark W. Smith, Director
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www.mpd.rit.edu

Product innovation is essential to business survival and growth. The creation and introduction of new products and services has reached an unprecedented level of complexity, requiring the coordination of diverse teams of professionals from research and development, marketing, finance, manufacturing, procurement, sales and service. Companies, especially technology-based organizations, need leaders with an enterprise-wide perspective and knowledge base in both engineering and management. This includes individuals who possess a broad blend of technical and business skills, understand markets and the value-chain and have the integrated systems perspective needed to commercialize increasingly complex products and systems. The master of science degree in product development program provides the educational foundation that technical professionals need for high-impact roles in product and technology innovation.

The product development program is for engineers, scientists and technical professionals who aspire to product development leadership positions throughout their organizations. Designed by academic and industry leaders at Massachusetts Institute of Technology and its Center for Innovation in Product Development, the curriculum integrates business and technical elements to develop leaders with the knowledge, skills, behaviors and perspective to effectively deploy best-in-class product development methods, tools and practices. The program integrates formal education, ongoing research and industrial practice, and continuously refreshes the curriculum through active partnerships with other world-class universities, research centers and companies.

Students acquire the foundation skills and strategic perspective necessary to become future leaders and senior managers responsible for driving business growth through product innovation. They develop receptiveness to change and continuous improvement, an understanding of the enablers to business success and an enhanced ability to recognize barriers to success early in the commercialization cycle, when corrective actions are least costly.

Format

The two-year program begins each December and continues for eight consecutive quarters, including summers, until graduation. Students take two courses per quarter on Fridays.

Business trips

Two business trips (including one international trip) are taken to augment course work and broaden exposure to product development around the world. The focus of these trips will vary, and students may participate in selecting the venues consistent with program objectives. When feasible, trips will be scheduled in conjunction with partner universities that offer the product development program. Please refer to the program's website for descriptions of prior business trips.

Curriculum

The MS in product development program is a 60-credit program consisting of 13 business and engineering courses (10 required courses and three electives) plus a capstone project. Students complete required courses in a defined sequence with the other members of their graduating class.

Core Courses

0303-780	Foundations in Product Development
0303-786	Engineering of Systems I
0303-788	Engineering of Systems II
0303-784	Systems and Project Management

Foundation courses

0102-740	Organizational Behavior and Leadership
0105-761	Marketing Concepts
0303-785	Engineering Risk-Benefit Analysis
0303-764	Operations and Manufacturing Systems
0303-787	Systems Optimization
0101-703	Accounting for Decision Makers

Elective courses

Elective courses afford the opportunity for students to tailor the program to better meet personal and organizational needs. Three elective courses (12 credits) are required. The program will offer each cohort of students a series of graduate-level electives from engineering and business during the normally scheduled class times on Fridays. Students may select from a list of other courses approved by the program, but at least one elective must be from business and one from engineering. Recommended electives may include such courses as Managing Research and Innovation, New Venture Creation, Systems

Dynamics, Sustainable Design and Advanced Topics in Product Development, among others.

Capstone project
Students must successfully complete a capstone project (8 credits) during the final nine months of the program, based on a real-world problem often identified in the companies where they work. The corporate-oriented capstone project encompasses the broad integrative aspects of new product development. It synthesizes, increases and demonstrates the student's understanding and knowledge of previous program material and underscores the behaviors essential to product development leadership. The capstone project provides immediate benefits to sponsoring organizations and is an excellent opportunity for students to gain visibility and recognition. See the program website for descriptions of previous projects.

Sponsorship

Most students are sponsored by an employer who is committed to improving leadership capabilities in product development. Sponsorship includes permitting students to attend classes and participate in business trips, and also involves a commitment to work with the student to provide clear expectations and well-articulated career development plans that build upon the program. Candidates are welcome to sponsor themselves. Contact the Office of Financial Aid and Scholarship for information.

Admission requirements

Candidates should have an undergraduate degree in engineering, or a related scientific or technical field, with a minimum GPA of 3.0, and at least five years' experience related to product development. Exceptions may be considered on a case-by-case basis. No graduate entrance exam is required, although candidates are welcome to support their application with results from the GMAT or GRE. All applicants must provide the following:

- A completed application form
- An official transcript for all undergraduate and graduate work completed
- At least one letter of recommendation from a current or recent supervisor
- A current résumé
- A personal interview with the admissions team (after other application materials are received)

All application materials are available from the Office of Graduate Enrollment Services.

Master of Science in Manufacturing Leadership

Mark W. Smith, Director
(585) 475-7102, mark.snith@rit.edu
Christine Fisher, Coordinator
585-475-7971, mml@rit.edu
www.mml.rit.edu

The master of science degree in manufacturing leadership is an 18-month program designed for experienced professionals moving to mid- and senior-level positions in manufacturing and service organizations. The program integrates business and engineering courses, delivering them in a part-time format where students continue to work while taking classes in the late afternoon and evening.

The MS in manufacturing leadership is a highly focused program developed jointly by the E. Philip Saunders College of Business and the College of Engineering. Particular emphasis is placed on supply chain management, global manufacturing and operations, lean thinking, leadership and decision making in a complex global economy. A capstone project, oriented to the solution of a management problem or to a business process, enables students to apply new skills and capabilities to the solution of a pressing real-world problem, with significant financial benefit to sponsors. An elective allows for additional depth or breadth in a subject of relevance to students and their sponsoring organizations.

Curriculum

The program consists of 48 credits of engineering and business courses and an integrative capstone project. The courses are:

0102-740	Organizational Behavior and Leadership
0303-703	Supply Chain Management
0303-784	Systems and Project Management
0303-766	Manufacturing Systems
0303-750	Management of Quality Systems
0101-794	Cost Accounting in Technical Organizations
0303-760	Product/Process Development and Design
0303-762	Systems Modeling and Decision Making
0303-723	Facilities Planning
0303-891	Capstone Integrative Project
	Electives (2)*

**Contact the program office for elective options.*

Format

The manufacturing leadership program was designed to be completed in two academic years (excluding summers). Each new class of students will be admitted in the fall quarter and will continue throughout the program as a cohort group. Classes are held in the late afternoon and evening to accommodate students' work schedules.

Prospective students also have the option to enroll at other times during the academic year or take a reduced course load. This flexibility offers other options for students who are interested in the program, but are constrained by time or financial restrictions. Candidates should follow the normal admission process. Contact the Office of Graduate Enrollment Services for more information.

Students also may take up to three courses on a nonmatriculated basis. Credits earned while enrolled as a nonmatriculated student may be applied to the degree program following formal admission.

Admission requirements

Applicants should have a baccalaureate or equivalent degree from an accredited institution and a minimum cumulative grade point average of 2.8. They also should have at least two years' experience in a manufacturing-related organization or business environment.

Exceptions may be considered on a case-by-case basis. No graduate entrance exam is required, although candidates are welcome to support their application with results from the GMAT or GRE.

Applicants must provide the following:

- A completed RIT graduate application
- Two professional recommendations
- A current résumé
- An interview with the program's admissions team (after other application materials are received)

All application materials are available from the Office of Graduate Enrollment Services, the manufacturing leadership office or the program website.

Prerequisite knowledge

Admitted students must possess knowledge and skills at the introductory course level in probability and statistics, engineering economy or basic accounting, basic properties of materials and manufacturing processes.

Areas that need strengthening can be addressed by guided reading, formal course work, independent study, seminars or other suitable means. For further information about the manufacturing leadership program, please contact the Office of Graduate Enrollment Services.

Microsystems Engineering Department

Doctor of Philosophy in Microsystems Engineering

Dr. Mustafa A. G. Abushagur, Director
(585) 475-2295, mustafa.abushagur@rit.edu
www.rit.edu/~630www/grad/phd.htm

The integration of entire systems into micron-scale devices and the sensing technology to interface these devices to the real world are and will be core disciplines required for next-generation technology. Within the past decade, microsystems (micro-optical, microelectrical, and micromechanical systems) have emerged as a critical technology worldwide. Simply stated, a microsystem is an ensemble of integrated components, the functionality of which derives from micron-size (or smaller) elements that collectively perform mechanical, electrical, optical, logical and even biological functions.

Microsystems technology will integrate small computer chips with tiny sensors, probes, lasers and actuators to allow the chips to sense, analyze and communicate. This enabling technology adds functionality and reduces costs in many product applications, particularly in the areas of telecommunications, imaging, electronics and biomedical diagnostics and treatment. In short, microscale devices and systems will be smaller, faster, cheaper and more reliable than their macroscopic counterparts.

RIT offers a unique educational and research program that leads to a Ph.D. in microsystems engineering. This multidisciplinary program builds on the strengths in microelectronic fabrications, photonic, imaging and micropower research programs at the university. The program is designed to be application-oriented without sacrificing the scientific and engineering fundamentals. Students will be involved in cutting-edge research and have access to a modern facility, the largest of its kind in any academic institution.

Mission

The need within the international scientific and engineering communities for students trained in microsystems has prompted RIT to combine resources and create the doctoral program in microsystems engineering, the first of its kind in the nation. The mission of the program is to meet the critical need for expanded knowledge and expertise in the design, fabrication and real-life application of micron-, submicron-, and nanometer-scale devices, components and systems.

The curriculum of this multidisciplinary program is structured to provide each student with a sound background and a thorough foundation in engineering and science for the analysis, design, fabrication and testing of microsystems. The curriculum provides world-class education through the innovative application of educational technologies and partnerships.

Program highlights

- A program designed for students with excellent preparation in the physical sciences and engineering
- Multidisciplinary faculty sharing resources and expertise
- Program administered by the doctorate program in microsystems engineering committee, which includes core faculty members from the colleges of Engineering and Science
- A unique clean-room and research laboratories designed for and dedicated to providing a world-class focus for microsystems engineering research
- Collaboration with industry and government laboratories

Degree Requirements

To be awarded the Ph.D. degree, students must satisfy the following minimum requirements:

1. Attain a minimum of 99 credit hours, including a minimum of 60 of graduate-level coursework and a minimum of 27 quarter credit hours of research
2. Pass the comprehensive examination (end of first year)
3. Pass the qualifying examination (before the end of third year and at least 12 months before the dissertation defense examination)
4. Pass the candidacy examination (at least six months before dissertation defense examination)
5. Publish two papers (at least one referred journal paper) based on his/her dissertation research
6. Pass the dissertation defense examination

Coursework

The coursework requirements for the Ph.D. are divided in four groups:

Group I: Foundation Courses (16 quarter credit hours)

1. Introduction to Material Science, 1028-701
2. Introduction to Theoretical Methods, 1028-704
3. Microelectronics Fabrications, 0305-701
4. Systems Engineering, 0303-886

Group II: Major Technical Interest Area (20 quarter credit hours)

1. A sequence of three courses (12 credit hours) in the major technical research area
2. A sequence of two courses (8 credit hours) in a support area

Group III: Two Minor Technical Interest Areas (16 quarter credit hours)

Two course sequence in each minor technical area. At least one sequence must be outside of the student's undergraduate degree major.

Group IV: Electives (12 quarter credit hours)

These courses can be prerequisite or remedial courses that are approved by the advisory committee of the student and satisfy the course requirements outlined below.

Research Seminar (0 quarter credit hours)

Ph.D. students are *strongly urged* to take this class during their first or second quarter in the graduate program.

Dissertation Research (27 quarter credit hours)

General course requirements

The total number of class hours actually taken for the Ph.D. degree depends upon the highest degree completed by the student before entering the program. Students entering the program without prior graduate work must complete a minimum of 60 hours of coursework as outlined. The course work consists primarily of 700- and 800-level graduate courses with no more than three 600-level courses.

All students are required to maintain a cumulative grade point average of at least 3.0 to remain in good standing with the program and RIT.

Students entering the Ph.D. program with a master's degree may be permitted to use as many as 32 hours of their master's course work toward the 60 hours of course work required for the Ph.D. degree. Master's thesis hours from other schools can only be used when they are recorded on the school's official transcript.

Examples of course sequence:

MEMS	(0308-786, 0308-811 and 0305-890)
Electronics	(0301-726, 0301-730 and 0301-814)
Photonics	(0308-721, 0308-831 and 0308-741)
Microfluidics	(0304-847 and 0301-798)

Preliminary examination

In order to complete this phase of the program and continue to specialize in a focus area, the student must pass the preliminary examination (only two attempts are allowed). The goal of the preliminary examination is to determine the student's ability and proper background to conduct independent research.

An examination committee presents three papers in different areas of concentration. The student chooses one paper and prepares a 30-minute oral presentation and a written review for the committee. During the preliminary examination, students are expected to identify the author's hypotheses and methodology, the key areas of investigation and why they are important to the field. The student should also state the status of the field prior to the author's work and present a critical appraisal of the work—its value and significance in advancing knowledge of the field. Finally, the student should propose valid research that would improve upon or extend the work described in the article.

Papers are given to students the first week in June. Examinations are scheduled the third week of June and results are posted by the first of July.

Ph.D. advisory committee

The student, along with his/her major adviser, should form an advisory committee comprised of four or more members, representing at least two concentration areas. Committee members should include faculty from two departments. A fifth external member from industry or a government research lab is highly encouraged.

Graduate Faculty

Harvey J. Palmer, BS, University of Rochester; Ph.D., University of Washington—Dean; Professor

Computer Engineering Department

Andreas Savakis, BS, MS, Old Dominion University; Ph.D., North Carolina State University—Professor and Department Head

Juan C. Cockburn, BS, Universidad Nacional de Ingernieria; MS, Ph.D., University of Minnesota—Associate Professor

Roy Czernikowski, BS, The Catholic University of America; ME, Ph.D., Rensselaer Polytechnic Institute—Professor

Kenneth Hsu, BS, National Taiwan Normal University; MS, Ph.D., Marquette University; P.E.—Professor

Fei Hu, BS, Shanghai Institute of Railway Technology; MS, Shanghai Tiedao University; Ph.D., Clarkson University—Assistant Professor

Dhireesha Kudithipudi, BS, Nagarjuna University; MS, Wright State University; Ph.D., University of Texas at San Antonio—Assistant Professor

Marcin Lukowiak, MS, Ph.D., Poznan University—Assistant Professor

Roy W. Melton, BS, MS, Ph.D., Georgia Institute of Technology—Visiting Assistant Professor

Pratapa V. Reddy, BE, M.Tech., Osmania University; Ph.D., Indian Institute of Technology—Professor

Muhammed E. Shaaban, BS, MS, University of Petroleum and Minerals; Ph.D., University of Southern California—Associate Professor

Shanchieh Jay Yang, BS, National Chio-Tung University; MS, Ph.D., University of Texas at Austin—Assistant Professor

Electrical Engineering Department

Vincent J. Amuso Sr., BS, Western New England College; MS, Syracuse University; Ph.D., Rensselaer Polytechnic Institute—Department Head; Associate Professor, Communications/Signal Processing

David Borkholder, BS, Rochester Institute of Technology; MS, Ph.D., Stanford University—Assistant Professor, Biosensors (electromagnetic and chemical), Biomedical Instrumentation MEMS Fabrication, Systems Engineering

Robert J. Bowman, BS, Pennsylvania State University; MS, San Jose State University; Ph.D., University of Utah—Professor, Analog Integrated Circuit Design, Semiconductor Physics, Biomedical Instrumentation

Edward Brown, BS, University of Pennsylvania; MS, Ph.D., Vanderbilt University—Assistant Professor, Rehabilitation, Robotics, Control Systems, Biomechatronics

Sohail A. Dianat, BS, Aria-Mehr University; MS, Ph.D., George Washington University—Professor, Control Systems, Communications, Signal/Image Processing

Christopher R. Hoople, BS, Union College; Ph.D., Cornell University—Visiting Assistant Professor, Power Electronics, Device Physics

Mark Hopkins, BS, Southern Illinois University; MS, Ph.D., Virginia Polytechnic Institute—Associate Professor, Control Systems

Syed Islam, BS, Bangladesh University of Engineering and Technology; MS, University of Saskatchewan; Ph.D., University of Connecticut—Assistant Professor, Semiconductor Device Modeling and Characterization

Sergey Lyshevski, MS, Ph.D., Kiev Polytechnic Institute—Professor, Microsystems

Athimoottil V. Mathew, BEE, Jadavpur University; M.Tech., Indian Institute of Technology; Ph.D., Queen's University—Professor, Control Systems, Robotic Vision

James Moon, BS, Carnegie Mellon University; MBA, University of Rochester; MS, Ph.D., University of California at Berkeley—Associate Professor, VLSI Design, Semiconductor Physics, Integrated Circuit Design, Electronic and Photographic Imaging Systems

P. R. Mukund, BS, MS, Ph.D., University of Tennessee—Gleason Professor, VLSI Design, Electronic Devices and Circuit Design

Dorin Patru, BS, MS, Technical University of Cluj-Napoca; Ph.D., Washington State University—Assistant Professor, Mixed-Signal and Digital Integrated Circuits and Systems

Eric Peskin, BS, Princeton; Ph.D., University of Utah—Assistant Professor, Digital Systems, Reconfigurable Computing

Daniel B. Phillips, BS, State University of New York at Buffalo; MS, Ph.D., University of Rochester—Associate Professor, Biomedical Instrumentation, Signal Processing and Visualization, and Embedded Systems

Sannasi Ramanan, BS, BE, M.Tech., Ph.D., Indian Institute of Technology—Associate Professor, Semiconductor Devices

Raghuveer Rao, BS, Mysore University; ME, Indian Institute of Science; Ph.D., University of Connecticut—Professor, Image and Signal Processing

Eli Saber, BS, State University of New York at Buffalo; MS, Ph.D., University of Rochester—Associate Professor, Signal Image and Video Processing, Communications, Biomedical Computer Vision

Ferat E. Sahin, BS, Istanbul Technical University; MS, Ph.D., Virginia Polytechnic Institute—Associate Professor, Artificial Intelligence, Control Systems, Robotics

Shailendhar Saraf, BS, Indian Institute of Technology; MS, University of Hawaii; Ph.D., Stanford University—Assistant Professor, Laser Optics, Electromagnetics

Jayanti Venkataraman, BS, MS, Bang. University; Ph.D., Indian Institute of Science—Professor, Electromagnetics

Industrial and Systems Engineering Department

Jacqueline Reynolds Mozrall, BS, Rochester Institute of Technology; MS, North Carolina State University; Ph.D., State University of New York at Buffalo—Department Head; Professor, Industrial Engineering, Human Factors, Ergonomics

Andres L. Carrano, BS, Universidad Catolica Andres Bello; MS, Ph.D., North Carolina State University—Associate Professor, Manufacturing, Sustainable Design and Development

Marcos Esterman, BS, MS, Massachusetts Institute of Technology; Ph.D., Stanford University—Assistant Professor, Systems Engineering, Product Development

Michael E. Kuhl, BS, Bradley University; MS, Ph.D., North Carolina State University—Associate Professor, Systems Simulation

Matthew M. Marshall, BS, Rochester Institute of Technology; Ph.D., University of Michigan—Associate Professor, Biomechanics, Ergonomics

Nabil Z. Nasr, BS, Helwan University; MS, Rutgers University; M.Eng., Pennsylvania State University; Ph.D., Rutgers University—Professor, Brinkman Professor of Screw Machine Technology, Robotics, NC Programming, Manufacturing, Remanufacturing

Sudhakar R. Paidy, BS, Osmania University; MS, Ph.D., Kansas State University—Professor, Systems Integration, Information Systems, Operations Research

N. Richard Reeve, BS, MS, Ph.D., State University of New York at Buffalo—Professor, Applied Operations Research

Moises Sudit, BS, Georgia Institute of Technology; MS, Stanford University; Ph.D., Purdue University—Visiting Associate Professor, Operations Research

James B. Taylor, BS, MS, Ph.D., Purdue University—Associate Professor, Manufacturing

Brian K. Thorn, BS, Rochester Institute of Technology; MS, Ph.D., Georgia Institute of Technology—Associate Professor, Applied Statistics, Sustainable Design and Development, Life Cycle Assessment and Costing

Mechanical Engineering Department

Edward C. Hensel, BS, Clarkson University; Ph.D., P.E., New Mexico State University—Department Head; Professor, Numerical Simulation of Diffusion-based Systems, Multidisciplinary Design

Lawrence Agbezuge, BS, Ghana Imperial College; MS, Columbia University—Visiting Associate Professor, Mechanics, Simulation

Margaret Bailey, BS, Pennsylvania State University; Ph.D., University of Colorado at Boulder—Kate Gleason Endowed Chair; Associate Professor, Energy Systems, Thermodynamics, Building Systems

Stephen Boedo, BA, State University of New York at Buffalo; MS, Ph.D., Cornell University—Associate Professor, Tribology and Lubrication

Agamemnon L. Crassidis, BS, MS, Ph.D., State University of New York at Buffalo—Associate Professor, Aerospace Engineering, Nonlinear Dynamics and Controls

Steven Day, BS, Ph.D., University of Virginia—Assistant Professor, Bioengineering, Implantable Devices, Fluids in Biosystems

Elizabeth A. DeBartolo, BS, Duke University; MS, Ph.D., Purdue University—Associate Professor, Fatigue and Fracture Mechanics, Materials Performance

Hany A. Ghoneim, BS, MS, Cairo University; Ph.D., Rutgers University—Professor, Finite Elements, Vibrations

Amitabha Ghosh, B.Tech., M.Tech., Indian Institute of Technology; Ph.D., Mississippi State University—Professor, Computational Fluid Dynamics, Aerodynamics, Aerospace Engineering

Surendra K. Gupta, B.Tech., Indian Institute of Technology; MS, University of Notre Dame; Ph.D., University of Rochester—Professor, Materials Science, Computer Software, Image Processing

Satish G. Kandlikar, BE, Marathwada University; M.Tech., Ph.D., Indian Institute of Technology—James E. Gleason Professor, Thermal Systems and Energy

Mark Kempski, BS, Purdue University; MS, Ph.D., State University of New York at Buffalo—Professor, Biomechanics, Bioengineering, Systems and Controls

Jeffrey D. Kozak, BS, Gannon University; MS, Ph.D., Virginia Polytechnic and State University of Virginia—Assistant Professor, Aerodynamics and Turbomachinery, Aerospace Engineering

Kathleen Lamkin-Kennard, BS, Worcester Polytechnic Institute; MS, Ph.D., Drexel University—Assistant Professor, Biomedical Engineering, Multi-physics Systems Modeling

Alan H. Nye, BS, MS, Clarkson College; Ph.D., University of Rochester—Associate Department Head; Professor, Automotive Engineering, Design of Systems

Ali Ogut, B.Ch.E., Hacettepe University; MS, Ph.D., University of Maryland—Professor, Fluid Mixing, Thermal Fluid Sciences, Energy and Environment

Risa J. Robinson, BS, MS, Rochester Institute of Technology; Ph.D., State University of New York at Buffalo—Associate Professor, Bioengineering, Aerosol Transport in Biological Systems

Frank Sciremammano Jr., BS, MS, Ph.D., University of Rochester—Professor, Geophysical Fluid Dynamics and Environmental Engineering

Robert Stevens, BS, Swarthmore College; MS, North Carolina State University; Ph.D., University of Virginia—Assistant Professor, Energy and Environment, MEMS, Thermal Properties, Energy Conversion, Thermoelectrics

Benjamin Varela, BS, Institute of Technology of Juarez; MS, Ph.D., New Mexico State University—Assistant Professor, Innovative Materials, Automation and Fluid Power, Dynamics

Panchapakesan Venkataraman, B.Tech., Indian Institute of Technology; MS, Ph.D., Rice University—Associate Professor, Optimal Control, Fluid Mechanics, Optimal Design, Aerospace Engineering

Wayne W. Walter, BS, State University of New York Maritime College; MS, Clarkson College; Ph.D., P.E., Rensselaer Polytechnic Institute—Professor, Applied Mechanics, Robotics, Vibrations

Microelectronic Engineering Department

Santosh Kurinec, BS, MS, Ph.D., University of Delhi—Department Head; Professor, Electronic Materials and Devices, IC Processing, Quantum and Nanoscale Devices

Dale E. Ewbank, BS, MS, Rochester Institute of Technology—Lecturer, Microlithography, Design of Experiments, Materials, Scanning Probe Microscopy

Lynn F. Fuller, BS, MS, Rochester Institute of Technology; Ph.D., State University of New York at Buffalo—Professor, IC Design, Semiconductor Manufacturing, MEMS and Microsystems

Karl D. Hirschman, BS, MS, Rochester Institute of Technology; Ph.D., University of Rochester—Micron Technology Professor, Director, Semiconductor and Microsystems Fabrication Laboratory; Associate Professor, Semiconductor Process Integration, Photonic Devices

Michael A. Jackson, BS, MS, Ph.D., State University of New York at Buffalo—Associate Professor, Surface Analysis, IC Metrology, Materials, CMP

Robert E. Pearson, BS, MS, Rochester Institute of Technology; Ph.D., State University of New York at Buffalo—Associate Professor, Advanced Device and Process Modeling, VLSI Design and Parameter Extraction

Sean L. Rommel, BS, Ph.D., University of Delaware—Assistant Professor, Emerging Semiconductor Devices, Photonic Devices, Integration

Bruce W. Smith, BS, MS, Ph.D., Rochester Institute of Technology—Intel Professor of Research and Technology, Professor, Advanced Microlithography, Nanolithography

The John D. Hromi Center for Quality and Applied Statistics

Donald D. Baker, BA, Trinity College; M.Ed., MBA, Ed.D., University of Rochester—Professor, Director; Quality Standards, Quality Management and Problem Solving, Lean Six Sigma

Peter Bajorski, MS, University of Wroclaw; Ph.D., Technical University of Wroclaw—Associate Professor, Regression Models, Multivariate Analysis, Nonparametrics, Imaging Science Applications

Steven M. LaLonde, BA, State University of New York at Potsdam; MBA, University of Rochester; MA, Ph.D., Syracuse University—Associate Professor, Multivariate Analysis, Survey Design and Analysis, Statistical Computing, Educational and Psychological Measurement

Daniel R. Lawrence, BA, BS, University of Akron; MA, Ball State University; MS, Rochester Institute of Technology; Ph.D., University of Toronto—Associate Professor, Multivariate Analysis (categorical data), Qualitative Measurement, Psychometrics, Survey Design and Analysis

Robert J. Parody, BS, Clarkson University; MS, Rochester Institute of Technology; Ph.D., University of South Carolina—Assistant Professor, Experimental Design, Response Surface Methods, Quality Control and Improvement

Joseph G. Voelkel, BS, Rensselaer Polytechnic Institute; MS, Northwestern University; Ph.D., University of Wisconsin-Madison—Associate Professor, Chair, Experimental Design, Process Modeling and Improvement, Multivariate Analysis, Reliability, Nonparametrics

Microsystems Engineering Department

Mustafa A. G. Abushagur, BS, Tripoli University; MS, Ph.D., California Institute of Technology—Director, Professor, Micro-optical Systems, Micro-and Nano-photonic Devices

Zhaolin Lu, BS, Chanogqing University; MS, Michigan Technological University; Ph.D., University of Delaware—Assistant Professor, Photonics, Electromagnetics, and Nanoelectronics

Stefan Preble, BS, Rochester Institute of Technology; Ph.D., Cornell University—Assistant Professor, Nanophotonics, Silicon photonics, and Optics

Steven Weinstein, BS, University of Rochester; MS, Ph.D., University of Pennsylvania—Professor, Interfacial Fluid Dynamics, Transport Phenomena, and Applied Mathematics

Note: Prerequisites are within parentheses at the end of the course description

Electrical Engineering

0301-702 Random Signals and Noise
In this course the student is introduced to random variables and stochastic processes. Topics covered are probability theory, conditional probability and Bayes theorem, discrete and continuous random variables, distribution and density functions, moments and characteristic functions, functions of one and several random variables, Gaussian random variables and the central limit theorem, estimation of a random variable, random processes, stationarity and ergodicity, auto correlation, cross-correlation and power spectrum density, response of linear prediction, Wiener filtering, elements of detection, matched filters. (Graduate standing) **Class 4, Credit 4**

0301-703 Matrix Methods in Electrical Engineering
This course deals with the elements of discrete transforms and linear algebra. Topics include: discrete-time signals and systems, the Z-transform and its application, solution of difference equations, concepts of stability, discrete Fourier analysis, DFT, FFT algorithms, topics in linear algebra and matrices, eigenvalues and eigenvectors, functions of matrices, matrix transformations and operations, matrix poly-nominals and the Cayley-Hamilton theorem, state variables, relation between transfer functions and state variable representation of LTI systems, state transition matrix, and solution of state equations. **Class 4, Credit 4**

0301-710 Advanced Electromagnetic Theory
The primary objective is to provide the mathematical and physical fundamentals necessary for a systematic analysis of electromagnetic field problems. Topics include potential representations, scalar and vector Green's functions, Green's theorem, reciprocity, duality, equivalence principle, image theorem, and radiation from apertures, scattering, integral equation solutions, perturbation and numerical methods. (Graduate standing) **Class 4, Credit 4**

0301-711 Advanced Carrier Injector Transistors
An advanced level course in electronic transport in semiconductors and the operation of bipolar devices (pn junction diodes, bipolar junction transistors and semiconductor-controlled rectifiers). Topics include electron drift, diffusion and carrier lattice interactions, energy band diagrams in non-uniformly doped semiconductors, continuity equations, impact ionization, tunneling, advanced static and dynamic analysis of diodes and bipolar transistors, design of bipolar devices. Topics also include Heterojunction physics and Heterojunction Bipolar Transistors (HBT), including SiGe HBT. **Class 4, Credit 4**

0301-712 Advanced Field Effect Devices
An advanced level course on MOSFETs and submicron MOS devices. Topics include MOS capacitors, gated diodes, long channel MOSFET, subthreshold conduction and offstate leakage, short channel effects, hot-carrier effects, ion-implanted channels, MOS scaling and advanced MOS technologies. **Class 4, Credit 4**

0301-713 Solid State Physics
An advanced level course on solid-state physics, with particular emphasis on semiconductor materials. Topics include: basic semiconductor properties, elements of quantum mechanics, general and time-independent formulation of wave mechanics, outcomes and predictions, energy band theory, statistical mechanics and equilibrium carrier statistics, excess carriers in semiconductors, carrier transport. **Class 4, Credit 4**

0301-717 Microwave Circuit Design
The primary objective is to study the fundamentals of microwave engineering with emphasis on microwave network analysis and circuit design. Topics include microwave transmission lines such as wave guides, coax, microstrip and stripline, microwave circuit theory such as S-matrix, ABCD matrices, and even odd mode analysis, analysis and design of passive circuits and components, matching networks, micro-wave resonators and filters. (0301-703) **Class 4, Credit 4**

0301-726 Mixed Signal IC Design
This course covers basic analog functional blocks and mixed signal blocks, in CMOS technology. Topics include: device models, current sources and active loads, precision reference, operational amplifiers, comparators, sample and hold circuits and data converters design. Course involves circuit design and layout projects. (Graduate standing) **Class 4, Credit 4**

0301-727 VLSI Design
A course in the design of very large scale integrated circuits at the level of Mead and Conway's VLSI Design. Topics include MOS devices and circuits, n-channel MOS process, data and control flow in systematic structures, implementing integrated system design, system timing and examples of LSI computer systems. **Class 4, Credit 4**

0301-729 Antenna Theory and Design
The primary objective is to study the fundamental principles of antenna theory applied to the analysis and design of antenna elements and arrays including synthesis techniques and matching techniques. Topics include antenna parameters, linear antennas, array theory, wire antennas, microstrip antennas, self and mutual impedances, equivalence principle, Huygen's principle, aperture antennas, traveling wave antennas, reflector antennas. **Class 4, Credit 4**

0301-730 Advanced Analog IC Design
An advanced course in analog integrated circuit design. Students will study bipolar and MOS realization of operational amplifiers, analog multipliers, A to D and D to A converters, switched capacitor filters and more. The students will participate in design projects including circuit design, layout and SPICE simulation. (0301-726) **Class 4, Credit 4**

0301-732 Advanced Topics in Digital System Design
The purpose of this course is to introduce students to advanced topics in digital systems design not covered in depth in undergraduate classes or topics that are new to the design community. Topics include: design of digital systems using Hardware Description Languages (VHDL/Verilog), design of digital systems using asynchronous circuits, design of digital systems using wave-pipelined circuits, clock distribution in large digital systems, design of digital systems with threshold gates, multi-valued logic and design of DSP specific blocks. For specific evaluation and grading policy, contact assigned instructor before registration. (0301-240, 347, 365, 545) **Class 4, Credit 4**

0301-733 Robust Control
One of the most useful qualities of a properly designed feedback control system is robustness, i.e., the ability of the closed-loop system to continue performing satisfactorily despite large variations in the open-loop plant dynamics. This course will provide an introduction to the analysis and design of robust feedback systems. Topics include overview of linear algebra and linear systems, H_2 and H_∞ control, spaces, modeling and paradigms for robust control; internal stability; nominal performance (asymptotic tracking); balanced model reduction; uncertainty and robustness; H_2 optimal control; H_2 control; H_2 loop shaping; controller reduction; and design for robust stability and performance. Software: MATLAB: Robust Control Toolbox, and mu-Toolbox. (0301-703) **Class 4, Credit 4**

0301-741 Design for Testability
This course deals with the design systems for testability and for maintainability. A survey of criteria for testability is given. A discussion of fault simulation and test pattern generation is included. Random test pattern generators and associated data compression schemes such as signature analysis are also described. Scanning techniques (both scan path and boundary scan) are discussed. The tradeoffs between built-in testing capacity and additional silicon structures are weighed. A small project, usually involving simulation, will be required. (0301-650) **Class 4, Credit 4**

0301-742 Advanced Topics in Embedded Systems
An introduction to the theory and application of top-down design, structure, abstraction, segmentation, high-level languages, and operating systems to real-time programs for microprocessors. Students will become proficient in a structured high-level language. Topics include structure diagrams, separate module compilation, data types, data structures, self-documenting code, procedures, meaningful variable names, linkage with other languages, object code libraries, operating system calls, multi-tasking concurrent and re-entrant programs, and symbolic debugging. (0301-655) **Class 4, Credit 4**

0301-749 Speech and Image Compression
Modern compression techniques used in efficient digital transmission and storage of speech and image waveforms are dealt with. Topics include digital communication channels, sampling and reconstruction of one-dimensional and two-dimensional signals, coding concepts, bit rate, coder complexity, rate distortion and information-theoretic bounds, characteristics of speech and image waveforms, quantization techniques, uniform nonuniform, logarithmic, optimum (Max), entropy coding, adaptive, pulse code modulation (PCM) of audio and video waveforms, DPCM, ADPCM, and delta modulation, linear prediction, transform coding, optimum (Karhunen-Loeve) transform and its gain, sub-optimum transforms, DFT, DCT, DST, DHT, and DWHT, special coding schemes, run-length coding, block truncation coding, sub-band coding, vector quantization, comparative performance of various schemes. Computer assignments and demonstrations. **Class 4, Credit 4**

0301-753 Optimization Techniques
This course provides a rigorous introduction to the principles and applications of optimization techniques. Optimization has applications in almost every branch of science and engineering. The course aims to present those aspects of optimization methods that are currently of foremost importance in solving real world engineering problems. The topics covered include linear optimization, Quadratic models, Descent methods and stability, Newton's technique, Conjugate direction methods, constrained optimization, Lagrange multipliers, Convexity, and Duality. Nonlinear programming and integer programming as well as principles of non-smooth optimization are included. (0301-703) **Class 4, Credit 4**

0301-761 Modern Control Theory
An advanced course in control theory, topics covered include review of state-space formulation of SISO systems, solution of state equations, STM and its properties, application of state-space concepts, state variable design, multivariate systems, preliminaries, systems of lease order, stability and control. **Class 4, Credit 4**

0301-763 Stochastic Estimation and Control
This course is concerned with the control of systems in the presence of uncertainties. Topics to be discussed: modeling of stochastic processes, estimation theory, least squares estimation, maximum likelihood estimation, MAP estimation, optimum filtering and prediction, optimum smoothing and interpolation, the Wiener-Hopf equation, solution to casual and non-casual cases, state estimation, Kalman filtering, discrete and continuous time filters, Riccati equation, optimum feedback control in presence of noise, LQC problem and applications. (0301-702, 761) **Class 4, Credit 4**

0301-764 Digital Control Systems
An introduction to the analysis and design of control systems in which the microcontroller plays a principal role. Topics include sampled data systems, Z and W-place analysis and design, algorithm generation and the effect of computer word length on noise and stability. The student will be expected to make use of the digital computer in the implementation of design procedures. (0301-703) **Class 4, Credit 4**

0301-765 Optimal Control
The course covers different optimization techniques, as applied to feedback control systems. The main emphasis is on the design of optimal controllers for digital control systems. The major topics are: different performance indices, formulation of optimization problem with equality constraints, LaGrange multipliers, Hamiltonian and solution of discrete optimization problem. Discrete Linear Quadratic Regulators (LQR), optimal and suboptimal feedback gains, Riccati equation and its solution, linear quadratic tracking problem, Dynamic Programming, Bellman's principle of optimality, and optimal controllers for discrete and continuous systems. (0301-761 or equivalent) **Class 4, Credit 4**

0301-768 Adaptive Signal Process
An introduction to the fundamental concepts of adaptive systems, open and closed loop adaptive systems, adaptive linear combiner, performance function and minimization, decorrelation of error and input signal. Adaptation algorithms such as steepest descent, LMS and LMS/Newton algorithm. Noise and misadjustments. Applications will include system identification, deconvolution and equalization, adaptive arrays and multipath communication channels. (0301-702 or permission of instructor) **Class 4, Credit 4**

0301-769 Fuzzy Logic and Applications
This course introduces fuzzy logic and its applications in areas like control systems, image processing, decision making, etc. Major topics: fuzzy sets, rule base, generation and combinations of rules, defuzzification. Fuzzy systems, choice of fuzzy variables, their division into fuzzy sets, choice of membership functions, the effect of these on system performance. Applications: discussion of published works and student projects using fuzzy logic. Students are required to research the published literature and/or do projects and take an active part in these discussions. **Class 4, Credit 4**

0301-770 Pattern Recognition
This course provides a rigorous introduction to the principles and applications of statistical pattern recognition. The topics covered include Bayesian decision theory, nearest-neighbor techniques, linear discriminant functions, and clustering. Parameter estimation and the supervised learning as well as principles of feature selection are included. (0301-702) **Class 4, Credit 4**

0301-772 Special Topics
Topics and subject areas that are not among the courses listed are frequently offered under the title of Special Topics. Such courses are offered in a normal format; that is, regularly scheduled class sessions with an instructor. (No regular course schedule) **Class 4, Credit 4**

0301-779 Digital Image Processing
This introductory course in digital image processing begins with a study of two-dimensional signal processing and transform methods with applications to images. Image sampling is discussed followed by gray level description of images and methods of contrast manipulation including linear/nonlinear transformation and histogram equalization and specification. Image smoothing methods are considered including spatial and frequency domain low pass filtering, ADHOC methods of noise removal and median filtering. Following this, methods of image sharpening are studied including derivative methods and high pass filtering. Edge and line detection methods are discussed using masks and Hough transforms, methods of image segmentation and degradation and image restoration, including deblurring. Several extensive computer and DSP lab assignments required. (0301-702, 703 or permission of instructor) **Class 4, Credit 4**

0301-780 Independent Study
This course number should be used by students who plan to study a topic on an independent study basis. The student must obtain the permission of the appropriate faculty member before registering for the course. **Credit 4**

0301-786 MEMS Devices
Microelectromechanical systems (MEMS) are widely used in aerospace, automotive, biotechnology, instrumentation, robotics, manufacturing, and other applications. There is a critical need to synthesize and design high performance MEMS that satisfy the requirements and specifications imposed. Integrated approaches must be applied to design and optimized MEMS, which integrate microelectromechanical motion devices, ICs, and microsensors. This course covers synthesis, design, modeling, simulation, analysis, control and fabrication of MEMS. Synthesis, design and analysis of MEMS will be covered including CAD. (Fourth or fifth year standing for undergraduates, or graduate standing) **Class 4, Credit 4**

0301-789 Fundamentals of MEMS
This course introduces the student to Microelectromechanical systems (microscale transducers, actuators and sensors with ICs). Synthesis, design, modeling, simulation, analysis, control and fabrication of MEMS will be covered. The primary emphasis of the course will be concentrated on development of basic theory to attain fundamental understanding of MEMS, the design, analysis, control, fabrication and application of MEMS in robotics, electronics, biotechnology, medicine, avionics, transportation, security, defense, etc. (Graduate standing for graduate students, 0301-531 for undergraduate students) **Class 4, Credit 4**

0301-794 Information Theory
This course introduces the student to the fundamental concepts and results of information theory. This is a very important course for students who want to specialize in signal processing, image processing, or digital communication. Topics include definition of information, mutual information, average information or entropy, entropy as a measure of average uncertainty, information sources and source coding, Huffman codes, run-length constraints, discrete memoryless channels, channel coding theorem, channel capacity and Shannon's theorem, noisy channels, continuous sources and channels, coding in the presence of noise, performance bounds for data transmission, rate distortion theory. (0301-702) **Class 4, Credit 4**

0301-796 Multiuser Detection
An introduction to the fundamental concepts of multiuser digital communications. Multiuser Detection deals with demodulation of interfering digital streams of information that appears in areas such as wireless communications, high-speed data transmission, satellite communications, and magnetic recording. The course begins with a review of multi-access communication channels, in particular Code Division Multiple-Access (CDMA) channels. This is followed by the design and performance analysis of optimum linear multiuser detectors. Topics such as decision-driven multiuser detection and noncoherent multiuser detection are covered. (0301-702 and 703 or permission of instructor) **Class 4, Credit 4**

0301-798 Microfluidic MEMS
The course begins with an overview of microfluidic technology to provide a framework and to clarify the relationship of microfluidics to microelectromechanical systems (MEMS) and microsystems in general. Three major topics comprise the course: 1) selected elements of fluidic dynamics theory, and the scaling and application of that theory to microscale dimensions; 2) design, fabrication, and characterization of microfluidic devices and microsystems including exploration of major alternative fabrication technologies, process integration and materials issues, and device- and system-level packaging/encapsulation challenges; 3) applications, including microvalves, micropumps, microflow control sensor, and devices for chemical and biochemical analysis. **Class 4, Credit 4**

0301-799 Nano and Microengineering
This course focuses on analysis and synthesis of nano- and micro electromechanical systems and devices. Synthesis, design, optimization, analysis, control and fabrication of nano and microsystems will be covered. Utilizing basic physical laws of nano and micro-engineering, distinct systems and devices will be examined. The application of nano and microengineering in nanocomputers avionics, security and transportation will be emphasized. Specific applications included are: super-fast data processing and computing, data storage, imaging, molecular intelligent automata, etc. (Graduate standing for graduate students; permission of instructor for undergraduate students) **Class 4, Credit 4**

0301-800 Graduate Paper
This course number is used to fulfill the graduate paper requirement under the non-thesis option for the MS degree in electrical engineering. The student must obtain the approval of an appropriate faculty member to supervise the paper before registering for this course. **Variable credit 0–5**

0301-803 Digital Video Processing I
In this graduate level course the following topics will be covered: Representation of digital video—introduction and fundamentals. Time varying image formation models including motion models and geometric image formation. Spatio-temporal sampling including sampling of analog and digital video, two-dimensional rectangular and periodic sampling, sampling of 3-D structures, and reconstruction from samples. Sampling structure conversion including sampling rate change and sampling lattice conversion. Two-dimensional motion estimation including optical flow based methods, block-based methods. Pel-cursive methods, Bayesian methods based on Gibbs Randon Fields. Three-dimensional motion estimation and segmentation including methods, point correspondences, optical flow and direct methods, motion segmentation, and stereo and motion tracking. (0301-779 or permission of instructor) **Class 4, Credit 4**

0301-804 MEMS Evaluation
This course focuses on evaluation of MEMS, microsystems and microelectromechanical motion devices utilizing MEMS testing and characterization. Evaluations are performed using performance evaluation matrices, comprehensive performance analysis and functionality. Applications of advanced software and hardware in MEMS evaluation will be covered. (0301-786, senior standing) **Class 4, Credit 4**

0301-805 Modern Optics for Engineers
This course provides a broad overview of modern optics in preparation for more advanced courses in the rapidly developing fields of lasers, fiber optics and non-linear optics. Topics covered: propagation of light, geometrical optics, polarization, interferometry, diffraction, and laser resonators. Introduction to non-linear optics: harmonic generation, optical parametric oscillators and amplifiers. At the end of the quarter, the students should have a firm foundation in classical optics. Lasers and non-linear optics will be introduced from a semi-classical perspective and will not require a quantum mechanical background. Students will write a paper on a topic of current research interest in the field. (0301-474) **Class 4, Credit 4**

0301-810 Advanced Computer Architecture
This course covers advanced topics in computer and processor architecture. Topics include: pipeline and parallel processor design, branch tables and prediction algorithms, single issue versus multiple issue processor architectures (VLIW, SIMD, superscalar), cache architectures, quantitative and qualitative evaluation of instruction set architectures. For specific evaluation and grading contact the assigned instructor before registration. (0301-240, 347, 365, 545) **Class 4, Credit 4**

0301-812 Advanced Topics-Physical Implementation
This course covers the analysis and physical design of very large scale integrated circuits. Topics covered include synthesis, cell layout, cell placement and system routing, extraction, layout versus schematic check, signal integrity, timing and noise immune design techniques. The course will address issues in current state-of-the art submicron and deep submicron CMOS technologies, with an emphasis on digital circuits and systems. For specific evaluation and grading policy contact the assigned instructor before registration. (0301-240, 347, 365, and 545) **Class 4, Credit 4**

0301-814 RF Integrated Circuit Design
An advanced course in analog RF integrated circuit design. Topics include: accurate modeling of passive elements, modeling of devices, low noise amplifiers, voltage controlled oscillators, and mixer circuits. Circuits will be designed using CMOS technology for frequencies up to 5 GHz. (0301-726) **Class 4, Credit 4**

0301-815 Multivariable Modeling and Control
This course introduces students to the major topics, methods, and issues in modeling and controlling multiple-input, multiple-output (MIMO) linear systems. In the first part of the course, students study methods of creating models and tuning them. Modeling topics include model-order determination, canonical forms, numerical issues in high-order models, numerical issues in broadband models, model transformations and information loss, and estimating model accuracy of MIMO models. In the second part of the course, students study approaches to observer and controller design for large-scale systems. Control topics include controller design goals, methods of model order reduction, observer/controller co-design, model uncertainty, sensitivity and robustness issues, and disturbance rejection. (0301-703 and 615 or 761) **Class 4, Credit 4**

0301-816 Design & Characterization of Microwave Systems
The primary objective is the design and experimental illustration of the fundamentals of microwave circuits and antennas. Projects will involve the design, construction and characterization a microwave system to satisfy a set of specified design criteria. Microwave measurement techniques will involve the use of network analyzers, and spectrum analyzers in conjunction with the probe station. Simulated results will be obtained using some popular commercial EM software for the design of microwave circuits and antennas. (0301-717, 729) **Class 4, Lab 3. Credit 4**

0301-820 Modeling and Simulation of Semiconductor Devices
Semiconductor process and device simulation techniques are introduced. Standard process simulators—ATHENA is used for modeling and simulation of process technologies—crystal growth, film deposition, oxidation, diffusion, ion implantation, dry etching, metallization, oxygen implantation, annealing, etc. Physics based modeling topics—carrier transport, Poisson's equation, current continuity equation, breakdown phenomena, device scaling, etc. are covered. Standard multi-dimensional device simulator—ATLAS is used to simulate different semiconductor devices. In conjunction with ATHENA and ATLAS, UTMOST is used to extract BSIM model parameters for circuit simulation using SPECTRE. (Graduate standing) **Class 4, Credit 4**

0301-821 Physics and Modeling of High Performance Semiconductors
Semiconductor devices based on III-V materials are introduced. Basic properties and physics of III-V materials and metal-semiconductor contacts and two-terminal Heterojunction devices are covered. Physical operation, non-idealities, modeling DC and microwave characteristics of Heterojunction Bipolar Transistors (HBT), Metal Semiconductor Field-Effect Transistors (MESFET) and High Electron Mobility Transistors (HEMT) are analyzed. Analysis of small and large-signal amplifiers is covered. (0301-360 or equivalent) **Class 4, Credit 4**

0301-831 Biomedical Sensors and Transducers II
This course will discuss the fabrication and design of sensors and transducers for biomedical applications. It will include discussion of applicable fabrication processes and techniques including consideration associated with the utilization of microelectromechanical and nanoelectromechanical structures to allow the integration of sensor and transduction mechanisms with signal simulation and fabrication design tools will be covered. The course will involve the design and simulation of an actual transducer suitable to be considered for actual fabrication. (0301-610, 631 and permission of instructor) **Class 4, Credit 4**

0301-887 Digital Signal Processing
A continuation of the topics studied in 0301-554. Topics include study of the design methods for digital IIR filters via s-plane transformations, study of design methods for digital FIR filters, including emphasis on the question of linear phase response, a review of the discrete Fourier transform (DFT) and an in-depth study of fast algorithms (FFTs) for implementing the DFT, including radix 2, radix 4 and mixed radix algorithms, quantization effects in discrete systems; an introduction to digital signal processing computer chips and their use in the implementation of digital processing systems, and applications of digital signal processing, including speech processing and two-dimensional image processing. Includes several design projects in the digital signal processing laboratory. (0301-554) **Class 4, Credit 4**

0301-890 Thesis
An independent engineering project or research problem to demonstrate professional maturity. A formal written thesis and an oral defense are required. The student must obtain the approval of an appropriate faculty member to guide the thesis before registering for the thesis. A thesis may be used to earn a maximum of 9 credits.

Industrial and Systems Engineering

0303-701 Linear Programming
Applied linear programming. Computational techniques for solving constrained optimization problems. Linear programming, the Simplex method and variations, duality and sensitivity testing. (1016-331 or equivalent) **Credit 4 (F)**

0303-702 Integer and Nonlinear Programming
An introduction to the mathematical foundations of integer programming and nonlinear optimization techniques. Study of algorithms and computer-aided solutions for applied optimization problems. (0303 701) **Credit 4 (W)**

0303-703 Supply Chain Management
As business competition becomes global and product life cycles shorten, the need exists for a systems approach to studying all elements of the supply chain. This course will give students breadth of knowledge in Supply Chain Management along with strategies that can be utilized in the design and operation of efficient subsystems within the supply chain. Students will understand the supply chain in the context of the business value chain and profitability goals. This course will take a "macro" view, without emphasizing the details of each subcomponent within the supply chain. For example, the importance of warehouse location and its impact on the overall system will be considered without looking at details associated with material handling within a warehouse. **Class 4, Credit 4 (F)**

0303-704 Logistics Management
The course is designed to give students the knowledge and experience of logistics problem solving. Attention is given to such problems as transportation and network planning, inventory decision making, facility location planning, vehicle routing, and logistics forecasting. Students will learn to use several quantitative tools commonly used in the field of logistics, which include algebra, geometry, differential calculus, and mathematical programming (0303-701 or equivalent). **Class 4, Credit 4 (S)**

0303-710 Systems Simulation
Methods of modeling and computer simulation of stochastic and dynamic manufacturing systems are discussed. A high-level simulation language such as ProModel, ARENA, etc., will be used to model the system and examine system performance. Model validation, design of simulation experiments, variance reduction techniques and random number generation will be discussed as time permits. (1016-352 or equivalent) **Credit 4 (W)**

0303-711 Advanced Simulation Techniques
An advanced course in developing simulation models using good model building, verification and validation procedures. Emphasis will be on review and use of probability distributions, simulation output data analysis for making good decisions, comparison of alternative system configurations, use of designed experiments and the use of advanced simulation techniques. Real world case studies will be examined to convey understanding and teaching of the material. Students will be asked to build models, so simulation experience and working knowledge of a simulation language will be required. (0303 710) **Credit 4 (S)**

0303-716 Applied Linear Regression Analysis
A first course in least squares linear regression. Topics covered include estimation of model parameters, significance testing of model parameters, detection and treatment of influential observations, model adequacy checking and variable selection techniques. May not be used as a professional elective. (1016-352 or equivalent) **Credit 4 (S)**

0303-720 Production Control
This course will cover the role, the steps and the analysis methods to produce goods and services in support of the production and operations management functions. Topics include: forecasting, inventory policies and models, production systems and philosophies (e.g. JIT/Lean), job shop scheduling, aggregate production planning, and Material Requirement Planning (MRP). Students will understand the importance of production control and its relationship to other functions within the organization. Case studies and the design of actual production systems will be emphasized. (0303-701, 1016-352) **Credit 4 (W)**

0303-723 Global Facilities Planning
This course addresses the global planning, and design, and utilization of fixed assets associated with design, of manufacturing, storage and distribution, service and support functions facilities. Topics include: strategic considerations in facilities planning to meet customer and market objectives, product, process, and schedule design; determining flow, resource, and space requirements; layout at the plant level; design of storage warehousing material handling systems design, warehousing, storage and retrieval policies, process technology transfer, incorporation of lean principles, and quantitative design and analysis tools. Students will understand facilities planning from a strategic and tactical perspective as well as the link between business goals, and design, and engineering activities. Visits to local companies are included. (Requires acceptance into MML program or permission of instructor) **Credit 4 (S)**

0303-726 Contemporary Production Systems
The focus of this course is lean; about doing more with less human effort, less equipment, less time, less space. In other words, lean is about the application of industrial engineering principles and tools to the entire supply chain or value stream. Lean can be summarized by five principles: specify value by product, identify the value stream for each product, let the value flow, let the customer pull value from the producer, and pursue perfection. By the end of the course, the student will have the essential tools and skills to be a lean consultant (staff role), a value stream leader, or a production manager or supervisor (line role) who wants to use lean thinking and principles as the basis of their production management system. (Theoretical or experiential background in manufacturing processes and production systems is recommended, or permission of instructor.) **Class 4, Credit 4 (F)**

0303-727 Advanced Manufacturing Engineering
This course will provide an advanced treatment of manufacturing engineering in the context of industrial and systems engineering. Emphasis will be place in process design, development and engineering, using state-of-the-art solid modeling tools and materials selection software. Process tooling, gauging, and automation will be cornerstones of the course and will provide material for a variety of term projects. Advanced processing, such as electronics and microsystems, will be explored and developed in depth. Quality systems and process documentation will also be covered. (0303-343, graduate standing or permission of instructor) **Class 4, Credit 4 (F)**

0303-729 Advanced Systems Integration
Basic concepts and techniques need to specify, design and implement systems that are computer controlled. Real-time data acquisition, process control as related to computer-integrated manufacturing, and information systems topics will be introduced within the context of systems integration. Cannot be used as a professional elective for ISE majors. (0303-302 or permission of instructor) **Class 3, Lab 1, Credit 4 (W)**

0303-730 Ergonomics and Human Factors
A survey course of human factors and ergonomics emphasizing a systems approach in looking at human capacity for physical and mental work versus the demands placed upon the human by the task, machine and environment. Various models of human performance are covered. **Credit 4 (on demand)**

0303-731 Advanced Topics: Ergonomics and Human
Advanced topics are selected based on current ergonomic and human factors issues and interests of students. Course is taught using a seminar format. (0303-730 or equivalent) **Credit 4 (W-even years)**

0303-732 Biomechanics
Theoretical fundamentals of human physiology and mechanics applied to work. Biomechanical models are developed to evaluate the effects of physical loading on the human body. Topics include modeling, biomaterials, and bioinstrumentation. (0304-331, 332, 0303-730 or equivalent) **Class 4, Credit 4 (S)**

0303-733 Cognitive Engineering
Measurements of human performance. Fundamentals of human information processing and how they relate to the design of human-machine systems. (0303-730 or equivalent) **Credit 4 (on demand)**

0303-734 Systems Safety Engineering
Acquaints students with practical aspects of safety engineering. Students acquire a working knowledge of legal and technical aspects of safety. Focuses on a systems approach to safety engineering. Topics include Workers Compensation, OSHA, Consumer Product Safety Commission and various hazard analysis and utilization techniques. Students also are exposed to various theories of accident causation, research methodology and ways of evaluating safety programs and related research. Professional elective. **Class 4, Credit 4 (W-odd years)**

0303-735 Design Project Management
Training for multidisciplinary studies in project management for leadership of product/process development and design projects. (e.g., senior design) (Permission of instructor required) **Class 4, Credit 4 (F, S)**

0303-742 Artificial Intelligence Applications
An introductory course in the development and application of "intelligent" (knowledge-based) systems. An introduction to Artificial Intelligence (AI) as a tool to deal with problems that require "intelligence." Computational complexity will be used to address "hard" problems. Generic and problem-specific procedures will be used and analyzed. (0303-701 or equivalent) **Credit 4 (on demand)**

0303-750 Management Quality Control Systems
This course is designed to expose upper-level students to managerial aspects of quality systems, with an emphasis on lean thinking and a customer-centric approach to quality. Students will learn to measure, analyze, improve, and control quality systems, consistent with corporate objectives. Ideas from a number of quality consultants (Juran, Gryna, Crosby, Taguchi, Deming, etc.) will be covered to give students an overview of topics such as fitness for use, quality costs, quality planning, statistical quality control and experimental design for quality improvement. Frameworks such as "lean six sigma" will be utilized extensively, and students will meet objectives associated with contemporary industry certification programs. (Requires acceptance into MML program or permission of instructor; 1016-352 or equivalent) **Credit 4 (S)**

0303-756 Decision Analysis
This course presents the primary concepts of decision analysis. Topics important to the practical assessment of probability and preference information needed to implement decision analysis are considered. Decision models represented by a sequence of interrelated decisions, stochastic processes and multiple criteria are also considered. (1016-352 or equivalent) **Credit 4 (on demand)**

0303-757 Reliability
This course deals with mathematical concepts and techniques for modeling and analyzing the reliability of systems. (1016-352 or equivalent) **Credit 4 (on demand)**

0303-758 Design of Experiments
This course presents the primary concepts of experimental design. Its applied approach uses theoretical tools acquired in other mathematics and statistics courses. Emphasis is placed on the role of replication and randomization in experimentation. Numerous designs and design strategies are reviewed and implications on data analysis are discussed. (1016-352 or equivalent) **Credit 4 (W)**

0303-760 Product/process Design and Development
This course covers the principles of product, manufacturing process and supply chain development in an integrated fashion. Examines the linkages between design specifications and manufacturability, between product architecture and manufacturing system, between the manufacturing system and supply chain and between in-house and outsourced manufacturing. Major topics include: product strategies, product, architectures and manufacturing strategies; product development processes and organizations; product requirements and benchmarking; concept generation and evaluation; the application of systems engineering tools to product design, design for "X" (manufacturing/assembly/service/environment, etc.) and life cycle costing. (Acceptance into the MML program or permission of instructor, 0303-766 or 764) **Credit 4 (F)**

0303-762 Systems Modeling and Decision Making
This course emphasizes how process modeling and simulation can be utilized to aid business and technical decision making. Students will learn to identify and analyze key decision making factors associated with topics such as sourcing and the supply chain, lean manufacturing systems, product and service delivery, activity based costing, call centers, and order-to-cash systems. Students will also learn how to identify performance measures for a manufacturing or service systems and use those measures in the evaluation of system performance. A high-level modeling language will be utilized to simulate systems and examine performance. (Requires acceptance into the MML program or permission of instructor) **Credit 4 (W)**

0303-764 Operation Management and Manufacturing Systems
This course introduces students to problems and analysis related to the design, planning, control, and improvement of manufacturing and service operations. Emphasis is placed on the principles of planning and designing modern manufacturing systems, consistent with corporate objectives and new product development strategies. The course will extensively utilize case studies and analytical problem sets. Topics include: enterprise and manufacturing strategies, operations strategy, architecting manufacturing systems, systems thinking, process and project analysis, materials management, production planning and scheduling, quality management computer-aided manufacturing, and process management options. The course will equip students with the basic tools and techniques used in analyzing operations and manufacturing systems, as well as the strategic context for making decisions. (Requires acceptance into MPD program) **Credit 4**

0303-765 Data Bases-information Systems
The course focuses on implementation of information systems applications using SQL and object oriented software for user interface design (e.g. Visual FoxPro). Students will design, develop and implement multiple database projects and also be expected to conduct literature searches on contemporary issues in information systems architectures. **Class 4, Credit 4 (F)**

0303-766 Manufacturing Systems
This course introduces the principles of planning and designing modern manufacturing systems that are consistent with corporate objectives. This course will provide an introduction to concepts and techniques in the design and analysis of manufacturing systems. A blend of traditional and modern approaches is used to assess and analyze the performance of a given manufacturing system as well as to provide a framework for system redesign and improvement. Topics include factory physics, queuing theory, cellular manufacturing, and lean manufacturing. (Permissions of instructor) **Credit 4 (W-MML only, S)**

0303-771 Special Topics in Industrial Engineering
This is a variable topics course that can be in the form of a regular course or independent study under faculty supervision. **Credit 4**

0303-775 Data Structures Using C
An introductory course in data structures and algorithms using the (visual) C++ programming language. Topics include sorting, searching and lists. This course can be used as a foundation for many computer-based courses in engineering. **Class 4, Credit 4 (F-odd years)**

0303-777 Engineering Internship
This course number is used by students in the master of engineering degree program to register for an internship experience. The number of credits is to be determined by the student's faculty adviser and is subject to the approval of the Graduate Committee of the College of Engineering. **Variable credit 1-16**

0303-778 Leadership Capstone
For students enrolled in the BS/ME dual degree program. Student must either: 1) serve as a team leader for the multidisciplinary senior design project, where they must apply leadership, project management, and system engineering skills to the solution of un-structured, open-ended, multi-disciplinary real-world engineering problems, or 2) demonstrate leadership through the investigation of a discipline-related topic. **Credit 0**

0303-779 Engineering Capstone
For the Master of Engineering programs in industrial engineering, engineering management, and systems engineering. Students must investigate a discipline-related topic in a field related to industrial engineering, engineering management, or systems engineering. The general intent of the engineering capstone is to demonstrate the students' knowledge of the integrative aspects of a particular area. The capstone should draw upon skills and knowledge acquired in the program. (Restricted To EIEG, EIEM, EIES, EIEA) **Credit 4 (W)**

0303-780 Foundations in Product Development
A modular course designed to lay the groundwork for the rest of the program and its overarching goal to prepare engineers and technical professionals to lead end-to-end product development initiatives. The course focuses on how all aspects of product development, with systems engineering at the core, must be integrated and accounted for in end-to-end product development. Students will gain a perspective and appreciation for the critical factors and inhibitors to the commercialization of complex products and systems. Emphasis will be on the role of the product development manager in leading product strategy and development activities, and on the experiences of engineering managers who have successfully led technical, task oriented, multi-disciplinary teams and organizations. (Requires acceptance into the MPD program or permission of instructor) **Credit 4**

0303-781 Advanced Topics in Product Development
This modular course is designed to complement previous coursework in the MS in Product Development program, with an emphasis on engineering concepts and tools needed by technical leaders of product development projects. Topics may include: impact of the Internet on product realization, the product development process within the extended enterprise, intellectual property management and implications for product and platform architecture, and information technology and supply chain management. (Requires completion of all coursework in the MPD program) **Credit 4**

0303-784 Systems and Project Management
Systems and Project Management ensures progress toward objectives, proper deployment and conservation of human and financial resources, and achievement of cost and schedule targets. The focus of the course is on the utilization of a diverse set of project management methods and tools. Topics include strategic project management, project and organization learning, cost, schedule planning and control, structuring of performance measures and metrics, technical teams and project management, information technology support of teams, risk management, and process control. Course delivery consists of lectures, speakers, case studies, and experience sharing, and reinforces collaborative project-based learning and continuous improvement. (Requires acceptance into the MML or MPD program or permission of instructor, 0101-740) **Credit 4 (W, S-MPD only)**

0303-785 Engineering Risk Benefit Analysis
The ERBA course addresses decision making in the face of risk and uncertainty. Various methodologies will be introduced that are useful in describing and making decisions about risks, with particular emphasis on those associated with the design of products. Students will be exposed to issues related to balancing risks and benefits in situations involving human safety, product liability, environmental impact, and financial uncertainty. Presentations will be made of risk assessment studies, public decision processes, and methods for describing and making decisions about the societal risks associated with engineering projects. Topics include probabilistic risk assessment, cost-benefit analysis, reliability and hazard analysis, decision analysis, port-folio analysis, and project risk management. (Requires acceptance into MPD program or permission of instructor; 0101-703) **Credit 4 (W)**

0303-786 Engineering of Systems I
The engineering of a system is an essential aspect of its development that focuses on the overall concept, performance requirements and behavioral aspects of the system. This course treats the creation of products, product platforms and product families as systems that create value for both the customer and the enterprise. Topics include value creation and strategy, product development processes, translating market requirements to system requirements, functional analysis, development of the system's architecture, development of platforms and modules, and concept selection. Students will learn several systems analysis techniques and apply them in a team-based project. (Acceptance into the MPD program or permission of instructor) **Credit 4 (W)**

0303-787 Systems Optimization
This course is an application-oriented introduction to optimization, focused on the understanding of system tradeoffs. It introduces modeling methodology (linear, integer and nonlinear programming), modeling tools (sensitivity and post-optimality analysis), optimization software, applications in production planning and scheduling, inventory planning, personnel scheduling, project scheduling, distribution systems planning, facility sizing and capacity expansion, communication systems design, and product development. (Requires acceptance into the MPD program or permission of instructor) **Credit 4 (W)**

0303-788 Engineering of Systems II
The engineering of a system is an essential aspect of its development that focuses on the overall concept, performance, requirements and behavioral aspects of the system. This course builds on the concepts discussed in Engineering of Systems I. Topics include an introduction to computer and software architecture, defining the structure and work content of the product development organization, refinement and flow-down of requirements to subsystems, performance and life cycle trade studies, interface management, robust design, and certification planning. Students will learn several systems analysis techniques and apply them in a team based project. (Requires acceptance into the MPD program or permission of instructor, 0303-786) **Credit 4 (S)**

0303-789 Systems Dynamics
Systems dynamics deals with the time-based behavior and control of nonlinear systems. This course will introduce the concepts of systemic thinking, nonlinear dynamics, and control principles as they apply to enterprise issues such as the product development process, innovation diffusion, product differentiation, supply chain dynamics, and organizational learning. Topics include casual models, system archetypes, feedback and feed forward loops, exponential growth, goal seeking behavior, instability and sensitivity analysis. A continuous time simulation tool, such as I Think, Stella or Vensim, will be utilized to model and analyze the behavior of a variety of enterprise systems. (Requires acceptance into the MPD program or permission of instructor) **Credit 4**

0303 790 Fundamentals of Sustainable Engineering
The product life cycle is reviewed from various perspectives and highlights the leverage over material, process, and environmental costs available at the design phase. An additional project is required that draws upon basic engineering knowledge. (0303-343, 0304-344). **Class 4, Credit 4 (F)**

0303-791 Lifecycle Assessment/Costing
This course will introduce students to the challenges posed when trying to determine the total costs and environmental impacts associated with a product/process design across its entire lifecycle. Various assessment and costing models and their inherent assumptions will be reviewed and critiqued. **Class 4, Credit 4 (W)**

0303-792 Design for Environment
A course on systematic approaches of designing and developing environmentally responsible products. Topics covered include: guidelines for product structure, materials selection, fastening, labeling and finishing, techniques to reduce environmental impact (such as design to minimize material usage, design for disassembly, design for recycling, design for remanufacturing, design to minimize hazardous materials, design for energy efficiency, design to regulations/standards), and environmental impact inventory methods. (0303-343, 0304-344 or equivalent) **Class 4, Credit 4 (S)**

0303-793 Applications in Sustainable Engineering
Students investigate a discipline-related topic in a field related to sustainable engineering through the completion of an individual or team-based project. The topic is chosen in conference with a faculty advisor. The general intent of the engineering capstone is to demonstrate the students' knowledge of the integrative aspects of a particular area. The capstone should draw upon skills and knowledge acquired in the program. (Graduate standing) **Class 4, Credit 4 (W)**

0303-800 Graduate Seminar
Seminar series intended to present the state of the art in industrial engineering. Other research-related topics may be presented such as library search techniques, thesis writing, etc. All MS industrial engineering students are required to register for at least 3 quarters. (Graduate standing in MS in industrial engineering) **Credit 0 (F, W, S)**

0303-801 Design for Manufacture
This course presents an overview of the factors influencing product design and the manufacturing cycle. Topics include component design and analysis, design for manufacturability as well as function and design for manual and automated assembly. Students will gain hands on experience with the Boothroyd-Dewhurst system to quantify design efficiency. The various manufacturing processes as they relate to modern trends in DFM are covered. (0303-343) **Class 4, Credit 4 (S)**

0303-886 Systems Engineering
An introduction to systemic thinking, systems architecture, and systems analysis with a focus on devices that are integrated into the larger systems. Systems engineering, systems architecture and product development processes are introduced and applied in a term-long project centered on a device of the student's choosing. Students identify customer requirements, translate them to critical design parameters, define a system architecture, then analyze the behavior, design windows, reliability and life-cycle cost trade-offs. Enrollment in microsystems engineering degree program or permission of the instructor) **Class 4, Credit 4 (W)**

0303-890 Research and Thesis
In conference with a faculty adviser, an independent engineering project or research problem is selected. The work may be of a theoretical and/or computational nature. A state-of-the-art literature search in the area is normally expected. A formal written thesis and an oral defense with a faculty thesis committee are required. Submission of bound copies of the thesis to the library and to the department and preparation of a written paper in a short format suitable for submission for publication in a refereed journal are also required. Approval of department head and faculty adviser needed to enroll. **Variable credit 0–9 (F, W, S, Su)**

0303-891 **Capstone Integrative Project**
In the Capstone Project students to demonstrate integrative applications of knowledge and skills that they have acquired through the MML program. A capstone project will be team-based and oriented to the solution of manufacturing management problems or to technically related processes. Each project will define an actual problem and solve it, or select and develop a needed process in a manufacturing firm. Each project must be approved by the capstone coordinator. A suitable project will be multi-disciplinary or multi functional in nature and will have significant impact on one or more competitive capabilities of the organization, e.g., quality, lead time, cost, flexibility, or service. Normally, a suitable project will constitute the equivalent of one quarter course workload per student, however, a suitable project could be larger (Requires acceptance into the MML program) **Credit 4 (W)**

0303-892 **Capstone Research Project**
For the MS program in product development (MPD). Students in the MPD program must demonstrate intellectual leadership in the field of new product development. The general intent of the capstone project is to demonstrate the students' knowledge of the integrative aspects of new product development in the context of a corporate-oriented problem solving research project. The project should address issues of significance to multiple functions or disciplines and should draw upon skills and knowledge acquired from various courses and experience in the program. Students are encouraged to start work on the project in advance of receiving formal credit during the final two quarters of the program. Team-based projects are strongly recommended (Requires acceptance into the MPD program) **Credit 4 (each course)**

Mechanical Engineering

0304-701 **Research Methods**
This course introduces students to research methods in mechanical engineering. A primary focus of the course is on conducting critical reviews of research literature, preparing a formal thesis proposal, and initiating background research on a thesis topic. At the conclusion of the course, the students are expected to submit a formal thesis proposal, literature review, and plan of study for the completion of the Master of Science degree. This course is specifically designed for students enrolled in the dual degree MS/BS program offered through the department. (Consent of instructor. Restricted to dual degree students.) **Class 4, Credit 4**

0304-710 **Fuel Cell Technology**
Fuel cell technology is an emerging technology for electric power on demand, and can be used for stationary power generation or for driving vehicles. Fuel cell, the heart of this technology, is an electrochemical devise that produces electricity via cell reactions from useful chemical energy stored in fuel. After learning fuel cell basics and operating principles, fuel cell performance will be considered from energy and thermodynamic viewpoints. Types discussed are polymer electrolyte membrane fuel cell (PEMFC), phosphoric acid fuel cell (PAFC), molten carbonate fuel cell (MCFC), and solid oxide fuel cell (SOFC). Modeling of one fuel cell type will demonstrate design and analysis of systems and the information and components needed to make the system successful. Also discussed: thermal system design and analysis issues, limitations, cost effectiveness and efficiency. **Class 4, Credit 4**

0304-714 **Thermal Radiation Heat Transfer**
Course focuses on the following topics: fundamentals of radiative heat transfer, the blackbody, electromagnetic theory, properties of solid materials, gray surfaces, and shape factors; energy exchange between surfaces and in enclosures when no attenuating media is present. An introductory discussion of radiative transfer in the presence of an attenuating medium is also included. (Graduate standing and departmental approval required) **Class 4, Credit 4**

0304-729 **Renewable Energy Systems**
This course provides an overview of renewable energy system design. Energy resource assessment, system components, and feasibility analysis will be covered. Possible topics to be covered include photovoltaics, wind turbines, solar thermal, and hydropower. Students will be responsible for a final design project. (0304-415, 514) **Class 4, Credit 4**

0304-730 **Design Project Management**
This course focuses on preparing students to take on a leadership role in design project teams. Topics include product development processes, management of design project teams, developing a business case for design projects, understanding customer needs and translating them into engineering specifications, tools for developing design concepts, tools for assessing the feasibility of design concepts, conducting engineering tradeoffs and analysis to synthesize a preliminary design. Students use the concepts and tools discussed throughout the course in a team-based environment to develop project readiness packages for subsequent use by senior design teams. **Class 4, Credit 4**

0304-733 **Sustainable Energy Management**
This course, Sustainable Energy Management and the Built Environment, provides an overview of mechanical and associated control systems within buildings with an emphasis on sub-systems which possess the most visible energy signature in terms of energy usage, energy inefficiency, and societal/global impact. Fundamentals of system operation are explored as well as energy management techniques. Using domestic and international case studies which highlight energy management within the built environment, students will explore methods by which engineers have achieved solutions aligned with sustainability. (0304-643, 660) **Class 4, Credit 4**

0304-739 **Alternative Fuels and Energy Efficiency**
This course, Alternative Fuels and Energy Efficiency for Transportation, provides an overview of the potential alternative fuels and energy efficiency technologies for powering current and future vehicles. Alternative fuel production technologies and utilization of fuels such as biodiesel, ethanol, and hydrogen will be covered. The primary technical and environmental issues associated with these alternative fuels will be discussed. Approaches to improving vehicle efficiency will also be explored. Students will be responsible for a final design or research project. (0304-640) **Class 4, Credit 4**

0304-743 **Intermediate Control Systems**
Introduces the student to the study of linear control systems, their behavior and their design and use in augmenting engineering system performance. Topics include control system behavior characterization in time and frequency domains, stability, error and design. This is accomplished through classical feedback control methods that employ the use of Laplace transforms, block diagrams, root locus, and Bode diagrams. A companion laboratory will provide students with significant hands-on analysis and design experience. (0304-543) **Class 3, Lab 3, Credit 4**

0304-745 **Micro/Nano Characterization**
This technical elective with weekly lab component focuses on tools and techniques for micro- and nano-characterization of materials surfaces and thin films. The course covers the principles and applications of four experimental techniques: quantitative imaging, x-ray diffraction, scanning probe microscopy, and micro- and nano indentation. Students will learn the physics of interaction processes used for characterization, quantification and interpretation of collected signals, and the fundamental detection limits for each technique. (0304-344 or 1028-701 or 0305-460) **Class 3, Lab 2, Credit 4 (W or S)**

0304-746 **Engineering Properties of Materials**
The course provides an understanding of the relationship between structure and properties for development of new materials. Topics include atomic and crystal structure, crystalline defects, diffusion theories, strengthening mechanisms, ferrous alloys, cast irons, structure of ceramic and polymeric materials, and corrosion principles. (Graduate standing or permission of instructor) **Class 4, Credit 4**

0304-752 **Tribology Fundamentals**
This course provides an overview of the role of fluid-film lubrication in mechanical design, with strong emphasis on applications. Various forms of the Reynolds equation governing the behavior of lubricant films for planar, cylindrical, and spherical geometry are derived. Mobility and impedance concepts as solution methods of the Reynolds equation are introduced for the performance assessment of lubricated journal bearings under static and dynamic loading. Short, long, and finite bearing assumptions are discussed. Finite element methods for the analysis of fluid-film bearings of arbitrary geometry will be introduced. (0304-415, 437 or equivalent, finite element background desirable but not required) **Class 4, Credit 4**

0304-754 **Fundamentals of Fatigue and Fracture Mechanics**
This course is an introduction to the fatigue life prediction methodologies and basic fracture mechanics. Students will be introduced to linear elastic fracture mechanics, including stress intensity factor and crack tip plastic zone models. The fatigue methodologies to be covered include the Stress-Life Theory (used for machine elements), Strain-Life Theory (used for large-displacement samples and low cycle fatigue problems), and a fracture mechanics approach to fatigue analysis (used in the aircraft and space industries). (0304-437, 440) **Class 4, Credit 4**

0304-756 **Aerosols in the Respiratory Tract**
This course introduces the student to the fundamentals of modeling and particulate flow in biological systems. Examples are drawn from a variety of fields, including deposition of particulates in the human lung, medicine delivery, and numerical modeling and simulation techniques. Students will be introduced to the morphology of the lung, diseases, and particulate characterization. (0304-415) **Class 4, Credit 4**

0304-758 Intermediate Engineering Vibrations
This is a course on the theory of mechanical vibrations with an emphasis on design applications and instrumentation. Fourier analysis techniques, numerical and experimental analysis and design methods are presented in addition to theoretical concepts. Vibrations of single-degree of freedom systems are covered including free damped and undamped motion; harmonic and transient forced motion including support motion, machinery unbalance, and isolation. Modal analysis of multi-degree of freedom systems is introduced. In addition to laboratory exercises on vibration instrumentation, an independent design project is assigned. (0304-658) **Class 3, Lab 2, Credit 4**

0304-793 Applications in Sustainable Engineering
Students investigate a discipline-related topic in a field related to sustainable engineering through the completion of an individual or team-based project. The topic is chosen in conference with a faculty advisor. The general intent of the engineering capstone is to demonstrate the students' knowledge of the integrative aspects of a particular area. The capstone should draw upon skills and knowledge acquired in the program. (Graduate standing) **Class 4, Credit 4**

0304-801 Design for Manufacture
This is a required course in the manufacturing option of the master of engineering degree program. The course is offered jointly by the departments of Industrial and Manufacturing Engineering and Mechanical Engineering and presents an overview of the factors influencing product design and the manufacturing cycle. Topics include component design and analysis, design for manufacturability as well as function and design for manual and automated assembly. Students will gain hands-on experience with the Boothroyd/Dewhurst system to quantify design efficiency through a term project. The various manufacturing processes as they relate to modern trends in DFM are covered in detail. (Graduate standing) **Class 4, Credit 4**

0304-810 Introduction to Continuum Mechanics
A rigorous basis for the study of advanced fluid mechanics and theory of elasticity is presented. Cartesian tensors. Analysis of stress and deformation. Motion of continuous medium. Applications to theory of elasticity, thermoelasticity, viscoelasticity and fluid mechanics. (0304-871) **Class 4, Credit 4**

0304-811 Theory of Elasticity/Plasticity
Stress-strain relations and formulation of boundary value problems. State of plane strain, state of plane stress. Solutions by potentials, Airy stress function. Torsion of bars with circular, elliptic, rectangular cross-sections. Stresses and displacements in thick cylinders, disks and spheres. Contact stress problems. Energy principles. (0304-810) **Class 4, Credit 4**

0304-816 Finite Elements
This is an introductory course on the modern theory of finite element analysis. Although the necessary mathematics will be kept to a minimum, the course content has been designed to provide the skills necessary to write an F. E. program and to understand the structure and capabilities of commercially available codes. Applications to problems in structural mechanics, heat transfer and fluid mechanics. (0304-870, 885) **Class 4, Credit 4**

0304-820 Advanced Optimal Design
Topics from nonlinear programming as applied to automated optimal design. Use of penalty functions for the transformation of constrained nonlinear optimization problems. Multivariate pattern and gradient based algorithms. Linear programming, Quasi-Newton's method, Newton's method and direct methods for constrained problems. Applications to the solution of practical nonlinear optimization problems will be required through available software on the mainframe computer. (0304-871) **Class 4, Credit 4**

0304-821 Advanced Vibrations
Vibration of discrete multi-mass systems using matrix methods. Normal mode theory and matrix eigenvalue extraction procedures. Matrix forced response. Practical examples using two-and-three degrees of freedom. Vibration of continuous systems. Computer simulations. (0304-758) **Class 4, Credit 4**

0304-823 Systems Modeling
This course is designed to introduce the student to state-space modeling techniques and response characterization. Both lumped and distributed parameter systems will be considered. Bond-graph theory will be used extensively. System performance will be assessed through numerical solution using MATLAB/Simulink. Traditional closed form solution methods utilizing Laplace and Fourier transforms and transfer functions are also discussed. (0304-543 or equivalent) **Class 4, Credit 4**

0304-828 Special Topics
In response to student and/or faculty interest, special courses which are of current interest and/or logical continuations of regular courses will be presented. These courses will be structured as ordinary courses with specified prerequisites, contact hours and examination. (Graduate standing) **Class 4, Credit 4**

0304-830 Introduction to CFD Analysis
This graduate core course covers basic numerical techniques applicable to equations in fluid mechanics and heat transfer. Numerical methods required for programming partial differential equations are introduced. Course work involves analytical programming and design examples. Commercial software is also explored. (0304-838, 851) **Class 4, Credit 4**

0304-831 CFD Applications
This course introduces the students to some of the commercial CFD codes being used for solving thermal-fluid problems. After an introduction to in-house CFD codes, students are expected to complete an individual CFD study project including a written report and a presentation of the results as part of the course requirements. (0304-830, 851) **Class 4, Credit 4**

0304-833 Heat Exchanger Design
This course presents an overview of the different heat exchangers used in industry including shell-and-tube, plate, tube-fin, and plate-fin heat exchangers. Analytical modeling of recuperators, regenerators, and transient performance is also covered. Thermal design methods for designing shell-and-tube and compact heat exchangers are presented. Students are required to carry out a major design project in the course. (0304-514; 0304-550 or 851) **Class 4, Credit 4**

0304-834 Boiling and Condensation
This course provides a basic understanding of the phase change phenomena associated with boiling and condensation heat transfer. This knowledge is applied in the design of industrial systems such as evaporators, condensers and distillation columns. Students are required to undertake a major design project in the course. (0304-514, 550) **Class 4, Credit 4**

0304-835 Grid Generation
This graduate elective course introduces modern topics in the theory of grid generation techniques. Although the primary focus will be on the topics of thermal/fluid sciences, the applicability of the theory holds in other fields of interest as well. Topics include algebraic and elliptic grid generation, structured and unstructured grids, and boundary element methods. Some commercially available software will be introduced. (0304-830) **Class 4, Credit 4**

0304-838 Ideal Flows
This graduate core course covers the fundamental topics in the theory of aerodynamics and high speed flows. The course discusses modern aerodynamic applications in the areas of wing and airfoil design, wind tunnel testing and compressible flows. (0304-415) **Class 4, Credit 4**

0304-840 Signal Processing
This course introduces the student to discrete-time signal processing fundamentals, analog-to-digital conversion, and computer-based data analysis. Analytical mathematical developments are supplemented with hands-on computer-based laboratory and homework assignments that promote practical understanding. Topics covered include continuous time and discrete time convolution, correlation, Fourier transformation, and power spectral estimation. Coverage includes the DFT, FFT, z-transform, autocorrelation and cross correlation functions, and an introduction to statistical data processing via ARMA models for spectral estimation. (Graduate standing) **Class 4, Credit 4**

0304-842 System Identification
This course introduces the student to continuous-time and discrete-time identification from input-output data series. Practical aspects of the "synthesis" of system character will involve data conditioning, analog-to-digital conversion, and computer-based system analysis using MATLAB. Analytical mathematical developments are supplemented with hands-on computer-based laboratory and homework assignments that promote practical understanding. Topics covered include system response functions, non-parametric and parametric model estimation, model definition and validation, and system response prediction; builds on topics covered in 0304-840, Signal Processing, and supplements this material as appropriate. (0304-823, 840) **Class 4, Credit 4**

0304-843 Advanced Control Systems
Introduction to advanced control systems, including elements of continuous, digital, and nonlinear control systems theory. Topics include continuous to digital control conversion using finite difference solutions; continuous to digital control conversions using state equation approach; stability of discrete systems; PID control design for digital systems; frequency domain control system design methods (PID, lead, lag, lead-lag compensation design) for continuous systems, and for digital systems using phase loss methods and bilinear transformations; z-transforms for discrete systems; digital control system design using root locus; deadbeat control design; nonlinear control design using feedback linearization; sliding control method; eigen-structure assignment methods; fuzzy logic; neural-net; and introduction to H-infinity control. (0304-743) **Class 4, Credit 4**

0304-844 Nonlinear Dynamical Systems
This course is an introduction to nonlinear systems theory and is intended for students in engineering and the physical sciences. Non linear systems are classified and analyzed using both analytical and computational methods. The emphasis is on the stability and bifurcation theory of discrete and continuous nonlinear systems. Specific examples from mechanics and other areas are discussed in detail. (0304-870) **Class 4, Credit 4**

0304-846 Modal Testing and Signal Processing
This course covers the important aspects of obtaining good modal data so that the natural frequencies, damping ratios, and mode shapes of a structure can be determined. Signal processing as applied to modal analysis will be covered including the auto- and cross-correlation functions, Fourier series and transforms, sampling and filtering and DFT/FFT theory. Transducers, excitation methods and commonly used practices in setting up a modal test will be discussed. Curve fitting techniques to extract modal parameters such as SDOF, MDOF, orthogonal polynomial and time domain will be covered. (0304-758) **Class 4, Credit 4**

0304-847 Microscale Heat/Mass Transfer
Deals with the effects of microscale dimensions on fluid flow, and heat transfer phenomena. The basic difference associated with these phenomena at microscale levels are presented through analytical equations, presenting theoretical aspects followed by practical examples. Topics covered include microscale heat conduction, heat transfer in thin film, transport equations for single-phase flow for high Knudsen number flows, gas compressibility, effects, single phase pressure drop equations for gases and liquids, heat transfer equations, laminar to turbulent transition, slip flow, transition flow, free molecular flow, two-phase flow considerations, and practical applications in micro-scale thermal and fluid flow devices. Each student will also work on an independent analytical or experimental project. (0304-413, 415, 416, 514. Consent of instructor) **Class 4, Credit 4**

0304-848 Special Topics-Thermal Fluids
In response to student and/or faculty interest, special courses that are of current interest and/or logical continuation of regular courses will be presented. (Graduate standing) See instructor for more details. **Class 4, Credit 4**

0304-851 Convective Phenomena
This course introduces the student to the flow of real incompressible fluids. The differential approach is used to develop and solve the equations governing the phenomena of mass, momentum, and heat transfer. The material in the course provides the necessary background for a study of computational fluid dynamics. (0304-415, 514) **Class 4, Credit 4**

0304-852 Advanced Turbomachinery
This course introduces the student to some of the advanced topics in turbomachinery. Topics include airfoil theory, two-and three-dimensional flow analysis in radial and axial turbomachines, and turbomachinery flow stability characteristics. Students are expected to do a design project using FLUENT Computational Fluid Dynamics code. (0304-550, 652) **Class 4, Credit 4**

0304-864 Production Tool Design
This is a course in the core group, CAD, of the manufacturing engineering option in the master of engineering degree program. Design of production tooling, jigs and fixtures for the economical manufacture of modern parts is covered in detail. The student must do research in current publications, and complete and present a project. Project selection can usually be arranged to incorporate an assembly of parts from the student's normal work. There will be field trips to local specialty firms. (Graduate standing) **Class 4, Credit 4**

0304-865 Computer Implementation of F.E.M.
This course emphasizes the application of the finite element method to problems in the area of static and dynamic structural analysis, heat transfer, and analogous solution. A standard commercial software package is used for these applications where the general structure, operating characteristics and use of a complex program are presented. Topics include the finite element method; shape factors, element formulation, and the element library; program sequencing; general modeling methods (loads, constraints, material factors, mesh generation, interactive graphics, model conditioning); convergence, error analysis and the "patch" test, vibration and heat transfer analysis, and analogous analysis such as acoustics, illumination, etc. (Graduate standing) **Class 4, Credit 4**

0304-870 Mathematics for Engineers I
A concise introduction to the concepts of matrix and linear algebra, including determinants, eigenvalues, systems of linear equations, vector spaces, linear transformations, diagonalization, orthogonal subspaces and the Gram-Schmidt orthonormalizing procedures. The use of complex exponentials in differential equations is introduced. Fourier series, Laplace and Fourier Transforms are also presented. (Graduate standing) **Class 4, Credit 4**

0304-871 Mathematics for Engineers II
Topics covered are orthogonal functions including Fourier Series, Fourier Integrals, Bessel functions, Legendre Polynomials, Sturm-Liouville problems and eigenfunction expansions; an introduction to calculus of variation including problems with constraints; vector analysis including the directional derivative, the gradient, Green's Theorem, the Divergence Theorem and Stokes' Theorem; Laplace transform methods. (Graduate standing) **Class 4, Credit 4**

0304-872 Analytical Mechanics
This is a course on advanced dynamics and variational methods. Newtonian vector mechanics and energy formulations are applied to two and three-dimensional problems involving discrete and continuous dynamical systems. The concepts of Virtual Work, Hamilton's Principle, and LaGrange's equations are thoroughly covered. Vibrations and multi-body systems are emphasized. The course also includes an introduction to the calculus of variations. (0304-543, 871) **Class 4, Credit 4**

0304-874 Numerical Analysis
This course emphasizes the development and implementation of methods available to solve engineering problems numerically. Specific topics include root finding for algebraic and transcendental equations, systems of linear and non-linear equations, interpolation of numerical data and curve fitting, numerical differentiation and integration, ordinary and partial differential equations, including initial and boundary value problems. (Graduate standing) **Class 4, Credit 4**

0304-875 Advanced Aerodynamics
This course covers the fundamental topics of aerodynamics and high speed flows. It discusses modern aerodynamic applications in the areas of wing and airfoil design, wind tunnel testing, and compressible flows. (0304-550 or 575, 838) **Class 4, Credit 4**

0304-877 Internship
This course number is used by students in the master of engineering degree program for earning internship credits. Students must submit a proposal for the internship, to be approved by an employing supervisor and the department prior to enrolling. Students are required to submit an evaluation report at the conclusion of the internship. **Variable credit 1-12**

0304-880 Independent Study
An opportunity for the advanced student to undertake an independent investigation in a special area under the guidance of a faculty member. A written proposal is to be forwarded to the sponsoring faculty member and approved by the department head prior to the commencement of work. (Graduate standing) **Variable credit (maximum of 4 credits per quarter)**

0304-885 Advanced Mechanics of Solids
This course extends the student's knowledge of stressed mechanical components covered in Mechanics of Materials and lays the foundation for a follow-on course in finite elements. The basic relationships between stress, strain, and displacements are covered in more depth. Stress and strain transformations, plane elastic problems, and energy techniques are covered. Topics from Advanced Strength of Materials include beam bending and torsion problems not covered in Mechanics of Materials. (0304-347) **Class 4, Credit 4**

0304-888 **Project with Paper**
This course is used by students in the master of engineering degree program for conducting an independent project. The student must demonstrate an acquired competence in an appropriate topic within mechanical engineering. The topic is chosen in conference with a faculty advisor. The work may involve an independent research and/or a design project and/or literature search with a demonstration of acquired skill. A written paper, approved by the advisor and the department, and an oral presentation of the work are required. **Credit 4**

0304-889 **Graduate Seminar**
This seminar course presents topics of contemporary interest to graduate students enrolled in the program. Presentations include off campus speakers, and assistance with progressing on your research. Selected students and faculty may make presentations on current research under way in the department. All graduate students enrolled full time (whether dual degree or single degree) are expected to attend each quarter they are on campus. **Credit 0 (F, W, S)**

0304-890 **Research and Thesis**
In conference with an advisor, a topic is chosen. Periodic progress reports and a final written document with an oral examination are required. (Approval of a thesis proposal approved by a thesis advisor and the department) **Variable credit 5–9**

Microelectronic Engineering

0305-701 **Microelectronics I**
This course introduces the beginning graduate student to the fabrication of solid-state devices and integrated circuits. The course presents an introduction to basic electronic components and devices, lay outs, unit processes common to all IC technologies such as substrate preparation, oxidation, diffusion and ion implantation. The course will focus on basic silicon processing. The students will be introduced to process modeling using a simulation toll such as SUPREM. Associated are a lab for on campus section (01), and discussion of laboratory results and a graduate paper for distance learning-section (90). The lab consists of conducting a basic metal gate PMOS process in the RIT clean room facility to fabricate and test a PMOS integrated circuit test ship. Laboratory work also provides an introduction to basic IC fabrication processes and safety. **Class 3, Lab 3, Credit 4 (S)**

0305-702 **Microelectronics II**
The fundamental silicon based processing that includes state-of-the-art issues such as thin oxide growth, atomistic diffusion mechanisms, advanced ion implantation and rapid thermal processing (RTP). Physical vapor deposition (PVD) to form conductive and insulating films introduced. Computer simulation tools (i.e. SUPREM) are used to model processes, build device structures, and predict electrical characteristics, which are compared to actual device structures that are fabricated in the associated laboratory for on campus (01) and discussion of laboratory results and a graduate paper for distance learning section (90). A bipolar IC process in conducted to build and test a variety of bipolar devices employing ion implantation. Extensive use of CAE and SUPREM. (0305-701) **Class 3, Lab 3, Credit 4 (W)**

0305-703 **Microelectronics III**
This course focuses on the deposition and etching of thin films of conductive and insulating materials for UIC fabrication. A thorough overview of vacuum technology is presented to familiarize students with the challenges of creating and operating in a controlled environment. Chemical Vapor Deposition (CVD) and electroplating technologies are discussed as methods of film deposition. Plasma etching and Chemical Mechanical Planarization (CMP) are studied as methods for selective removal of materials. Applications of these fundamental thin film processes to IC manufacturing are presented. Associated is a laboratory for on campus (01) and a graduate paper for distance learning (90). Labs include: vacuum pumpdown and evaporation, dc sputtering, reactive magnetron sputtering, chemical mechanical planarization, atmospheric and low pressure chemical vapor desposition and plasma and reactive ion etching. **Class 3, Lab**

0305-704 **Semiconductor Process and Device Modeling**
A senior graduate level course on the application of simulation tools for design and verification of microelectronic processes and operation of semiconductor devices. Technology CAD tools include MicroTec and Silvaco (Athena/Atlas) process/device simulators, as well as other simulation tools for specific processes, and math programs that can be used for custom simulation. Various models that describe front-end silicon processes are explored emphasizing the importance of complex interactions and 2D effects, as devices are scaled deep submicron. Includes laboratory exercises on simulation and modeling. (0305-560, 701, 702) **Class 3, Lab 3, Credit 4 (W)**

0305-705 **Quantum and Solid State Physics for Nanostructures**
This course describes the key elements of quantum mechanics and solid state physics that are necessary in understanding the modern semiconductor devices. Quantum mechanical topics include solution of Schrodinger equation solution for potential wells and barriers, subsequently applied to tunneling and carrier confinement. Solid state topics include electronic structure of atoms, crystal structures, direct and reciprocal lattices. Detailed discussion is devoted to energy band theory, effective mass theory, energy-momentum relations in direct and indirect band gap semiconductors, intrinsic and extrinsic semiconductors, statistical physics applied to carriers in semiconductors, scattering and generation and recombination processes. **Class 4, Lab 0, Credit 4 (F)**

0305-706 **SiGe and SOI Devices and Technologies**
This course introduces students to the fundamentals of SiGe and Silicon on Insulator (SOI) devices and fabrication technologies. The course will first discuss the band structure of the SiGe material system, and how its properties of band structure and enhanced mobility may be utilized to improve traditional Si devices. Basic heterojunction theory is introduced to students. Some specific applications that are introduced include heterojunction bipolar transistors (HBTs), SiGe-channel MOS devices, and high-electron mobility transistors (HEMTs). Fabrication technologies for realizing SOI substrates that include SIMOX and SMART CUTTM technologies are described. The physics of transistors built on SOI substrates will be discussed. At the completion of the course, students will write a term paper summarizing the literature in a key topical area of this course. **Class 4, Lab 0, Credit 4 (S)**

0305-707 **Nanoscale CMOS and Beyond**
An in-depth study of principles and practice of scaling-driven CMOS front and back end processing. The course discusses the Semiconductor Industry Association (SIA) International Technology Roadmap for Semiconductors (ITRS) and exposes students to the next generation of nanometer-scale CMOS with device concepts that include quantum mechanical phenomena such as channel confinement and dopant fluctuations. Front end processing includes super steep retrograde wells, high-k gate insulators, metal gate, and ultra shallow source/ drains. Back end topics include interconnect modeling and delay, Low k dielectric and copper damanscence processes. The use of novel substrates such as strained silicon, SiGe and Ge will be described. (0305-560, 701, 702, of nanometer-scale CMOS with device concepts that take advantage of 703) **Class 4, Lab 0, Credit 4 (W)**

0305-714 **Micro/Nano Characterization**
This mechanical elective with weekly lab component focuses on tools and techniques for micro- and nano-characterization of materials, surfaces and thin films. The course covers the principles and applications of four experimental techniques: quantitative imaging, x ray diffraction, scanning probe microscopy, and micro- and nano-indentation. Students will learn the physics of interaction processes used for characterization, quantification and interpretation of collected signals, and fundamental detection limits for each technique. (0304-344 or 1028-701 or 0305-460) **Class 3, Lab 2, Credit 4 (W or S)**

0305-721 **Microlithography Materials and Processes**
Covers the chemical aspects of microlithography and resist processes. The chemistry of positive (novolac-based) and chemically amplified resist systems will be studied. Topics include the principles of photo polymerization, including synthesis, photo absorption and emission, processing technologies and methods of process optimization. Also advanced lithographic techniques and materials, including multi-layer techniques for BARC, TARC, and silylation are applied to optical lithography. Associated lab for on campus section (01) and discussion of lab results and a graduate paper for distance learning section (90). In the lab, materials characterizations and process optimization are carried out using experimental design techniques. Processes to be studied include development rate monitoring, DUV resists, BARC, resist silylation and SEM evaluation of imaged resists and etched structures. **Class 3, Lab**

0305-722 **Microlithography Systems**
A course covering the physical aspects of lithography. Image formation in optical projection, optical proximity, and high-energy systems (DUV/VUV, e-beam/SCALPE, X-ray, and EUV) are studied. Fresnel diffraction, Fraunhofer diffraction, and Fourier optics are utilized to understand diffraction-limited imaging processes. Topics include illumination, lens parameters, image assessment (resolution, alignment and overlay), phase-shift masking, and resist interactions. Litho-graphic systems are designed and optimized through use of modeling and simulation packages. Current status of the practical implementation of advanced technologies in industry as well as future requirements will be presented. Lab for on campus section (01) and a graduate paper for distance learning section (90). Lab topics emphasize optical microlith modeling, illumination systems, reticle enhancement techniques, alignment and others. **Class 4**

0305-731 Microelectronics Manufacturing I
A course in CMOS manufacturing. Topics include CMOS process technology, work in progress tracking, CMOS calculations, process technology, long channel and short channel MOSFET, isolation technologies, back-end processing and packaging. Associated is a lab for on-campus section (01) and a graduate paper/case study for distance learning section (90). The laboratory for this course is the student-run factory. Lot tracking, data collection, lot history, cycle time, turns, CPK and statistical process control are introduced to the students. Silicon wafers are processed through an entire CMOS process and tested. Students design unit processes and integrate them into a complete process. Students evaluate the process steps with calculations, simulations and lot history, and test completed devices. **Class 3, Lab 3, Credit 4 (W)**

0305-732 Microelectronics Manufacturing II
A course in CMOS manufacturing. Topics include query processing, measuring factory performance, factory modeling and scheduling, cycle time management, cost of ownership, defect reduction and yield enhancement, reliability, 6 sigma manufacturing, process modeling and RIT's advanced CMOS process. Associated is a lab for on campus section (01) and a graduate paper for distance learning section (90). Laboratory experiences are related to the operation of the student run integrated circuit factory. Silicon wafers are processed through a complete CMOS process. (0305-731) **Class 3, Lab 3, Credit 4 (S)**

0305-760 Principles of Semiconductor Devices
This course will discuss the fundamentals underlying the operations of basic semiconductor devices employed in modern integrated circuits. The course includes modules on semiconductor fundamentals, p-n junction diodes, metal-semiconductor junctions, metal-oxide semiconductor capacitors, field effect transistors, and bipolar junction transistors presented through a series of lectures that qualitatively and quantitatively explain the operation of semiconductor devices. Each module features a segment on "deviations from ideality" that are observed in practical semiconductor devices and will provide insight into the constraints imposed by VLSI design rules and processing. This course is an online course only intended for professionals employed in various aspects of the semiconductor industry. **Class 4, Credit 4 (F, S)**

0305-770 Independent Study
This course number should be used by students who plan to study a topic on an independent basis under the guidance of a faculty member. A written proposal with an independent study form is to be submitted to the sponsoring faculty member and approved by the department head prior to the commencement of work. **Credit variable (maximum of 4 credits per quarter)**

0305-777 Internship
This course number is used to fulfill the internship requirement for the master of engineering degree program. The student must obtain the approval of the department head before registering for this course. **Credit variable**

0305-801 Seminar/Research
Weekly seminar series intended to present the state of the art in microelectronics research. Other research-related topics will be presented such as library search techniques, contemporary issues, ethics, patent considerations, small business opportunities, technical writing, technical reviews, effective presentations, etc. Required of all MS microelectronic engineering students for one credit up to total 4 credits total. After 4 credits, graduate students are required to register each quarter for zero credits. (Graduate standing in MS in microelectronic engineering) **Credit 0–1 (F, W, S)**

0305-830 Metrology for Yield and Failure Analysis
Successful IC manufacturing must detect defects (the non-idealities) that occur in a process), eliminate those defects that preclude functional devices (yield enhancement), and functionality for up to ten years of use in the field (reliability). Course surveys current CMOS manufacturing to compile a list of critical parameters and steps to monitor during manufacturing. This survey is followed with an in depth look at the theory and instrumentation of the tools utilized to monitor these parameters. Tool set includes optical instrumentation, electron microscopy, surface analysis techniques, and electrical measurements. Case studies from industry and prior students are reviewed. Students are required to perform a project either exploring a technique not covered in class, or to apply their course knowledge to a practical problem. (0305-560, 701) **Class 4, Lab 0, Credit 4 (F)**

0305-870 Microelectromechanical Systems
This course will provide an opportunity for students to become familiar with the technology and applications of microelectromechanical systems (MEMS)—one of the fastest growing areas in the semiconductor business. MEMS represents the integration of microelectronic chips with microsensors, probs, lasers, and actuators. Topics include basic principles of MEMS and fabrication methodologies. The accompanying laboratory will carry out design and fabrication of MEMS structures/devices using microfabrication techniques. **Class 3, Lab 3, Credit 4 (W, S)**

0305-890 Special Topics
This is a variable credit, variable special topics course that can be in the form of a regular course or independent study under faculty supervision. Some of the topics are SOI device technology, compound semiconductors and devices, quantum devices, and Nanotechnology. **Class 4, Lab 0, Credit 4**

0305-899 Thesis
The master's thesis in microelectronic engineering requires the student to prepare a written thesis proposal for approval by the faculty; select a thesis topic, adviser and committee; present and defend thesis before a thesis committee; submit a bound copy of the thesis to the library and to the department; prepare a written paper in a short format suitable for submission for publication in a journal; complete course work and thesis within a seven-year period; register for one credit of Continuation of Thesis each school term (except summer quarter) after the 45 credits required for the master's degree until the thesis is completed. (Graduate standing in MS in microelectronic engineering) **Class 0, Lab 0, Variable credit 0–9 (F, W, S, SU)**

Computer Engineering

0306-710 Network Modeling, Design and Simulation
This course covers theories for network design and modeling and case studies to apply the theories. Mathematical models, such as queuing theory, graph theory, and optimization techniques for analyzing network topology, traffic, and algorithms will be introduced. State of-the art network problems and solutions will be discussed and analyzed using the various network theories as well as net-work simulation tools (e.g., OPNET). Students are expected to actively research technical papers and participate in in-class discussions. Assignments include homework, exams, paper readings, projects, and individual presentations. (0306-381, 694; or permission of instructor) **Class 4, Credit 4**

0306-715 Wireless Networks
As interest in wireless technology is booming, wireless networks are enjoying very fast growth. This course covers fundamental techniques in design and operation of first, second, and third generation wireless networks: cellular systems, medium access techniques, radio propagation models, error control techniques, handoff, power control, common air protocols (AMPS, IS-95, IS-136, GSM, GPRS, EDGE, WCDMA, cdma2000, etc), radio resource and network management. As an example for the third generation air interfaces, wireless Internet and sensor networks are discussed in detail since they are expected to have a large impact on future wireless networks. This course is intended for graduate students who have some background on computer networks, but it is also open to senior undergraduates. (0306-694) **Class 4, Credit 4**

0306-720 Electronic Design Automation
The creation of large, complex electronic systems has grown beyond the capabilities of any number of designers without computer support. Successful completion of large design projects requires that computers be used in virtually all aspects of design. This course will investigate some of the basic design automation tools and algorithms in order to understand their capabilities, limitations and internal operations. Topics covered will be review of the VHDL hardware description language, simulation techniques, design synthesis, placement and routing, and design verification methods. Laboratory projects in the use and creation of design automation tools will be required. (0306-351, 0306-561 or equivalent; 0306 630/730 recommended) **Class 3, Lab 3, Credit 4**

0306-722 Advanced Computer Architecture
This course will emphasize the impact of VLSI and communication issues on computer architecture. Topics include highly concurrent, multiprocessor and reconfigurable computer systems as well as data flow architectures. Modeling techniques for system verification will also be included. (0306-551, 0605-720 recommended) **Class 4, Credit 4 (W)**

0306-724 High Performance Architecture
This course is an in-depth study of state-of-the-art high performance computer architectures. The primary objective of the course is to understand the architectural features used in modern processors and the corresponding impact on performance. The course material will be derived from current and recent micro-architecture research publications. The course includes programming assignments and a term paper. (0306-551) **Class 4, Credit 4 (W)**

0306-730 VLSI Design
An introduction to the design and implementation of Very Large Scale Integration (or VLSI) including NMOS and PMOS devices, CMOS circuits and digital subsystems. The procedures for designing and implementing digital integrated systems will be covered including the Mead and Conway structured design approach consisting of the use of stick diagramming, scaling of CMOS design rules and techniques for estimating time delays. Emphasis will be placed on the use of static CMOS circuits and regular structures such as programmed logic arrays in custom and standard cell-based designs. The use of workstations with Mentor Graphics design tools for circuit simulation and physical layouts will be stressed. Graduate level laboratory design projects will be required. (0306-561, 460 or equivalent) **Class 4, Lab 2, Credit 4 (F, S, SU)**

0306-731 VLSI Design Projects
A second course in the design and implementation of Very Large Scale Integration (VLSI) circuits and systems. Emphasis will be placed on the design and use of dynamic precharge and precharge-evaluate CMOS circuitry including Domino, NORA and Zipper CMOS logic, and sub-systems. Basic requirements of a clocking system and a general clocking strategy for timing design in both static and dynamic CMOS circuits will be investigated. Topics on the design and use of a standard cell library in the implementation of large system designs will be covered. The use of workstations with Mentor Graphics design tools and Synopsys synthesis tool suite will be required in laboratory projects leading to the design, VHDL synthesis and testing of an integrated circuit device. (0306-730) **Class 4, Lab 2, Credit 4 (S)**

0306-740 Analytical Topics for Computer Engineers
This course begins by reviewing signal and system analysis techniques for analyzing linear systems. It includes Fourier techniques and moves on to present fundamental computational techniques appropriate for a number of applications areas of computer engineering. A section on numerical linear algebra covers techniques for analyzing discrete time signals and systems. Other course areas are symbolic logic and discrete optimization techniques. (0306-451 and 1016-265, 314) **Class 4, Credit 4**

0306-741 Design for Testability
This course will introduce the concepts of failure mechanisms and fault modeling in digital circuits. It describes various test strategies for the digital systems. Techniques to integrate design and test for VLSI circuits will be included. Design for autonomous test, SCANPATH concepts and testability analysis will be discussed. Built-in self-test (BIST) techniques will be detailed. Concepts of easily testable logic will be introduced. In addition, testability bus and the boundary-scan techniques will be included for system level testability. (0306-730) **Class 4, Credit 4**

0306-756 Multiple Processor Systems
Introduces basic concepts of parallel and high-performance computing and current methodologies and trends in the design and programming of multiprocessor systems. Theoretical models of parallel computing and performance metrics are studied and contrasted with practical parallel system architectures, programming environments, and benchmarking techniques. Parallel architectures are classified according to mode and degree of parallelism, memory organization, and type and topology of interconnection networks used in the design. In depth study of various architectures in meeting demands with representative samples of current commercial machines included. Students complete programming assignments on a parallel computer illustrating practical issues. A review and analysis of a commercial parallel processor system or an active research area is required; written review presented in class. (0306-551) **Class 4, Credit 4**

0306-758 Fault Tolerant Digital Systems
This course address the following advanced topics: formal models and concepts in fault diagnosis, test generation, design for testability techniques, design techniques to achieve fault tolerance, system evaluation techniques, design of practical fault-tolerant systems, and fault-tolerant design of VLSI circuits and systems. (0306-561, 550) **Class 4, Credit 4**

0306-759 Principles of Digital Interfacing
The objective of this course is to give students basic concepts of interfacing to microcomputer bus systems, including familiarity with various peripheral components currently available. Students will gain experience in the actual implementation of microcomputer systems. The course is hardware oriented, but some high-level software will be required to make the experimental systems operational. (0306-561, 560) **Class 3, Lab 3, Credit 4 (F)**

0306-761 Engineering Design of Software
An advanced course moving the student beyond computer programming to the engineering of complex software systems. At the end of this class, students will be able to make the right selection of design methodologies or architectures, produce executable structure models that can be verified by computer, formulate a design that meets all functional and performance requirements, and perform trade-off analyses that enhance decision making. Students work in teams on large-scaled software projects. (Knowledge of software engineering process models and related activities, basic familiarity with a high-level programming language) **Class 4, Credit 4**

0306-762 Concurrent and Embedded Software Design
This course introduces methods for developing and designing concurrent software, which consists of many cooperating processes. Formal logical formulas are used to characterize sets of states and sets of program behaviors. The software is then analyzed by manipulating these logical formulas. Several classical concurrent programming problems such as critical section, producers and consumers, and resource allocation are examined. Practical examples and exercises are used to illustrate key are used to illustrate key points and evaluate design tradeoffs. (0306-761 or instructor permission) **Class 4, Credit 4**

0306-763 Embedded and Real-time Systems
A first course in an elective sequence begins by presenting a general road map of real-time and embedded systems. Conducted in a studio class/lab format with lecture material interspersed with lab work, this course introduces a representative family of microcontrollers exemplifying unique positive features as well as limitations of microcontrollers in embedded and real-time systems. Microcontrollers will be used as external, independent performance monitors of more complex real-time systems. Much of the material focuses on a commercial real-time operating system, using it for programming projects on development systems and embedded target systems. Fundamental material on real-time operating systems will be presented, including scheduling algorithms, priority inversion, and hardware-software co-design. (4010-361 and 0306-250 or equivalent, 4003-440 recommended) **Class 4, Credit 4**

0306-764 Modeling of Real-time Systems
This course introduces the modeling of real-time software systems. It takes an engineering approach to the design of these systems by analyzing a model of the system before beginning implementation. UML will be the primary modeling methodology. Non-UML methodologies will also be discussed. Implementations of real-time systems will be developed manually from the models and using automated tools to generate the code. (0306-763) **Class 4, Credit 4**

0306-772 Special Topics in Computer Engineering
Topics and subject areas that are not among the courses listed here are frequently offered under the title of Special Topics. Such courses are offered in a normal format; that is, regularly scheduled class sessions with an instructor. **Variable credit (no regular course schedule)**

0306-775 Robotics
This course is a seminar style survey of mobile robotics. The development of the field and an overview of the different approaches to mobile robot guidance (knowing where we are and where we want to go) navigation (formulating a plan to get where we want to go) and control (following a desired path) will be given. The emphasis of the course will be on algorithms and techniques. (0306-451) **Class 4, Credit 4**

0306-776 Robust Control
One of the most useful qualities of a properly designed feedback control system is robustness, i.e., the ability of the closed-loop control system to continue to perform satisfactorily despite large variations in the (open-loop) plant dynamics and the environment. This new approach has been successfully applied to high performance servo drive systems, unmanned aerial vehicles, visual feedback systems and mobile robots among others. This course will provide an introduction to state-of-the-art techniques for analysis and design of robust feedback systems. MATLAB will be used extensively for analysis, design and simulation. (0306-553 or equivalent, 1016-331 or equivalent is recommended) **Class 4, Credit 4**

0306-784 Digital Image Processing Algorithms
Emphasizes both theory and implementation of image processing algorithms. Two-dimensional sampling, transforms, and filtering are introduced and used for image enhancement, compression, restoration, segmentation, and applications in color and video processing. Project assignments involve Matlab implementation of algorithms and paper reviews. (0306-451, 1016-314) **Class 4, Credit 4**

0306-785 Computer Vision
This course covers both fundamental concepts and the more advanced topics in Computer Vision. Topics include image formation, color, texture and shape analysis, linear filtering, edge detection and segmentation. In addition, students are introduced to more advanced topics, such as model based vision, object recognition, digital image libraries and applications. Homework, literature reviews and programming projects are integrated with lectures to provide a comprehensive learning experience. (0306-451, 1016-314) **Class 4, Credit 4**

0306-790 Graduate Seminar in Computer Engineering
The purpose of the Graduate Seminar in Computer Engineering is to prepare graduate students to effectively conduct their thesis research. Current literature topics in the computer engineering discipline are reviewed through interactive presentations and discussions. Professional communications are stressed for the purpose of giving presentations and writing thesis documents and technical papers. Student assignments include literature surveys, in class presentations, and critical analysis reports. (Graduate standing or permission of instructor) **Class 1, Credit 1**

0306-794 Data and Computer Communications
Provides a unified view of the broad field of data and computer communications and networks. Emphasis is on the basic principles underlying the technology of data and computer networks. Critical issues in data communication networks as well as the current and evolving standards in computer communication architecture are discussed. The topology, access control and performance of various types of networks are studied in detail. A comprehensive student project is required. (1016-351 or permission of instructor) **Class 4, Credit 4 (F, W)**

0306-795 Networking Security
This course covers a set of advanced topics in the network area. The topics include advanced scheduling algorithms (e.g., WFQ), queue management schemes (e.g., RED), and network security (e.g., cryptography, DOS, key management, firewalls, etc.) In addition, network programming based on Java (RMI, UDP/TCP socket, etc.) and network simulation using C++ and OPNET will be introduced and carried as course projects. (0306-694 or equivalent, 0306-381 or equivalent) **Class 4, Credit 4**

0306-890 Thesis
An independent engineering project or research problem to demonstrate professional maturity. A formal written thesis and an oral defense are required. The student must obtain the approval of an appropriate faculty member to guide the thesis before registering. The thesis may be used to earn a minimum of 1 and a maximum of 9 credits. **Variable credit**

Applied Statistics

0307-711 Fundamentals of Statistics I
For those taking statistics for the first time. Topics include organizing observed data for analysis, understanding of variability, graphical methods, and summary statistics; simple, conditional, and joint probabilities; combinations, permutations; binomial, Poisson, and normal distributions; sampling distributions and the Central Limit Theorem. This course does not count as credit for either the CQAS advanced certificates or MS degree. **Credit 3 or 4**

0307-712 Fundamentals of Statistics II
Continuation of 0307-711. Topics include estimation, confidence intervals, and hypothesis testing; tests for independence and analysis of categorical data; two-sample problems; designed experiments with one or two factors; introduction to analysis of variance, simple and multiple linear regression, and correlation. This course does not count as credit for either the CQAS advanced certificates or MS degree. (0307-711 or equivalent) **Credit 3 or 4**

0307-714 Principles of Applied Statistics
Review of fundamental probability theory; review of key distributions in statistics; syntheses of key ideas; use of simulations; probability plotting; linear combinations of random variables; hypothesis testing; importance of assumptions; confidence intervals and other statistical intervals; goodness-of-fit tests; multiple comparisons. This course does not count as credit toward either the CQAS advanced certificate or MS degree. (0307-712 or equivalent) **Credit 3**

0307-717 Design and Analysis of Experiments I
How to design and analyze experiments, with an emphasis on applications in engineering and the physical sciences. Topics include the role of statistics in scientific experimentation: general principles of design, including randomization, replication, and blocking; replicated and un-replicated two-level factorial; de-signs, two-level fractional-factorial designs; response surface designs, and evolutionary operation. (0307-712 or equivalent, 0307-742 suggested) **Credit 3 or 4**

0307-721 Statistical Process Control
A practical course designed to provide in-depth understanding of the principles and practices of statistical process control. Topics include statistical concepts relating to processes, Shewhart charts for measurement and attribute data, CUSUM charts, EWMA charts, measures of chart performance, tolerances, specifications, process capability studies, short-run control charts. (0307-712 or equivalent) **Credit 3 or 4**

0307-731 Statistical Acceptance Control
How to apply modern process-oriented sampling plans to assess performance of product and processes. Topics include single, double, multiple and sequential sampling plans, variables sampling, techniques for sampling continuous production, skip-lot plans, chain plans, AOQL schemes, AQL sampling systems and recent contributions to literature. (0307-712 or equivalent) **Credit 3 or 4**

0307-742 Statistical Computing
This course focuses on the programming language used in SAS statistical software to read in raw data, create and manipulate SAS data sets, and create SAS macros. This course covers the material required for "SAS Base Programmer" certification. Students seeking employment in statistical professions are encouraged to attain this certification. Corresponding Minitab commands and macro programming will also be covered. (0307-712 or equivalent) **Credit 3**

0307-751 Mathematics for Statistics
This is a survey of the mathematical tools of some of the more rigorous statistics courses of the MS program. The topics include partial and higher-order differentiation, various methods of integration, the gamma and beta functions, and a brief overview of linear algebra, all in the context of application to statistics. (The course assumes calculus prerequisites for the program have been met; it is not a substitute for the program's calculus requirements.) (0307-712 or equivalent) **Credit 3**

0307-770 Design of Experiments for Engineering and Science
This course covers the fundamentals of the logical and economical approach to the design and analysis of engineering, scientific and industrial experiments. It integrates the essential organizational aspects of experimentation with proven statistical approaches. Designs covered include the two-level factorial and fractional factorial, response surface designs (CCD), blocking designs when randomization is restricted, nested designs to uncover sources of variation. The appropriate analysis methods complement the designs. Simulation modeling and robust design show the power and applicability of the information derived from the designed experiments. This course is intended for non-CQAS students. It does not count as credit for either the CQAS advanced certificates or MS degree. (Any of 0307-362, 712, 714, 1016-314, 319, 352 or equivalent) **Credit 4**

0307-772 Applied Survey Design and Analysis
This course is an introduction to sample survey design with emphasis on practical aspects of survey methodology. Topics include survey planning, sample design and selection, survey instrument design, data collection methods, and analysis and reporting. Application areas discussed will include program evaluation, opinion polling, customer satisfaction, product or service design, and evaluating marketing effectiveness. Data collection methods to be discussed will include face-to-face, mail, Internet and telephone. (0307-712 or equivalent) **Credit 3 or 4**

0307-781 Quality Management
This course focuses on ASQ's Certified Quality Manager body of knowledge and introduces process improvement methodologies, including the Six-Sigma framework. Topics include quality standards and awards, organization for quality, customer satisfaction, continuous improvement, team management, quality costs, project management, process improvement methodologies. **Credit 3 or 4**

0307-782 Quality Engineering
This course, in conjunction with 0307-781, covers the non-statistical elements in ASQ's Certified Quality Engineer body of knowledge. Topics include quality philosophies, elements of a quality system, quality planning, supplier management, quality auditing, quality and management tools, process and material control, measurement systems, and safety and reliability. **Credit 3 or 4**

0307-803 Design and Analysis of Experiments III
A continuation of the DOE sequence, covering more advanced, but applied, topics and providing a strong foundation for handling complex and non-standard situations. Topics include design and analysis of general, complete balanced designs, including continued study of variance components, mixed models, split-plot, and arbitrarily complex "no-name" designs; restricted and unrestricted forms of the model; design and analysis of general unreplicated designs; optimal designs for non-standard situations, using D optimality and related criteria. (0307-818, 0307-841; 0307-742 suggested) **Credit 3**

0307-818 Design and Analysis of Experiments II
Continuation of 0307-717, but with an emphasis on more general designs. Topics include completely randomized designs, randomized complete block designs, Latin square designs, incomplete block designs; general factorial designs, including fixed, random, and mixed-effects models and expected mean squares; nested designs; split plot designs. (0307-717; 0307-742 suggested) **Credit 3 or 4**

0307-821 Theory of Statistics I
This course introduces the student to the fundamental principles of statistical theory while laying the groundwork for study in the course sequel and future reading. Topics include classical probability, probability mass/density functions, mathematical expectation (including moment-generating functions), special discrete and continuous distributions, and distributions of functions of random variables. (1016-273 or equivalent and any of 0307-714/362, 1016-352 or equivalent) **Credit 3**

0307-822 Theory of Statistics II
Building on foundations laid in the first course, this second course in statistical theory answers some of the "How?" and "Why?" questions of statistics. Topics include the sampling distributions and the theory and application of point and interval estimation and hypothesis testing. (0307-821) **Credit 3**

0307-824 Probability Models
An introduction to stochastic processes, this course is intended to encourage a greater appreciation of statistical theory. Topics include Poisson processes and their relationship to uniform, exponential, gamma and beta distributions; the basics of queuing theory; and discrete-time Markov chains. Characteristic functions and using Taylor series to approximate the mean and variance of functions of one or more random variables are among miscellaneous topics. (0307-821) **Credit 3**

0307-830 Multivariate-Analysis Theory
Multivariate data are characterized by multiple responses. This course concentrates on the mathematical and statistical theory that underlies the analysis of multivariate data. Some important applied methods are covered. Topics include matrix algebra, the multivariate normal model, multivariate t-tests, repeated measures, MANOVA and principal components. (Basic matrix algebra; 0307-712 or equivalent; 0307-818 or equivalent; 0307-822 recommended; 0307-742 suggested) **Credit 3**

0307-831 Multivariate-Analysis Applications
This course includes some theory, but concentrates on the applications of multivariate analysis methods. The course relies heavily on the use of computer software. Topics include principal components, factor analysis, canonical correlation, discriminant analysis, cluster analysis and scaling. (Basic matrix algebra; 0307-712 or equivalent, 0307-830 is useful; 0307-742 suggested) **Credit 3 or 4**

0307-834 Multivariate Statistics for Imaging Science
This course introduces multivariate statistical techniques and shows how they are applied in the field of Imaging Science. The emphasis is on practical applications, and all topics will include case studies from imaging science. Topics include the multivariate Gaussian distribution, principal components analysis, singular value decomposition, orthogonal subspace projection, cluster analysis, canonical correlation and canonical correlation regression, regression, multivariate noise whitening, least squares energy minimization, and signal-to-noise optimization with generalized eigenvector (matched filter). This course is intended for students from the Imaging Science department. It does not count as credit for either the CQAS advanced certificates or the CQAS MS degree. (Basic matrix algebra; 0307-712 or equivalent; 0307-841 or equivalent is recommended) **Credit 4**

0307-841 Regression Analysis I
A course that studies how a response variable is related to a set of predictor variables. Regression techniques provide a foundation for the analysis of observational data and provides insight into the analysis of data from designed experiments. Topics include happenstance data versus designed experiments, simple linear regression, the matrix approach to simple and multiple linear regression, analysis of residuals, transformations, weighted least squares. (Any of 0307-362, 712, 1016-314, 352, 0307-818 is useful; 00307-742 suggested) **Credit 3 or 4**

0307-842 Regression Analysis II
A continuation of 0307-841. Topics include dummy variables, orthogonal polynomials, selection of best linear models, regression applied to analysis of variance problems, the geometry of least squares, ridge regression, generalized linear models, nonlinear estimation, and model building. (0307-841; 0307-742 suggested) **Credit 3 or 4**

0307-851 Nonparametric Statistics
This course emphasizes how to analyze certain designs when the normality assumption can not be made, with an emphasis on applications. This includes certain analyses of ranked data and ordinal data. The course provides a review of hypothesis testing and confidence-interval construction. Topics include sign and Wilcoxon signed-rank tests, Mann-Whitney and Friedman tests, runs tests, chi-square tests, rank correlation, rank order tests and Kolmogorov-Smirnov statistics. (0307-801) **Credit 3**

0307-856 Interpretation of Data
How to use statistics in troubleshooting processes and interpreting data. Topics include coordination of use of statistical measures, employing control charts in data analysis, outlier tests, analysis of small-sample data, narrow-limit gauging, analysis of means for variables and attributes data, identification of assignable causes. (0307-802) **Credit 3**

0307-862 Reliability Statistics I
A methods course in statistical aspects of reliability. Topics include the theory and application of exponential and Weibull lognormal and other models to reliability problems; censored data; probability and hazard plotting; series systems and multiple-failure modes; maximum likelihood estimation and likelihood inference; introduction to accelerated-life models and analysis. (1016-272, 0307-841; 0307-742 and 822 recommended) **Credit 3**

0307-873 Time Series Analysis and Forecasting
The course develops statistical methods in modeling and forecasting of time series data with emphasis on model identification, model fitting and diagnostic checking. Topics include survey of forecasting methods, regression methods, moving averages, exponential smoothing, seasonality, analysis of forecast errors, Box-Jenkins models, transfer function models. (0307-841) **Credit 3 or 4**

0307-883 Quality Engineering by Design
This course introduces the Taguchi approach to off-line quality control including loss function, signal-to-noise utility function, parameter design and tolerance design leading to improved products and processes at lower costs. During the presentations of the Taguchi concepts, full attention is given to the controversial aspects of these methods, the basis for the controversies, and alternatives to the methods that follow better statistical protocol. Students get to see the power of robust design in a set of carefully constructed exercises that illustrate the major components of parameter design and tolerance design. (0307-818; 0307-742 suggested) **Credit 3**

0307-886 Sample Size Determination
This course presents procedures to determine the proper sample size needed for the most commonly applied statistical methods. Topics include confidence intervals and hypothesis tests for the parameters of applied distributions and approximations to distributions. Sample size determination for designed experiments is covered extensively. (0307-818) **Credit 3**

0307-889 Independent Study Project
Credit will be assigned at the discretion of the candidate's instructor and will depend on the extent of the project. A written proposal will be required of the candidate and may be modified at the discretion of the instructor before approval is given to proceed. (Consent of instructor) **Credit 1, 2, 3, 6 or 9**

0307-891 Special Topics in Applied Statistics
This course number provides for the presentation of subject matter of important specialized value in the field of applied statistics not offered as a regular part of the statistics program. (Consent of instructor) **Credit 3**

0307-894 **Capstone**
This course is designed to provide a capstone experience for MS students at the end of the graduate studies, and will require a synthesis of knowledge obtained from earlier coursework (0307-822, 307-818, 0307-842, 0307-742, and consent of instructor) **Credit 3**

0307-895 **Statistics Seminar**
This course, required for full-time students, offers opportunities for additional learning through formal seminars, informal presentations, and special projects. **Credit 0**

0307-896 **Thesis**
For students working for the MS degree who are writing a research thesis. (Consent of department chair) **Credit 3, 6 or 9**

0307-899 **Individual Achievement Project**
Research project under faculty supervision for students working for the MS degree. (Consent of faculty supervisor) **Credit 1–9**

Microsystems Engineering

0308-711 **Microsystem Fundamentals**
This course covers the fundamentals of microsystems with emphasis on a broad range of applications. The course covers the underlying principles of micro-actuators and micro-sensors; analysis and modeling of micro-devices; scaling laws; microfluidics; photonics; microsystems fabrication processes; microelectromechanical (MEMS) and micro-optoelectromechanical (MOEMS) systems analysis; applications in the fields of telecommunications and sensing will be presented. **Lecture, Credit 4**

0308-720 **Independent Study**
This course number should be used by students who plan to study a topic on an independent basis under the guidance of a faculty member. A written proposal with an independent study form is to be submitted to the sponsoring faculty member and approved by the program director prior to the commencement of work. **Credit 4**

0308-721 **Micro-optics**
This course covers the propagation and diffraction of light and micro-optical components. Subjects covered: diffraction, Fourier optics, diffractive optical elements analysis and design, fabrication of micro-optic components and micro-optics for microsystems applications. (0301-474 or equivalent) **Class 4, Credit 4**

0308-731 **Integrated Optical Devices and Systems**
This course covers principles, analysis and design of integrated optical devices and systems. The integration of various active and passive optoelectronic devices in a system is the focus of the course. Topics include optical waveguides, optical couplers, semiconductor lasers, modulators, optical detectors, micro-optical resonators, photonic crystals, optical signal processing systems, design tools, fabrication techniques, and the applications of optical integrated circuits. Some of the current state-of-the-art devices and systems will be investigated by reference to journal articles. **Class 4, Credit 4**

0308-786 **MEMS Design**
Microelectromechanical systems (MEMS) are widely used in aerospace, automotive, biotechnology, instrumentation, robotics, manufacturing and other applications. There is a critical need to synthesize and design high-performance MEMS that satisfy the requirements and specifications imposed. Integrated approaches must be applied to design and optimized MEMS, which integrate microelectromechanical motion devices, ICs, and microsensors. This course covers synthesis, design, modeling, simulation, analysis, control and fabrication of MEMS. Synthesis, design and analysis of MEMS will be covered including CAD. (Fifth year BS/MS, MS and PhD students) **Class 4, Credit 4**

0308-798 **Microfluidic MEMS**
The course begins with an overview of microfluidic technology to provide a framework and to clarify the relationship of microfluidics to microelectromechanical systems (MEMS) and microsystems in general. Three major topics comprise the course: 1) selected elements of dic dynamics theory, and the scaling and application of that theory to microscale dimensions; 2) design, fabrication, and characterization of microfluidic devices and microsystems including exploration of major alternative fabrication technologies, process integration and materials issues, and device- and system-level packaging/encapsulation challenges; 3) applications, including microvalves, micropumps, microflow control sensor, and devices for chemical and biochemical valves, micropumps, microflow control sensor, and devices for chemical and biochemical analysis. **Class 4, Credit 4**

0308-799 **Nano and Microengineering**
This course focuses on analysis and synthesis of nano- and micro electromechanical systems and devices. Synthesis, design, optimization, analysis, control and fabrication of nano and microsystems will be covered. Utilizing basic physical laws of nano and micro-engineering, distinct systems and devices will be examined. The application of nano and microengineering in nanocomputers, avionics, security and transportation will be emphasized. Specific applications included are: super fast data processing and computing, data storage, imaging, molecular intelligent automata, etc. **Class 4, Credit 4**

0308-804 **MEMS Evaluation**
This course focuses on evaluation of MEMS, microsystems and microelectromechanical motion devices utilizing MEMS testing and characterization. Evaluations are performed using performance evaluation matrices, comprehensive performance analysis and functionality. Applications of advanced software and hardware in MEMS evaluation will be covered. (0301-786, 0305-870) **Class 4, Credit 4**

0308-811 **Microsystem Design and Packaging**
Design considerations; design process; mechanical design; photonic design; modeling; system integration; packaging technologies; microsystems packaging; assembly of microsystems; testing; design case studies. (0308-711) **Class 4, Credit 4**

0308-821 **Micro-Optics and Photonics**
Light propagation; passive optical components; micro-optics; digital devices; laser diodes; photodiodes; micro-optical systems; design case studies. (0308-711) **Class 4, Credit 4**

0308-831 **Micro and Nano-Photonics**
This course covers the generation and propagation of light in guided media. Subjects covered: two and three-dimensions slab wave guides, coupled-wave analysis, wave guide modeling and design, photonic crystals structures, photonic band gap devices in one and two dimensions and fabrication of photonic wave guides. (0308-721) **Class 4, Credit 4**

0308-841 **Advanced Microphotonics**
This course covers the latest advances in the field of microphotonics as published in the current literature. Subjects covered will include: silicon photonics as applied to light generation, detection and guiding, photonic crystals and microring resonators. The class format will be based on reviewing, analyzing and critiquing recent published research results in this field. Active student participation is required. (0308-721) **Class 4, Credit 4**

0308-890 **Dissertation and Research**
Research in an appropriate topic as arranged by doctoral candidate and dissertation advisor in fulfillment of the dissertation requirement. Department approval required. **Credit 0–4**

0308-990 **Doctoral Dissertation I**
Research in an appropriate topic as arranged by doctoral candidate and dissertation advisor in fulfillment of the dissertation requirement. Departmental approval required. **Credit 4**

0308-991 **Doctoral Dissertation II**
Research in an appropriate topic as arranged by doctoral candidate and dissertation advisor in fulfillment of the dissertation requirement. **Credit 8**

The College of Imaging Arts and Sciences

http://cias.rit.edu

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⇆ *Online learning option available*

Joan Stone, Dean

The College of Imaging Arts and Sciences offers the most comprehensive graduate imaging programs in the world, encompassing design, science, technology, engineering, management, crafts and fine arts. The college is a diverse, world-class collaboration of six schools: School of Art, School of Design, School for American Crafts, School of Photographic Arts and Sciences, School of Film and Animation and School of Print Media. Its scope gives students a perspective that can be found nowhere else—a place where some students create fine art using centuries-old methods while others push the edges of digital creativity. At no other university can students explore so many different aspects of the imaging fields to such a level of professional excellence. In addition, the college offers expertise in the professional aspects of running a studio or gallery.

Faculty

RIT's world-class faculty are noted for their excellence, from creating award-winning sculptures and visual communications to receiving international recognition as innovators in their fields. They excel in the practice of their profession, using state-of-the-art equipment and studio facilities supporting both course work and research. Their role as mentors is evidenced in the national awards won by their students.

Both graduate students and our alumni have received numerous prestigious awards:

- Students have won the Graduate Film Honorarium of the Princess Grace Award.
- A computer graphics design alumnus was awarded a Golden Globe.
- An emerging filmmaker has received the overall grand prize in the Adobe Flash Point Student Design Contest for multimedia projects.
- Computer graphics design students have won awards in the Macromedia Student Web Design Contest.
- Graphics design alumni have received awards of excellence from the Society of Technical Communications, both locally and internationally.
- Students have received a "finalist" designation in the People's Choice Awards at the Macromedia International User Conference and Exhibition.
- A computer graphics design graduate has received honors from *Communication Arts* and *I.D.* magazines for her interactive thesis project.
- An industrial design student has received an award from Volvo of North America for his winning child car seat in the Design for Automobile Safety Competition at the World Traffic Safety Symposium.
- Students from the School of Print Media have won the best paper award from Technical Association of the Graphic Arts.
- Current students and alumni have been peer-selected speakers at the Society for Photographic Education's national conference.

With this practical, professional experience, graduates' success upon employment is excellent. Their achievements represent what our programs are about—excellence through exploration and experimentation.

General Information

Master of fine arts degrees

The MFA is a professional degree for artists, designers, craftspeople, animators, photographers and filmmakers. Those seeking the MFA desire to leave a lasting impression on their fields by exhibiting dedication to their work, high standards of discipline and educational ideas. Students who possess a baccalaureate degree will develop expertise in their major area and related fields under the guidance of professionals.

The college sponsors many guest lectures, seminars and exhibits to further encourage personal and professional growth.

The MFA is generally a two-year, full-time program that requires the presentation of a visual thesis.

Acceptance for graduate study

Students are admitted to graduate study by action of the Graduate Committee. Enrollment in graduate courses does not constitute admission to the graduate program, and credit is not given for courses taken prior to acceptance unless the grade received in the course is a B or higher. In such cases, students, if admitted to graduate study, may petition for a grant of credit, but not in excess of 12 quarter credit hours.

A student who needs additional undergraduate study requirements may be admitted. This study will be structured for breadth or increased performance in areas designated, and will be determined at the time of acceptance.

Such prerequisites must be satisfied as defined in the letter of acceptance, which applicants will receive prior to admission as graduate students. Extended study may require additional time on campus. Human gross anatomy and biology, or equivalent content, are necessary for the MFA in medical illustration.

Upon full acceptance into any of the graduate programs, the student is considered qualified to pursue the degree. This status would change by evidence of poor performance in the program. A 3.0 grade point average must be maintained. A student is accepted into the program with the understanding of full-time status, unless granted part-time status at admission.

Admission as a nonmatriculated student

Students who have a baccalaureate degree and who wish to take particular courses may be admitted as nonmatriculated students to courses for which they are qualified. They may receive graduate credit, but it may not be submitted toward degree requirements. Students deficient in admission requirements or competence may take undergraduate courses, as advised, to qualify for admission.

Those coming from foreign countries where the baccalaureate is not given for programs in the practice of art may be admitted to graduate study if the diploma or certificate received approximates the standards of the BFA, BA or BS degrees, and their academic records and portfolios indicate an ability to meet graduate standards.

Admission requirements

Applicants should hold a baccalaureate degree in a field of the arts, sciences or education from a regionally accredited college in the United States or Canada, and demonstrate, through quality of the undergraduate record in creative production, a genuine, professional potential. (Please see section regarding nonmatriculated students.) The undergraduate degree should include 75 quarter credit hours (50 semester hours) in studio courses.

International students need a minimum score of 550 (paper-based) or 213 (computer-based) on the Test of English as a Foreign Language. Those coming from countries where the baccalaureate degree is not given for programs in the practice of art may be admitted to graduate study if the diploma or certificate received approximates the standards of the BFA, BA or BS degrees, and if their academic records and portfolios indicate an ability to meet graduate standards.

Applicants to the MFA program in computer graphics design must have an understanding of basic design principles and

computer skills. Software skills must include Adobe Photoshop, Macromedia Freehand or Adobe Illustrator, Macromedia Director and Flash.

To apply for admission to graduate study, a student must submit the following items:

Application: Submit a graduate application for admission, accompanied by the application fee, to the Office of Graduate Enrollment Services in the envelope provided in the application packet. When making a program choice, applicants should indicate the major on the application and the degree for which they are applying (master of fine arts or master of science in teaching). Some programs are sequential in nature and begin in the fall quarter only.* Art education is a full-time program offered only during the regular three quarters of the academic year.

** Major courses for art education, computer graphics design, graphic design, industrial design and medical illustration are offered only during fall, winter and spring quarters. Art education applicants should arrange a personal interview by calling (585) 475-7562.*

Transcripts Evidence of a baccalaureate degree is required. Official transcripts should be sent to the Office of Graduate Enrollment Services from all colleges and universities the applicant has previously attended.

Recommendations Two letters of recommendation from individuals familiar with the applicant's education/work experience should be submitted.

Personal statement Applicants should craft a personal statement of objectives as outlined in the admissions application. This statement should indicate in what manner RIT's graduate program would assist the student in attaining these goals. See the application form for directions.

Portfolio Each applicant must submit a portfolio of work to be considered for admission. Each graduate program has specific portfolio guidelines. Please consult with each program before constructing a portfolio.

Portfolio guidelines for graduate applicants

The MFA program in imaging arts-photography (in the School of Photographic Arts and Sciences) and all of the graduate programs in the School of Art, School of Design and School for American Crafts require the submission of a portfolio that will be used to assess applicants' performance and academic capabilities. Following are guidelines to be used when constructing a portfolio:

- Label the portfolio with the applicant's name and address (and e-mail address, if available). While every precaution is taken to ensure proper care and handling, the university assumes no responsibility for lost or damaged materials.
- A written description of contents must accompany the portfolio. Include project name, date, media used and purpose.
- Send portfolio and application materials to The Office of Graduate Enrollment Services.

The individual schools will keep applicants' portfolios until the graduate application, scholarship and assistantship process is completed. The portfolio will be returned if a return postage-paid envelope is enclosed. Any correspondence concerning applications, catalogs and portfolios should be addressed to the Office of Graduate Enrollment Services.

School of Art and School for American Crafts

Portfolios submitted to the School of Art and the School for American Crafts should consist of at least 20 to 40 examples of the applicant's best visual work. The work should be presented as 35mm slides, displayed in 8 ½" x 11" vinyl protective slide pages, or as a digital portfolio. (Additional computer files for video or interactive samples should be stand-alone files that will run on a MAC or PC.) For additional information on submitting a digital portfolio, or for a guide to shooting slides for use in a portfolio, please visit the Office of Undergraduate Admissions website at www.rit.edu/~960www/applyonline.php3.

School of Design

Portfolios submitted to the School of Design should contain samples of the applicant's work, including a combination of drawings, two- and three-dimensional design, photo imaging, website design, product renderings, CAD drawings, page layouts, etc. Visual content is dependent upon the applicant's experience and the program for which the applicant is applying. The portfolio should consist of 20 to 40 samples of the applicant's best work. Slides, CD-ROMs, DVDs or a combination is acceptable. They must be stand-alone files that will run on a MAC or PC.

School of Film and Animation

The portfolio submitted to the School of Film and Animation should contain the applicant's best visual work on CD or DVD. Slides should be submitted in sleeves, not in a carousel. Apple QuickTime movies and Mac-friendly CDs are preferred. For more information, refer to the graduate admissions application.

School of Photographic Arts and Sciences

The portfolio submitted for the MFA program in imaging art-photography in the School of Photographic Arts and Sciences must consist of 20 examples of the applicant's best work. Portfolio materials should be presented as 35mm slides, displayed in 8 ½" x 11" vinyl protective slide pages. CD-ROM and DVD are acceptable formats. For more information, refer to the graduate admissions application.

Transfer of credit

At the discretion of the Graduate Committee, 12 quarter credit hours (nine semester hours) of graduate work pursued at other institutions may be applied to specific course requirements. Transfer of credit will depend on the nature of the student's program and major, and must have been completed within the five preceding years. This evaluation will be made after one quarter of full-time study.

Policy regarding student work

The School of Art, School of Design and School for American Crafts reserve the right to retain student work for educational use or exhibition for a period of time not to exceed one and a half quarters beyond the year the object has been made.

Attendance regulations

All graduate programs utilize the studio, lab and/or shop experiences as an essential part of the educational program. Therefore, it is imperative that the student regularly attend all classes unless specifically excused for special projects or activities by the instructors. Failure to attend classes and complete assignments will be taken into consideration in grading.

Graduate scholarships, assistantship and other financial aid

To be considered for a graduate scholarship, please see the graduate application packet and submit required application materials by deadline indicated.

Applications for graduate and teaching assistantships are usually distributed in early spring to applicants and current graduate students. If you have questions, contact the appropriate school office: School of Art, (585) 475-7562; School of Design, (585) 475-7469; School for American Crafts, (585) 475-6114; Imaging Arts-Photography, (585) 475-2884; School of Film and Animation, (585) 475-7403.

Need-based financial aid, such as loans and grants, may be investigated through the Office of Financial Aid and Scholarship.

Bevier Gallery

During the year, RIT's Bevier Gallery presents a continuing series of important exhibitions planned to present new directions in the fields of art, design and the crafts, as well as to honor the works of the past. The gallery, an architecturally impressive building located on campus, serves to enrich the cultural life of the community and the university at large, as well as to inform and inspire the college's graduate body.

The faculty show, graduate thesis shows and the student honors show are annual events on the gallery calendar.

School of Art

www.rit.edu/~651bwww/ART/Art.html

Master of Fine Arts in Fine Arts Studio

http://cias.rit.edu/art/

Painting/Printmaking/Sculpture/New Forms

The master of fine arts studio program offers intensive study in painting, printmaking, sculpture, new forms and related media, leading to mastery in the fine arts field on a professional level. Moving from the sound fundamental backgrounds of their undergraduate art programs, students explore advanced techniques in painting, sculpture, new forms and nontoxic printmaking. These may be pursued singly and combined, or brought together with nontraditional media to create new forms. Faculty guidance focuses upon research strategies that support sequential studio production, leading to individual solutions.

Critical discussion is developed from the traditions of fine art and contemporary directions in our culture. These contemporary and historical concepts stimulate and provoke the development of an individual approach to expression. Along with engaging in critical dialogues, students progress toward the production of a body of work and a report for the master's thesis.

Gallery r, an art gallery in downtown Rochester operated by School of Art students, helps solidify the learning experience by bringing the work of our students to the greater Rochester community.

The following provides an overview of the degree requirements in the MFA studio art program:

Major Concentration	Qtr. Cr. Hrs.
Major	30
Minor	15
Studio Electives	18
Humanities	8
Forms of Inquiry	2
Graduate Forum	3
Thesis	48
Total	**90**

Master of Fine Arts in Medical Illustration

The master of fine arts program in medical illustration enables students to exhibit critical and creative thinking and problem solving through the accurate translation of medical and scientific concepts into effective visual support for instruction or advertisement. Students utilize effective research techniques and demonstrate efficient use of time and resources during concept and development of projects to satisfy course assignments. Entrance requirements include one year of biology and three courses in the following areas of study: histology, embryology, immunology, genetics, pathology or cellular physiology. The following provides an overview of the degree requirements in the MFA medical illustration program:

Major Concentration	Qtr. Cr. Hrs.
Major	36
Minor	15
Electives	15
Humanities	10
Thesis	14
Total	**90**

Admission requirements

Applicants should hold the baccalaureate degree in a field of the arts, sciences or education from a regionally accredited college in the United States or Canada. Applicants should also demonstrate, through the quality of the undergraduate record and

creative production, a genuine, professional potential. (Please see section regarding nonmatriculated students.) The undergraduate degree should include 75 quarter credit hours (50 semester hours) in studio courses.

International students need a minimum score of 550 (paper-based) or 213 (computer-based) on the Test of English as Foreign Language. Those coming from countries where the baccalaureate degree is not given for programs in the practice of art may be admitted to graduate study if the diploma or certificate received approximates the standards of the BFA, BA or BS degrees, and if their academic records and portfolios indicate an ability to meet graduate standards.

Master of Science for Teachers Programs

MST Visual Art

The MST in visual art leads to permanent New York state certification of art for grades K-12. This certification allows applicants to teach in New York state public schools and features pedagogical studies and student teaching. Master of science for teachers in art education is for those holding the BFA or BA (art major) degree. Classes begin in September and end in May. Graduates of teacher education programs at RIT have a 96 percent pass rate on the New York State Teacher Certification Examination.

Admission requirements

The applicant should have received a baccalaureate degree in an arts field from a regionally accredited college or university in the United States or Canada, with a major concentration in art, art education or industrial arts education. The applicant's undergraduate studies should include a minimum of 54 quarter credit hours (36 semester hours) in drawing, painting, design or the crafts. If the applicant for admission holds the BA or BFA degree and seeks the MST degree in art education, the undergraduate program must have adhered to the studio course distribution required by the New York State Department of Education.

The following provides an overview of the degree requirements in the MST art education program:

Major Concentration	Qtr. Cr. Hrs.
Education, Psychology, and Sociology	20
Art Education Concentration	22
Methods and Materials in Art Education, Seminar in Art Education, Practice Teaching Studio Electives	6
Total Credits	**48**

Master of Science in Teaching—Fine Arts Studio

The MST fine arts studio offers a master's option for students who have received "initial" teaching certification from another institution. Students combine major fine arts studio classes in painting, printmaking, sculpture, drawing and new forms with supporting courses, if desired, from graduate offerings in other schools and departments of the university. This MST option alone does not result in teacher certification. This program may be completed in one year.

Admission requirements

The MST fine arts studio program is offered to candidates who hold an undergraduate art education degree (with a minimum of 36 semester credits in art). Candidates need to be well-versed in studio production, art history and aesthetic and art criticism. Candidates must have in-depth knowledge of the subject matter they plan to teach as described in professional, state and institutional standards. Candidates must submit a slide portfolio representing their studio practice, a reflection essay on becoming an art educator and a completed graduate application form.

The following provides an overview of the studies covered by the degree requirements:

Major Concentration	Qtr. Cr. Hrs.
Fine Arts Studio	24
Humanities, Art History	8
Forms of Inquiry	2
Minor Concentration	9
Electives	5
Total	**48**

Advanced Certificate in Nontoxic Intaglio Printmaking

This advanced certificate program offers technical training and retraining for artists and printmaking professionals seeking a comprehensive working knowledge of nontoxic intaglio printmaking techniques, including a study of methodology and aesthetic applications.

	Qtr. Cr. Hrs.
2021-741 Non-Toxic Intaglio Printmaking I	4
2021-742 Non-Toxic Intaglio Printmaking II	4
2021-743 Non-Toxic Intaglio Printmaking II	4
Total	**12**

Admission requirements

To be considered for admission, candidates must submit the following: a letter of intent, a resume, a slide portfolio (between 10–20 slides) and a list of three references, with contact information. Candidates must either currently hold a BFA or an MFA or be recognized as a master printer or professional printmaker.

School of Design

http://cias.rit.edu/design

The School of Design offers three professional MFA degree programs: graphic design, industrial design and computer graphics design. These unique programs allow for advanced study that integrates creativity, philosophy, history, theory, applied

concepts and technology. Students who seek to advance their skills or change careers find our programs to be challenging and professionally based. The school sponsors guest lecturers, interdisciplinary projects and special events to encourage personal and professional growth.

The school also offers four cross-disciplinary courses. All graduate students in the School of Design's MFA programs take the following courses: Design Theory and Methods Seminar (2010-711), Design History Seminar (2010-713), Design Issues Seminar (2010-726) and Design Research (2014-713). These cross-disciplinary courses help to foster a sense of community among students and faculty, and encourage dialogue and interaction related to philosophy, process, practice, history, goals and responsibilities across the design disciplines.

The MFA programs in graphic design and industrial design require a fall entry. Computer graphics design prefers a fall entry but can be flexible, depending upon the student's qualifications/experience. The application deadline is February 15. Applications reviewed and accepted after the deadlines are based upon available space. Applicants may be placed on a waiting list.

Master of Fine Arts in Computer Graphics Design

Marla Schweppe, Coordinator
(585) 475-2754, mkspph@rit.edu

This internationally recognized program offers concentrations in motion graphics, instructional multimedia, game art and design, Web design and visualization. The curriculum combines knowledge of design theory, methodology and aesthetics with skills in two- and three-dimensional computer graphics, interactive techniques and interfaces. Students utilize cutting-edge technology to produce a vast array of dynamic work.

The program focuses on experimental and practical approaches to the expression of unique visions. Students create interactive installations, kiosks for museums, opening titles for movies, interactive animation, Web-based environments, virtual theater and computer games realized from their imaginations. Resources in the Digital Studio are accessible 24 hours a day, seven days a week and include three-dimensional digitizers, physical computer interfaces, motion capture systems, three-dimensional printers, monitor tablets and a wide variety of software applications.

As part of the entrance requirements, applicants must demonstrate an understanding of basic design principles and visual computer skills. Software skills must include: Adobe Photoshop, Adobe Illustrator, Maya, Apple Shake or Macromedia Flash.

MFA in Computer Graphics Design	Qtr. Cr. Hrs.
Major Studio Courses	45
Elective/Minor	17
Academic Courses	14
Thesis	14
Total	**90**

Master of Fine Arts in Graphic Design

Deborah Beardslee, Coordinator
(585) 475-2664, dabfaa@rit.edu

Graphic design is a professional major that addresses advanced visual communication problems, with an emphasis on meaning, form and function. In a professional studio setting, students work with faculty on the understanding and implementation of design process, design theory, history and criticism, research methods, visual aesthetics, systems design, information design, ethics and values, project development and evaluation, and cross-disciplinary problem-solving methods.

Course work and thesis projects incorporate both theory and application in the solution of hypothetical or actual design problems. Courses within this major evidence a balanced approach toward the application of electronic media and traditional processes. Final design outcomes may range from small- or large-scale, two-dimensional printed artifacts to electronic, time-based, and/or interactive applications. Special lectures, guest speakers, exhibitions and workshops complement studio work. Student projects also utilize other RIT resources such as the Graphic Design Archive and the Cary Graphic Arts Collection.

MFA in Graphic Design	Qtr. Cr. Hrs.
Major	28
Design Core	12
Minor	15
Electives	11
Liberal Arts	12
Thesis	12
Total	**90**

Master of Fine Arts in Industrial Design

David Morgan, Coordinator
(585) 475-4769, dcmfaa@rit.edu

The master of fine arts degree program is available for students pursuing specialized study in industrial design at the graduate level for the purpose of career enhancement or redirection. The educational experience is project-oriented, requiring research into design methods and technologies. Cross-disciplinary collaboratives provide an experiential dimension.

The first year of study includes seminar courses in design history, issues, research, theory and methods, which are common to all graduate students in the School of Design. In addition, there are studio courses that involve extensive design work with respect to environmental issues, the meaning of artifacts and critical analysis. Extensive course work using three-dimensional software for product modeling and animation fills out the program.

In the second year, students conduct research and develop a thesis project, which is presented in a graduate thesis exhibition or presentation and is documented in a written thesis report.

MFA in Industrial Design	Qtr. Cr. Hrs.
Major	39
Electives/Minor†	21
Design Core	12
Liberal Arts	4
Thesis	14
Total	**90**

† Minors are declared within the College of Imaging Arts and Sciences and in other colleges at the university. This is done with approval from the individual program's graduate adviser/coordinator: The minor should support the goal of the MFA degree.

School for American Crafts

www.rit.edu/~652www/

Master of Fine Arts

The MFA is a professional degree for practicing artists, craftspeople or designers who desire to leave a lasting impression on their fields by devotion to their work and high standards of discipline and artistic ideals. The MFA is generally a two-year, full-time program that involves the presentation of a thesis. The thesis includes written documentation and the formal exhibition of a body of work.

MFA in American Crafts	Qtr. Cr. Hrs.
Major	42
Humanities	10
Graduate Forum	3
Electives (optional minor)	15 (18)
Thesis	18
Total	**90**

Studio residence program

The School for American Crafts offers a craft residence program. Participants are accepted in the ceramics, glass, metals and wood studios.

Residence positions are limited and are awarded after the review of all applicants' portfolios, transcripts and references. An interview is required. Accepted studio residents are required to register for at least two credits of independent study during every quarter of residence. These two credits can be taken as an audit, thus reducing the tuition cost to the resident.

Accepted residents are expected to be present in their assigned studio during class hours and to contribute up to 10 hours of work per week in the main studio. These work hours will be coordinated and overseen by the major faculty in the area. In exchange, the school will provide workspace, access to facilities and supportive instruction. The resident is invited to participate in the full range of studio activities.

Participants may be people seeking additional studio experience prior to undergraduate or graduate study, early career professionals or teachers on leave who wish to work again in an academic studio environment. The major faculty in the area will make decisions concerning appropriate candidates.

Inquiries should be made to the Residence Program, College of Imaging Arts and Sciences, School for American Crafts, Rochester Institute of Technology, 73 Lomb Memorial Drive, Rochester, NY 14623-5603.

Admission requirements

Applicants should hold a baccalaureate degree in a field of arts, sciences or education from a regionally accredited institution in the United States or Canada. Applicants should demonstrate, through the quality of the undergraduate record and creative production, a genuine, professional potential. (Please see section regarding nonmatriculated students.) The undergraduate degree should include 75 quarter credit hours (50 semester hours) in studio courses.

International students need a minimum score of 550 (paper-based) or 213 (computer-based) on the Test of English as a Foreign Language. Those coming from countries where the baccalaureate degree is not given for programs in the practice of art may be admitted to graduate study if the diploma or certificate received approximates the standards of the BFA, BA or BS degrees, and if their academic records and portfolios indicate an ability to meet graduate standards.

Master of Fine Arts in Ceramics

The ceramics studio embraces the contemporary spectra of aesthetic ideas and innovative techniques to educate and train professional artists/craftspeople. It strives to support students' career goals with pragmatic information and suitable facilities and equipment.

Our structured courses address specific issues inherent to utilitarian pottery, vessel aesthetics, ceramics sculpture and mixed media. The ceramics program also receives substantial reinforcement from the other craft studios because they, too, explore similar formats and concerns that face artists and craftspeople in the 21st century.

Master of Fine Arts in Glass

This two-year program is structured on the basis of individual needs, interests and professional preparation, as may be determined through individual/group discussions. A rapid series of exploratory works is developed during the first year, with emphasis on broadening technical and aesthetic understanding. The second year's focus will be on developing a body of work based on a sustained interest from the first year's investigation. The final work must be supported by a written thesis, a high-quality portfolio and an exhibition.

Master of Fine Arts in Metals

This program is structured on the basis of individual needs, interests and background preparation, as may be determined through faculty counseling. The program gives the student a broad exposure to metal working techniques, expands the student's knowledge of applied design, strengthens perceptual

and philosophical concepts and develops an individual mode of expression. This sequence leads to the master's thesis, inaugurated by the student and overseen by the faculty.

Master of Fine Arts in Wood

This program leads to the MFA degree in the studio arts. Men and women come to the program from diverse backgrounds such as architecture, interior design, industrial design, art history, law and teaching, as well as undergraduate wood programs. In the first year, students identify issues in their technical and aesthetic background and, along with faculty, create a program of study to address these areas. Simultaneously, they discover directions in their work that are promising for further exploration. Based upon this experience, they develop a thesis proposal and, in the second year, create a comprehensive body of work. This work culminates in the end-of-the-year graduate thesis exhibition in the college gallery and a written thesis in support of the work.

School of Print Media

www.rit.edu/printmedia

The graphic communication industry is large and extremely varied. The field continues to be driven by changes in technology. With state-of-the-art facilities and technology, internationally renowned faculty and an unequaled offering of courses, RIT's School of Print Media is widely considered the premier provider of graphic communications education in the world. Our programs offer students the tools necessary to be successful as a manager and leader in the graphic communications industry.

Graduates from the School of Print Media are working as professionals in production management, marketing, technical sales, research and development, quality assurance, administration, education and other areas. A graduate degree from the School of Print Media attracts leading employers from every graphic discipline. The master of science degree in print media has had a greater than 95 percent placement rate for the past several years.

Admission requirements

Prior to being admitted to a master of science degree program, applicants must show the Graduate Admission Committee of the School of Print Media that their previous training, ability and practical experience indicate a reasonable chance of success.

Requirements

- A bachelor's degree from a four-year program in an accredited college or university
- An undergraduate grade point average of 3.0 or higher
- A completed application form, including official transcripts, personal statement and two letters of recommendation

GRE requirements

Applicants should submit Graduate Record Examination scores. Minimum required scores are 500 (V), 650 (Q) and 3.5 (A). International students must submit scores from the Test of English as a Foreign Language. Minimum scores should be 550 (paper-based), 213 (computer-based) or 79 (Internet-based).

Students are encouraged to apply to the graduate program at any time during the year. To be assured of the best opportunity for admission and scholarships, students interested in the on-campus program should have their application process completed by April 1. Applications received later than April 1 will be considered on a space-available basis.

Foundation program

The Foundation Program is common to the graduate programs within the School of Print Media. During the admissions process, the graduate program chair evaluates the background of an applicant to determine whether a portion of the Foundation Program might be waived because of prior course work or work experience.

The Foundation Program involves the following course work:

0307-711	Fundamentals of Statistics I (or equivalent)
2082-303	Professional and Technical Writing (or equivalent)

If the applicant has taken Technical Writing and Statistics I as an undergraduate, the requirement may be waived. If not, these courses may be taken at RIT or another undergraduate institution.

Master of Science in Print Media

Twyla J. Cummings, Graduate Program Chair
(585) 475-5567, tjcppr@rit.edu

The print media program provides an in-depth understanding of technical printing and imaging concepts, as well as exposure to high-level research methods. Although this program provides broad exposure to the graphic communication industry, it allows students an opportunity to specialize in a relevant technical or business area. The program offers the maximum flexibility in terms of tailoring the program to meet individual needs. Recent students have focused on information technology, imaging science and business, depending upon interest and aptitude.

Curriculum		Qtr. Cr. Hrs.
2081-701	Research Methods and Trends	4
2081-711	Tone and Color Analysis	4
2081-716	Grad Materials and Processes I	4
2081-717	Grad Materials and Processes II	4
2081-747	Cross-Media Workflow I	4
2081-748	Cross-Media Workflow II	4
0307-712	Fundamentals of Statistics II or equivalent	4
2081-890	Thesis	4
	Minor Concentration	16
Total		**48**

Minor concentration options

Minor concentration courses are selected by the student to develop additional expertise in a particular area of interest. The degree offers flexibility in terms of tailoring the program to meet individual needs. The electives and minor concentration courses are comprised of selected courses offered by the College of Imaging Arts and Sciences or other RIT colleges. All courses must be preapproved by the graduate program chair.

Proposed plan of study

Fall Quarter		Qtr. Cr. Hrs.
2081-701	Research Methods and Trends	4
2081-716	Grad Materials and Processes I	4
0307-712	Fundamentals of Statistics II	4

Winter Quarter		Qtr. Cr. Hrs.
2081-711	Tone and Color Analysis	4
2081-717	Grad Materials and Processes II	4
2081-747	Cross Media Workflow I	4
	Minor Concentration	4

Spring Quarter		Qtr. Cr. Hrs.
2081-748	Cross Media Workflow II	4
	Minor Concentration	4
	Minor Concentration	4

Summer Quarter (options)		Qtr. Cr. Hrs.
	Research - Fellowships, PIC, Grad Co-op	
	Grad Assistantships	

Fall Quarter		Qtr. Cr. Hrs.
2081-890	Thesis	4
	Minor Concentration	4
	Full-Time Equivalency	

Winter Quarter		Qtr. Cr. Hrs.
2081-890	Continuation of Thesis	
	Full-Time Equivalency	

Spring Quarter		Qtr. Cr. Hrs.
2081-890	Continuation of Thesis	
	Full-Time Equivalency	

Thesis

All students in the on-campus print media graduate programs are required to complete a research thesis that demonstrates original thinking and creativity in the search for new knowledge in the graphic communications industry. Students select topics in which they have an intense interest, exhibiting a desire to contribute to the body of knowledge in the industry. Fellowship awards often are available to help fund research. Students may not register for thesis prior to the fall quarter of their second year.

Online option

Next-generation technologies are transforming the workplace and creating new challenges for the entire graphic communications industry. The competitive and fast-changing nature of today's marketplace requires printing and publishing professionals who can react to market needs more quickly than ever before.

To assist students in preparing for these changes in the workplace, the master of science degree is available online. For working professionals who cannot participate in a full-time program, RIT's online curriculum can be completed in two years (two courses per quarter). The courses are as rigorous as those taught on campus. People with full-time jobs may wish to start with one course per quarter.

Course material is presented in many forms: Web resources, multimedia, video and audio lectures and demos, and one-on-one interaction with faculty via e-mail and chat conferences. Online courses receive the same course credit, and are taught by the same faculty, as on-campus courses.

This degree program is oriented toward individuals in technical and management positions within the printing and publishing industry. Whether you aim to strengthen your resume or explore new career directions, this degree can help you achieve your goals.

Curriculum (Online Option)		Qtr. Cr. Hrs.
2081-767	Media Industry Analysis	4
2081-709	Printing Industry: Trends and Issues	4
2081-711	Tone and Color Analysis	4
2081-721	Digital Printing and Publishing	4
2081-723	Contemporary Publishing	4
2081-728	Database Publishing	4
2081-740	Technology Practicum	2
2080-840	Project Design	2
2081-840	Research Projects	4
	Electives	16
Total		**48**

Advanced Certificate in Digital Print and Publishing

Digital technologies are continuing to transform the workplace and create new challenges for the entire graphic communications industry. The competitive and ever-changing nature of today's marketplace requires printing and publishing professionals who can react to market needs more quickly than ever before.

The advanced certificate in digital print and publishing was created with the following goals in mind:

- to help students understand the advantages of customized, personalized publishing products, especially in terms of marketing goals;
- to facilitate learning about digital technologies that support publishing objectives, in particular, on-demand publishing;
- to promote an understanding of how information must be structured to achieve certain publishing objectives;
- to examine the advantages and disadvantages of various digital printing technologies; and
- to provide in-depth knowledge of various segments of the publishing industry.

The advanced certificate in digital print and publishing certificate is open to all students who qualify for graduate study. Credit earned through this certificate may be applied to the MS in print media.

On-campus requirement

In the summer, students are required to attend a one-week Technology Practicum (2080-740) course on campus. This course gives students a hands-on opportunity to familiarize

themselves with the digital software and hardware, as well as the conventional systems that make up the workflows in today's imaging and printing systems.

Advanced certificate, digital print and publishing		Qtr. Cr. Hrs.
2081-721	Digital Print and Publishing	4
2081-723	Contemporary Publishing	4
2081-728	Database Publishing	4
2081-740	Technology Practicum	2
2080-799	Independent Study	2
Total		**16**

Laboratory facilities

Within the School of Print Media, students have full access to powerful tools for learning in our cutting-edge laboratory facilities. The campus is wired to provide instant access to information resources with more than 500 computer workstations dedicated for student use in the College of Imaging Arts and Sciences alone. Our print media labs include:

- **Prepress and Publishing Lab,** featuring 25 fully configured and networked dual-processor Macintosh G5 workstations, the latest graphics and imaging software, scanners and a complete selection of output devices.
- **Design and Color Lab,** containing 25 fully configured and networked flat-screen "superdrive" Macintosh G5 computers loaded with the latest design, imaging and multimedia software.
- **Advanced Publishing Lab,** containing 14 fully configured and networked Macintosh G5 computers loaded with cutting-edge graphics, imaging and database publishing software.
- **Color Proofing Lab,** featuring the Kodak Approval digital color proofing system in addition to other state-of-the-art color proofing systems.
- **Desktop Scanning Lab,** a facility that reflects the growing range of image-capture tools available to professionals, including high-end flatbed and drum scanners.
- **Color Measurement Lab,** addressing the growing industry focus on managing color and containing spectrophotometers, colorimeters and color profiling, and color analysis software.
- **Digital Printing Lab,** one of the few educational facilities in the world that houses a full array of digital color printing equipment.
- **Web Offset Lab,** which has developed from a partnership development with Heidelberg based on the donation of a world-class Goss Sunday 2000 six-color commercial web offset press.
- **Print Science Laboratory,** a materials research and teaching laboratory housed in the Gannett Building and the Center for Integrated Manufacturing Studies; home to the materials and process course series, among other print science courses, and the activity center for materials research in the field of printing.
- **Integrated Printing Lab,** containing a Heidelberg Speedmaster six-color press and a Creo Trendsetter; for flexography, there is a Mark Andy multicolor web press.

School of Film and Animation

www.rit.edu/~sofa/

The School of Film and Animation offers the master of fine arts degree in imaging arts, with concentrations in computer animation, traditional animation and narrative and documentary film.

Master of Fine Arts in Imaging Arts—Animation, Film, Video Production

Malcolm Spaull, Coordinator, MFA Program, Film and Animation
(585) 475-7403, mgscdm@rit.edu

The master of fine arts program in film and animation emphasizes a broad interpretation of the moving image as an art form, with the intention of inspiring and nurturing the individuality of each student as a creative, productive person. The program encourages graduate study in filmmaking and animation as a means to personal aesthetic, intellectual, and career development.

The MFA curriculum provides a flexible pattern of study that is continually sensitive to the needs of each student, building upon the strengths that each individual brings to the program. A full range of courses in two-dimensional computer animation; three-dimensional computer animation; drawing for animation; stop motion animation; and documentary, experimental, and narrative film are available. Successful completion of the program enables a student to seek a career in film or animation production.

Program goals

1. Provide students with the opportunity to use animation, filmmaking and other imaging arts as a means to pursue a career and earn a livelihood.
2. Provide students with the opportunity to use animation, filmmaking and other imaging arts as a means to enrich their personal lives and society as a whole.
3. Provide a nurturing intellectual environment that encourages a sense of community, creativity, scholarship and purpose.

Degree requirements

The MFA degree in imaging arts normally requires a minimum of two years of full-time course work as a resident graduate student and completion of a thesis film. A minimum of 90 quarter credit hours of graduate work is outlined below. The 90 hours do not include undergraduate work required by action of the MFA admission committee in accepting a

particular applicant, nor do they include undergraduate prerequisites for graduate courses.

Computer and traditional animation

The computer animation concentration incorporates courses in two-dimensional and three-dimensional computer and camera animation.

The computer animation concentration consists primarily of courses in single-frame filmmaking, taught in the School of Film and Animation, and programming courses, offered by the computer science and information technology programs of the B. Thomas Golisano College of Computing and Information Sciences. Course work includes exercises and major projects in both two- and three-dimensional computer animation, as well as support courses in filmmaking technique and interactivity.

The computer animation degree encompasses 90 quarter credit hours of course work in the following areas of study:

1. Concentration (computer animation) designed to give depth of experience in the area of the student's primary interest. All students must complete required courses; other course work is selected from many flexible alternatives. (40 quarter credit hours)
2. History and aesthetics of film and related art forms (12 quarter credit hours)
3. Programming (8 quarter credit hours)
4. Electives (12 quarter credit hours)
5. Research Seminar, Graduate Seminar and Research and Thesis (18 quarter credit hours)

Distribution of work within these guidelines is subject to modification based upon the candidate's background, abilities, and interests. An individualized course of study will be prepared with the advice of the graduate faculty and made a matter of record. Modifications in this prescribed program thereafter must be approved and recorded.

Film concentration

The film concentration incorporates courses in film, digital video and scriptwriting. Students produce fiction, documentary, and experimental films. The film degree encompasses 90 quarter credit hours of course work in the following areas of study:

1. Concentration (film) designed to give depth of experience in the area of the student's primary interest. All students must complete required courses; other course work is selected from many flexible alternatives. (40 quarter credit hours)
2. History and aesthetics of film and related art forms (20 quarter credit hours)
3. Electives (12 quarter credit hours)
4. Research Seminar, Graduate Seminar, and Research and Thesis (18 quarter credit hours)

Distribution of work within these guidelines is subject to modification based upon the candidate's background, abilities and interests. An individualized course of study will be prepared with the advice of the graduate faculty and made a matter of record. Modifications in this prescribed program thereafter must be approved and recorded.

General Information

Electives

Elective courses are available in animation, film, video, multimedia, screenwriting, printmaking, painting, sculpture, communication design, museum studies, crafts, bookmaking, typography, color photography, new media, studio photography, advertising photography, perception, sensitometry, computer graphics, art history and archival preservation and conservation. There are also opportunities for independent studies, internships and concentrations.

The faculty

The MFA in imaging arts computer animation program is supported by a staff of 13 full-time faculty members with the School of Film and Animation and a variety of adjunct faculty members. Faculty and course work also are available from the School of Photographic Arts and Sciences, School of Print Media, School of Art, School of Design, School for American Crafts and the College of Liberal Arts.

Admission requirements

Students with a baccalaureate degree or equivalent from an accredited college or university, or equivalent, are eligible for admission, provided they present a portfolio of work that demonstrates their skills, visual sophistication and aesthetic awareness. Acceptance depends on the strength of portfolios as judged by the graduate faculty, past academic performance, letters of recommendation and personal statements of purpose.

There are no examination requirements for admission to this MFA program. If applying with an undergraduate GPA of less than 3.0, however, the GRE or GMAT test is strongly recommended. Applicants who are capable of good academic work as well as artistic visual expression and who demonstrate an interest in the exploration of new artistic ideas and experiences will be favored. The graduate faculty will make recommendations based on the above interlocking criteria.

Students who are evaluated to have MFA potential but need additional study in preparation for graduate courses will be advised to take such courses either prior to entrance or during their first year of study. The graduate faculty will make recommendations.

To apply for admission, students must submit an official transcript of their undergraduate degree(s), an acceptable portfolio (slides, videotape, CDs, etc.), a statement of purpose detailing why they want to attend graduate school and what they will bring to the program and a minimum of two letters of reference. All correspondence concerning applications or

catalogs should be addressed to the Office of Graduate Enrollment Services.

Transfer credit
Graduate-level course work taken prior to admission to the program should be submitted for approval upon entrance into the program. Up to 12 quarter credit hours (8 semester hours) of graduate work with a grade of B or better is transferable and may be counted toward the MFA degree, with the approval of the graduate faculty.

Portfolio
The portfolio, along with written records of accomplishment and recommendations, serves to inform the faculty of the applicant's imaging accomplishments. It provides a visual statement of the candidate's performance to date in terms of his or her skills, aesthetic development and maturity.

Applicants are encouraged to submit their best visual work in their portfolio, whether computer-generated or not. Photography, painting, film, animation, illustration, webpage design and other forms of visual expression can be included. Do not send master tapes or originals of any work. We strongly prefer all digital media to be Macintosh compatible. For CDs, the only type of movie files we can accept are QuickTime. We will not accept slide carousel trays. Slides should be submitted in plastic sleeves.

Admission selection for the fall quarter in the imaging arts program is made in the spring from among all portfolios and completed applications received. Applications should be postmarked by February 15 to optimize the opportunity for fall admission. Portfolios and completed applications will be reviewed as they are received. Once the available slots are filled, qualified candidates will be placed on a waiting list, and any slots that open will be filled by the candidate at the top of the list.

Along with the submission of the student's work, a list detailing the contents of each tape should be included. The list should detail the title and length of the work, as well as the applicant's role in the production of the piece. Please include a table of contents on CDs and DVDs.

Submit the portfolio with the application material to the Office of Graduate Enrollment Services.

Grades and time limit
The average of all grades for graduate credit taken at the university must be at least a B (3.0) to qualify for the MFA imaging arts degree. Thesis hours are usually taken over several quarters. Only the letter "R" is recorded, indicating a thesis in process. No letter grade is assigned. Acceptance or rejection of the thesis is made by the candidate's thesis board and the graduate faculty. All course work, including an accepted thesis, must be completed within seven years of entrance into the program.

Screenings
Screenings are required for all student-produced films and are coordinated through the professor or the thesis chair.

Thesis
The thesis project should be an original production appropriate to the major commitment of the degree candidate. A written report will be prepared for inclusion in the library. Specific directions are available in the "MFA Guide for Students and Faculty: Policy Regarding Student Work." The School of Film and Animation reserves the right to retain copies of student-produced films to be used for educational purposes, to show to prospective students and as examples of student productions. Graduates must also leave the school copies of complete work and master's thesis projects on videotape or CD.

Cultural influences
Rochester is a unique place for anyone seriously interested in a broad pursuit of studies in imaging arts. Fine-art imaging at RIT is keeping pace with some of the newer visual imaging methods through courses in computer graphics, interactive installations, virtual reality, computer animation and webpage design. The Rochester area is enhanced by such outstanding resources as the George Eastman House International Museum of Photography and Film and the Visual Studies Workshop, and has historically been noted as a center for experimental film.

The MFA program in imaging arts computer animation is unique in that it is the only such program housed in a School of Film and Animation with full production facilities, as well as the additional support of highly specialized faculty in photography, imaging science, computer science and information technology, and printing.

School of Photographic Arts and Sciences

http://photography.rit.edu

Master of Fine Arts in Imaging Arts—Photography

Therese Mulligan, Ph.D., Coordinator,
MFA Program, Photography
(585) 475-2616, mtmpph@rit.edu

The master of fine arts program in imaging arts emphasizes a broad interpretation of photography as an art form, with the intention of inspiring and nurturing the individuality of each student as a creative, productive person. The program encourages graduate study in photography and related media as a means to personal, aesthetic, intellectual and career development.

The MFA curriculum provides a flexible pattern of study that is continually sensitive to the needs of each student, building upon the strengths each individual brings to the program. Successful completion of the program enables a student to

seek careers in education, museum or gallery work, or as a self-employed professional.

Photography concentration

This concentration provides students with the opportunity to pursue a rigorous course of study in photography and related media. It incorporates the study of practice, history and criticism, from the beginnings of photography to present-day digital, moving image, new media, experimental techniques and aesthetics. Students engage in discursive studies, extensive research and experimental learning in a content-rich environment. Parallel courses in art and related areas complement core classes.

Art electives

Elective courses are available in animation, video, multimedia, film, printmaking, painting, sculpture, communication design, museum studies, crafts, bookmaking, typography, color photography, new media, studio photography, advertising photography, perception, sensitometry, computer graphics, art history and archival preservation and conservation. There also are opportunities for independent studies and internships.

Program goals

1. Provide students with the opportunity to use the still and moving image as a means to pursue a professional career and earn a livelihood
2. Provide students the opportunity to use the still and moving image as a means to enrich their personal lives and society as a whole
3. Provide a nurturing intellectual environment that encourages a sense of community, creativity, scholarship and purpose

Faculty

Ten full-time faculty members, all critically regarded for their artistic work in exhibition and publication, contribute to the MFA program. The faculty brings individual expertise and dedication to their work with graduate students, encouraging intellectual inquiry of contemporary art making practices and aesthetics. The MFA program is also supported by a staff of 40 full-time faculty members from the School of Photographic Arts and Sciences, School of Print Media, School of Art, and adjunct faculty members from George Eastman House International Museum of Photography and Film, as well as noted regional, national and international practitioners, critics and historians.

Admission requirements

Students with a baccalaureate degree or equivalent from an accredited college or university are eligible for admission, provided they present a portfolio of work that demonstrates their skills, visual sophistication and aesthetic awareness. Acceptance depends on the strength of portfolios as judged by the graduate faculty, past academic performance, letters of recommendation and personal statements of purpose.

There are no examination requirements (e.g., GRE) for admission to this MFA program. Personal interviews are encouraged but not required. Applicants who are capable of good academic work, as well as artistic visual expression, and who demonstrate an interest in the exploration of new artistic ideas and experiences will be recommended.

Students who are evaluated to have MFA potential but require additional study in preparation for graduate courses will be advised to take necessary courses either prior to entrance or during their first year of study.

To apply for admission, students must submit an official transcript of their undergraduate degree, an acceptable portfolio and a minimum of three letters of reference, as well as a statement of purpose detailing what attributes they bring to graduate study, including expectations and professional goals they wish to achieve. All correspondence concerning applications or catalogs should be addressed to the Office of Graduate Enrollment Services.

Transfer credit

Graduate-level course work taken prior to admission to the program should be submitted for approval upon entrance into the program. Up to 12 quarter credit hours (8 semester hours) of graduate work with a minimum grade of a B better is transferable toward the degree, with the approval of the graduate coordinator.

Portfolio

The portfolio, along with written records of achievements and recommendations, serves to inform the faculty of the applicant's readiness for advanced graduate study. It provides a visual statement of the applicant's performance to date in terms of his or her skills, aesthetic development and maturity.

Applicants should send 20 images representing a cohesive body or bodies of recent work.

Admission selection for the fall quarter in the imaging arts program is made in the spring from among all portfolios and completed applications received. Applicants should be certain that portfolios are postmarked no later than January 15 to ensure review of the application. Acceptance occurs only once a year for a fall admission.

Portfolio instructions

- Submit no more than 20 images.
- Submit 35mm slides, CDs or DVDs
- If submitting 35mm slides, place a red dot in the lower left corner of each slide mount. Label each slide with applicant's name, title of work, date, size of work and medium.
  If submitting CDs or DVDs, size each digital file to no more than a maximum of 5 megabytes.
- Images should be numbered 1 to 20 in the order the applicant wishes them to be projected.
- Include a numbered page detailing the slide, CD or DVD

image information. Include the title of the work, date, size and medium.
- Include a self-addressed, stamped envelope for return of the portfolio. The school cannot return portfolios lacking sufficient postage or inadequate packaging. The school will retain the work of admitted applicants.
- Submit the portfolio with the application material to the Office of Graduate Enrollment Services.

Degree requirements

The MFA degree in imaging arts normally requires a minimum of two years of full-time resident graduate study. A minimum of 90 quarter credit hours of graduate work is outlined below. These minimums may be exceeded by intent or necessity to cover particular areas of study.

The 90 hours do not include undergraduate work required by action of the MFA admission committee in accepting a particular applicant or undergraduate course prerequisites for graduate courses.

The MFA degree encompasses 90 quarter credit hours of course work in the following areas of study:

1. Concentration designed to give depth of experience in the area of the student's primary interest. All students must complete required courses and other course work selected from many flexible alternatives. (40 quarter credit hours)
2. History and Aesthetics and History and Criticism of Imaging Arts and related media (15 quarter credit hours)
3. Electives (19 quarter credit hours)
4. Research Seminar, Graduate Seminar, and Research and Thesis (16 quarter credit hours)

Distribution of work within these guidelines is subject to modification based upon the candidate's background, abilities and interests. An individualized course of study will be prepared with the advice of the graduate faculty and made a matter of record. Modifications in this prescribed program thereafter must be approved and recorded.

Grades and time limit

The average of all grades for graduate credit taken at the university must be at least a B (3.0) to qualify for the MFA imaging arts degree. Thesis hours are usually taken over several quarters. Only the letter "R" is recorded, indicating a thesis in process. No letter grade is assigned. Acceptance or rejection of the thesis is made by the candidate's thesis committee and the graduate faculty. All course work, including an accepted thesis, must be completed within seven years of entrance into the program.

Thesis

The thesis exhibition/project should be an original body of work appropriate to the major commitment of the degree candidate. A written thesis will be prepared for inclusion in Wallace Library. Specific guidelines are available in the "MFA Guide for Students and Faculty: Policy Regarding Student Work."

Policy regarding student work

The School of Photographic Arts and Sciences reserves the right to retain at least one original piece of work from a student's MFA thesis show for inclusion in the MFA Collection, to be used for educational, promotional and exhibition purposes. Graduates must also leave the school one set of no less than 20 slides, a CD or a DVD of thesis work completed for the master's degree.

Cultural influences

Rochester is a unique place for anyone seriously interested in a broad pursuit of photographic studies. Fine art imaging at RIT is keeping pace with the latest visual imaging methods researched and practiced in larger metropolitan areas, in art institutions and in industry. The Rochester area is enhanced with outstanding intellectual and human resources. In addition to those located in the College of Imaging Arts and Sciences, there are resources to be found in two major cultural institutions heavily involved in photographic education and innovation: George Eastman House International Museum of Photography and Film and the Visual Studies Workshop.

School of Photographic Arts and Sciences (SPAS) Gallery

The SPAS Gallery supports the exhibition of graduate thesis work, student work and the works of contemporary image-makers. It maintains an academic year calendar of exhibitions, public lectures and receptions. Importantly, it also provides real world experience for interested graduate students, where they learn firsthand about gallery operations, installation and communications.

Graduate Faculty

School of Art

Donald Arday, BFA, Cleveland Institute of Art; MFA, Syracuse University—Administrative Chair, School of Art; Professor

Bob Cole, BA, MS, University of Maryland—Professor

Robert Dorsey, BFA, Rochester Institute of Technology; MFA, Syracuse University—Associate Professor

William Finewood, BA, State University of New York at Geneseo; MFA, Syracuse University—Associate Professor

Robert Heischman, BFA, Miami University; UCFA, Ruskin School of Art—Professor

Glen R. Hintz, BA, Lafayette College; MS, The Medical College of Georgia—Associate Professor

Keith Howard, Painting Diploma, National Art School, Australia; MA, New York University—Associate Professor

Thomas R. Lightfoot, BA, BFA, University of Connecticut; MFA, Institute Allend; MA, Ed.D., Columbia University Teachers College—Associate Professor

James Perkins, BA, Cornell University; ABD, University of Rochester; MFA, Rochester Institute of Technology—Associate Professor

Luvon Sheppard, BFA, MST, Rochester Institute of Technology—Professor

Alan D. Singer, BFA, Cooper Union; MFA, Cornell University—Professor

Carole Woodlock, BFA, Alberta College of Art; MFA, Concordia University—Associate Professor; MST Program Coordinator, Art Education

School of Design

Deborah Beardslee, BFA, Syracuse University; MFA, Virginia Commonwealth University—Associate Professor; MFA Program Coordinator, Graphic Design

Alex Bitterman, BS, M. Arch, State University of New York at Buffalo—Assistant Professor, Industrial Design

Peter Byrne, BFA, Alberta College of Art and Design; MFA, York University—Associate Professor; Program Chair, Graphic Design

Nancy A. Ciolek, BFA, MFA, Indiana State University—Associate Professor

Eddie Davis, BFA, Rhode Island School of Design; MFA, Rochester Institute of Technology—Assistant Professor, Industrial Design

Daniel DeLuna, BFA, Ball State University; MFA, Pratt Institute—Assistant Professor, Computer Graphics Design

Lorrie Frear, BFA, MFA, Rochester Institute of Technology—Assistant Professor, Graphic Design

Chris B. Jackson, BFA, Alfred University; MFA, Rochester Institute of Technology—Associate Professor, Computer Graphics Design

C. Bill Klingensmith, BFA, Youngstown State University; MFA, University of North Carolina—Assistant Professor, Graphic Design

Heinz Klinkon, BFA, MFA, Rochester Institute of Technology—Associate Professor, Graphic Design

Patti J. Lachance, BFA, Herron School of Art at Indiana and Purdue Universities at Indianapolis; MFA, Rochester Institute of Technology—Associate Professor; Administrative Chairperson, School of Design

Bruce I. Meader, BFA, MFA, Carnegie Mellon University—Associate Professor, Graphic Design

David Morgan, BFA, Brigham Young University; MID, Rhode Island School of Design—Assistant Professor; MFA Program Coordinator, Industrial Design

R. Roger Remington, BFA, Rochester Institute of Technology; MS, University of Wisconsin—Professor, Graphic Design

Marla Schweppe, BA, University of Kansas; MA, Ohio State University—Professor; Director of Visualization; MFA Program Coordinator, Computer Graphics Design

School for American Crafts

Andy Buck, BA, Virginia Commonwealth University; MFA, Rhode Island School of Design—Associate Professor, Wood

Juan Carlos Caballero-Perez, BFA, MFA, Rochester Institute of Technology—Assistant Professor, Metals

Robin Cass, BFA, Rhode Island School of Design; MFA, State University of New York at Alfred—Assistant Professor, Glass

Wendell Castle, BFA, MFA, University of Kansas—Professor; Artist-in-Residence, Chair in Contemporary Crafts

Julia Galloway, BFA, New York State College of Ceramics; MFA, University of Colorado—Associate Professor; Chair, School for American Crafts

Richard Hirsch, BS, State University of New York at New Paltz; MFA, Rochester Institute of Technology—Professor, Ceramics

Albert Paley, BFA, MFA, Tyler School of Art, Temple University; Ph.D. (honorary), University of Rochester—Artist-in-Residence, Charlotte Fredericks Mowris Chair in Contemporary Crafts

Michael Rogers, BA, MA, Western Illinois University; MFA, University of Illinois—Professor, Glass

Richard Tannen, BS, Cornell University; Certificate of Mastery, Boston University—Professor, Wood

Leonard A. Urso, BFA, MFA, State University of New York at New Paltz—Professor, Metals

School of Film and Animation

Cat Ashworth, MA, State University of New York at Buffalo—Associate Professor

Carl (Skip) Battaglia, BA, Boston College; MS, Syracuse University—Professor

Jack Beck, BA, Denison University; MFA, University of Iowa—Associate Professor

Johannes Bockwoldt, MA, Temple University—Visiting Assistant Professor

Adrianne Carageorge, MFA, Ohio University—Associate Processor

Stephanie Maxwell, BA, University of California at Los Angeles; MFA, San Francisco Art Institute—Professor

Howard Lester, BA, Cornell University; MFA, University of California at Los Angeles—Professor; Administrative Chair, School of Film and Animation

Naomi Orwin, MA, Institute of Transpersonal Psychology; BA, University of Chicago—Assistant Professor

Duane Palyka, BA, BFA, Carnegie Mellon University; MFA, University of Utah—Associate Professor

Johnny Robinson, BFA, MFA, Syracuse University—Assistant Professor

Malcolm Spaull, BS, St. Lawrence University; MFA, Rochester Institute of Technology—Professor; MFA Coordinator

School of Photographic Arts and Sciences

Imaging Arts Photography Concentration

Patti Ambrogi, MFA, Visual Studies Workshop—Associate Professor

Myra Greene, BFA, Washington University; MFA, University of New Mexico—Assistant Professor

Angela M. Kelly, MA, Columbia College—Associate Professor

Susan Lakin, BFA, Art Center of Design; MFA, University of California—Associate Professor

Dan Larkin, BFA, Rochester Institute of Technology; MFA, Bard College—Assistant Professor

Therese Mulligan, BA, University of Missouri; MA, Michigan State University; Ph.D., University of New Mexico—Professor; Graduate Program Coordinator

Elaine O'Neil, BFA, Philadelphia College of Art; MS, Illinois Institute of Technology—Professor

Willie Osterman, MFA, University of Oregon—Professor

Elliott Rubenstein, MFA, State University of New York at Buffalo; MA, St. John's University—Professor

Ken White, BA, Princeton University; MA, MFA, University of New Mexico—Associate Professor

School of Print Media

Patricia Albanese, BA, State University of New York at Geneseo; MS, Rochester Institute of Technology; MSLS State University of New York at Geneseo—Gannett Distinguished Professor

Charles Bigelow, BA, Reed College; MFA, University of California, Los Angeles; Certificate of Advanced Studies, Harvard University—Melbert B. Cary Distinguished Professor

Barbara Birkett, BA, Aquinas College; MBA, Rochester Institute of Technology; CPA, Maryland—Associate Processor, Print Media Management

Robert Y. Chung, BS, Eastern Washington State University; MS, Rochester Institute of Technology—Professor, Color Management

Twyla Cummings, BS, MS, Wright State University; Ph.D., Union Institute and University—Associate Professor, Paul and Louise Miller Professor, Print Media Management; Graduate Program Chair

Franziska Frey, MS, University of Zurich; Ph.D., Swiss Federal Institute of Technology—Associate Professor, McGhee Professor, Materials and Digital Imaging

Michael Kleper, MS, Rochester Institute of Technology

David Pankow, MLS, Columbia University—Professor; Curator, Melbert B. Cary Jr. Graphics Art Collection

Michael Riordan, MS, Rochester Institute of Technology—Assistant Professor, Color Image Processing Systems

Frank J. Romano, BA, City University of New York—Emeritus Professor, Electronic Publishing

Patricia Russotti, BS, Empire State College; MS, Ed.D, Indiana University—Associate Professor, Pre-press Imaging

Franz Sigg, BS, MS, Rochester Institute of Technology—Research Associate, Test Targets

Patricia Sorce, BA, Kent State University; MS, Ph.D., University of Massachusetts—Associate Professor, Roger K. Fawcett Professor, Administrative Chair; Print Media Management

Scott Williams, BA, Purdue University; Ph.D., Montana State University—Associate Professor

Interdisciplinary Studies

2001-723 **The College Teacher**
This course is for students at the graduate level who are thinking about entering teaching at the college level. Students will learn about the teacher's role and responsibilities within the college structure. They will learn course development, course presentation, and course evaluation. They will have the chance to develop and present instruction. **Credit 3**

Graduate Study

2037-785 **Forms of Inquiry**
The exploration and organization of forms of inquiry is required for all MFA students. It aims to expose students to a broad range of critical issues related to the conception and production of art, to inspire and provoke critical reflection, and facilitate the development of a preliminary thesis topic. Presentations, discussions, and written assignments will examine concerns as they relate to contemporary art, crafts, and design. **Credit 2 (offered each year)**

2037-790 **Graduate Forum**
Graduate Forum is a course designed to expose students to a broad range of issues related to the conception and production of art. Presentations and discussions will deal with current approaches to aesthetics, criticism, creativity and perception through the work of contemporary artists and craftspeople. Weekly presentations will be given on specific issues relevant to contemporary practice. In addition, visiting faculty will participate in studio discussions, activities and critiques. The goal of this course is to place you in a position of awareness related to contemporary practice, the world that you are going to occupy and the cultural models that influence your beliefs. **Credit 3**

School of Art

Art Education

2011-701 **Art Education Methods and Materials I**
The course will explore the process of teaching art in the public/ private school classroom and focus on specific information and theories relevant to the teaching of visual art. Students will be encouraged to explore highly structured as well as highly experimental approaches to teaching art. Projects will include lesson planning, unit planning, investigating new technologies, urban education, action research, and other relevant topics, such as: human development, students with disabilities, multiple intelligences, assessment processes, and personal inquiry as reflective practice. (Course is restricted to art education majors) **Credit 5**

2011-702 **Art Education Methods and Materials II**
This course is a continuation of Methods I. In this course students will further explore the process of teaching art in the public/private school classroom and focus on specific information and theories relevant to the teaching of visual art with the specific goals defining a teaching methodology that meets State and National Standards. Students will be encouraged to explore highly structured as well as highly experimental approaches to teaching art. Projects will include lesson-planning, unit planning, investigating new technologies, urban education, action research, and other relevant topics, such as: human development, students with disabilities, multiple intelligences, assessment processes and personal inquiry as reflective practice. (2011-701, course is restricted to art education majors) **Credit 5**

2011-820 **Seminar in Art Education**
This course supports the student who is currently student teaching. In this course students will explore the day-to-day issues they experience in their student teaching experiences. The focus will be on making connections with theory, state and national standards, and reflecting on student experience to address overall goals of the program. Students focus on the following areas to meet NYSED requirements: Content/Subject matter knowledge, pedagogical knowledge, teaching skills, curriculum development, assessment, and professional skills. The development of a teaching portfolio occurs in conjunction with a culminating project. On-line technology is utilized in addition to slide lectures, videotapes and other forms of media. **Credit 3**

2011-860 **Practice Teaching**
The student teaching experience is the single most important activity of the MST. program. It is designed to provide the student with experiences and challenges which will help them to further develop into the art teacher they are becoming. Two student teaching placements are arranged for each student for the duration of seven weeks each. Students are assigned a cooperating teacher and a college supervisor for each setting. A student teaching handbook is provided. (Restricted to art education majors) **Credit 9**

Illustration

2019-706 **Illustrative Design I Graduate**
This course is an introduction to the principles and methods used to incorporate illustration with typography and layout. Students will conceptualize, organize, and execute illustrations within a design context. Illustrative Design I will emphasize the use of graphic elements such as symbols, charts, and type to be incorporated into illustrations. Layout terminology and illustration production methods will be included. Projects will expose students to various examples of real-world assignments what will demand the use of traditional illustration methods as well as computer-based production media; emphasizing the language of visualization and the relationship and coordination of concept, illustration, and word. **Credit 3**

2019-711 **Digital Illustration I Graduate**
Digital Illustration I will introduce graduate students to the principles of visualization used to create digital illustrations. Students will apply their ability to conceptualize effective solutions to digital illustration renderings. The course curriculum and assignments encourage a high level of creative conceptual development, with theory and practice in the use of digital techniques. The goal is to advance conceptual problem-solving methodology and the language of visualization for professional illustration production. Color systems, digital terminology, and pre-press file formats will be covered. **Credit 3**

2019-723 **Digital Editorial I Graduate**
Digital Editorial I Graduate will introduce students to editorial illustration. Importance will be placed on interpretation of editorial subject matter and preparation of digital imagery for print reproduction. Students will apply approaches to creative illustration while creatively interpreting editorial text. Students may use vector and rastor-based software applications and a variety of input and output devices. Stylistic issues, conceptual strategies, production restrictions, and color systems will also be covered. **Credit 3**

2019-733 **Illustration Portfolio Preparation Graduate**
Portfolio Preparation is the final preparatory course for visual artists. Its purpose is to provide students with information, strategies, and guided instruction to organize and create their final portfolio. The course will include individual critique and analysis of work created in prior studio classes and progress to the definition of a career agenda. Projects will be individually assigned based on the quality of each student's body of work and their career intentions. Presentation methods, formatting, and stylization will also be addressed. The final culminating projects will be finished hard copy and digital portfolios. In addition to the portfolio document, students will be instructed in job seeking strategies including interviewing dynamics, resume writing, and correspondence. **Credit 3**

2019-742 **Digital Narrative II Graduate**
Digital Illustration Narrative II expands upon the translation of verbal concepts to pictorial narrative introduced in Digital Illustration Narrative I. Particular emphasis will be placed on illustration sequences including story-line illustration, and thematic series pictorials. Importance will be placed on the digital representation of narrative story telling with reference to style, content, and interpretation. Assignments will involve vector and raster-based software applications and a variety of input and output devices. Conceptual strategies, production methodologies, narrative composition, and color systems will also be covered. **Credit 3**

2019-761, 762, 763, 764 **Illustration Graduate Elective**
Individual drawing projects related to graduate students' major area of study, an opportunity to refine drawing skills on the graduate level. Elective offerings are Adobe PhotoShop, Personal Focus, and Figure in Motion. **Credit 3 per quarter**

Medical Illustration

2020-707 **Contemporary Media for Interactive Portfolio**
Students will create an interactive portfolio of their artwork and/or animations designed to attract potential clients and employers. The portfolio will be available for viewing on the World Wide Web and as a CD or DVD. It will include interactive navigation and be able to download vitae and promotional materials to site visitors. (2020-711) **Credit 3**

2020-710 Anatomic Illustration-Mixed Media
Students will learn to use raster painting software to modify scanned artwork and create new images from scratch. Students will also use page layout applications to combine digital images with text and other graphic elements. Coursework emphasizes creation of illustrations to support medical education, for advertising, and to editorialize health and medical concepts. **Credit 3**

2020-711 Computer Animation and Interactivity I
This course continues advancement of animation skills used in Medical Illustration topics (2020-784). Students will create an interactive lesson using computer illustrations and two-dimensional computer animations designed for delivery via the World Wide Web. Coursework will also require students to create "puzzles" and other games requiring interactive learner participation. (2020-784) **Credit 3**

2020-712 Computer Animation and Interactivity II
This course introduces variables as a tool in constructing tests designed to measure learner comprehension. Students will create interactive lessons that use animation and interactive teaching strategies to deliver instructional objectives to a specific audience. Learner interaction with the symbols and control of animation remains a prime focus of the course. (2020-784) **Credit 3**

2020-731 Human Gross Anatomy I
A two-quarter sequence devoted to the study of the human body. Detailed dissection of a human cadaver is supplemented with lectures on the structure and function of the major organ systems. In the fall quarter, dissection focuses on the muscles of the torso, the contents of the thorax and abdomen, and the upper limb. **Credit 4**

2020-732 Human Gross Anatomy II
The second half of a two-quarter sequence devoted to the study of the human body. Detailed dissection of a human cadaver is supplemented with lectures on the structure and function of the major organ systems. This quarter begins with a detailed dissection of the head and neck and moves on to the pelvis, perineum, and lower limb. (2020-731) **Credit 4**

2020-761 3-D Modeling of Organic Forms
This course introduces students to NURB, Polygon, and Subdivision modeling techniques for creating virtual three-dimensional organic subjects. Accurate portrayal of the subject, including form, texture, and color are emphasized. Developing models from student drawings is required. **Credit 3**

2020-762 3-D Animation of Organic Forms I
Coursework focuses on accurate animation of organic and/or biomedical subjects using three-dimensional computer modeling. All animations are intended for display on the World Wide Web. Projects are three-dimensional animations that teach or portray an assigned topic. (2020-761 recommended) **Credit 3**

2020-763 3-D Animation of Organic Forms II
Students are introduced to three-dimensional computer animation using character rigging. Assignments focus on creating joint skeletons and binding three-dimensional surfaces to these "joints". Coursework introduces manipulating surface deformations in response to movements and surface material. All animations are intended for display on the World Wide Web. Projects are "applied animations" that teach or portray an assigned topic. (2020-762 or permission of instructor) **Credit 3**

2020-767 Molecular Illustration
Accurate representations of molecular structures are essential to illustrate recent advances in biotechnology, medical genetics, and pharmacology. This course provides a basic overview of molecular biology and introduces the principles of molecular illustration. Students will locate three-dimensional molecular model files on the Internet and manipulate these models to create two-three dimensional, and animated representations of molecules and biochemical processes. **Credit 3**

2020-781 Medical Illustration Topics I
This is an introductory course; designed to acquaint the illustration student with art techniques commonly used in medical illustration and with the medical library and audio-visual television supporting milieu in which the medical illustrator works. **Credit 3**

2020-782 Medical Illustration Graphics
A course emphasizing the use of computer software and hardware as a resource for generating titles, charts and graphs, schematics, and illustrations as vehicles to meeting instructional and communicative needs. Students will learn the various techniques available and will apply those techniques while designing pamphlets, in-house publications and poster exhibits. **Credit 3**

2020-783 Anatomical Studies
Sketches drawn from human dissection are translated into instructional illustrations using watercolor wash, pen, and ink. Emphasis will be on rapid but accurate sketching and observation in the laboratory, with a representation of form and structure in living tissue for publication. **Credit 3**

2020-784 Medical Illustration Topics II
This course is an introduction to two-dimensional computer animation as it applies to contemporary methods of instruction in medicine and allied health. Students will research current topics in health care and develop an interactive lesson that matches the instructional objectives of their topic. **Credit 3**

2020-785 Surgical Procedures I
The application of creating instructional aids designed to increase learner understanding of surgical procedures and concepts. Sketches are to be drawn while observing the surgery, consulting with the surgeon for accuracy of detail and development. The final preparation of the artwork will match its intended use (publication, slide graphic, computer graphic, etc.). **Credit 3**

2020-786 Surgical Procedures II
A continuation of the concepts begun in 2020-785; specifically, combining anatomical knowledge with surgical observation to construct a concise and accurate surgical series. Students will concentrate on communicating essential surgical concepts to a specific audience, as well as ensuring that their artwork will meet the demands of reproduction. **Credit 3**

2020-890 Research and Thesis-Medical Illustration
The development of a thesis project initiated by the student and approved by a faculty committee. Primarily a creative production, the thesis must also include a written report and participation in a graduate thesis show. (Approval required) **Credit 3–14 (offered every quarter)**

Fine Arts Studio

2021-710 Introduction to Painting: Acrylic Graduate Elective
A course in the basic materials and processes of acrylic painting. Students will explore the expressive and stylistic possibilities of the medium. Subjects will include various interpretations of still life and model as well as individual projects. Discussion of work will focus on form, composition, and color. **Credit 3**

2021-711 Introduction to Painting: Oils Graduate Elective
This course introduces students to oil painting. Along with learning about the properties and techniques of this medium, students will be encouraged to experiment and seek solutions to problems of composition and structure in painting. Preparatory sketches and studies will be encouraged for the production of finished works. Lectures, demonstrations, examples, and slide talks will compliment the growth gained through the students' creation of a variety of paintings from both observation and imagination. **Credit 3**

2021-712 Introduction to Painting: Figure Graduat Electivee
The fundamentals of representational figure painting in oils or acrylics using traditional materials and process. Color-mixing and painting application techniques related to depicting the figure and its immediate environment will be explored. Observational study of form, space, and quality of light will be stressed. **Credit 3**

2021-721 Watercolor: Graduate Elective
Use and control of the technique of water color painting. Exploring watercolor as an illustrative and painting media. **Credit 3**

2021-722 Contemporary Drawing Graduate Elective
Emphasis is on drawing and the development of form, space and expression from a variety of sources, including the human figure. Emphasis on basic techniques, materials, and concepts for further study are explored. **Credit 3**

2021-730 Introduction to Printmaking: Etching Graduate Elective
Conceptual and technical assignments introduce the basic techniques in etching focusing on line, value and texture. An investigation of line using the following techniques: line etch, litho crayon, open bite, scraping, and burnishing. Personal expression will be encouraged through variations in the use of line, value, and texture. **Credit 3**

2021-731 Introduction to Printmaking: Lithograph Elective
Conceptual and technical assignments that introduce the basic techniques in lithography focusing on line, value, and texture. An investigation of form relationships using the techniques of etching on litho-plates and stones; using pencils, crayons, inks, and transfer imagery to create and encourage personal expression. **Credit 3**

2021-733 Introduction to Printmaking: Non-toxic Graduate Elective
The student will explore of a wide range of non-toxic printmaking processes and techniques. In the mastery and application of these processes and techniques the student will achieve personal aesthetic goals. **Credit 3**

2021-741 Non-toxic Intaglio Printmaking I
The first of three graduate level non-toxic intaglio courses. The aim of this introductory level is to gain a technical understanding of basic Intaglio-Type and non-toxic alternative techniques for hand etching copper plates. Aspects of health and safety as applied to the intaglio studio along with working methodology will also be explored. (Matriculation into GCNIP) **Credit 4**

2021-742 Non-toxic Intaglio Printmaking II
The second of three graduate level non-toxic intaglio courses. The aim of this second level is to gain a technical understanding of Intaglio-Type etch techniques and gain a greater understanding of non toxic alternative techniques for hand etching. Introduction of computer generated methods of making halftones. To learn about the Edinburgh Etch. (2021-741 or portfolio review) **Credit 4**

2021-743 Non-toxic Intaglio Printmaking III
The last course in a series of three graduate level non-toxic intaglio courses. The aim of this third-level is to gain an advanced technical understanding of Intaglio-Type etch techniques and to either; 1) learn how to make high quality photographic halftones, 2) learn more advanced hand etching techniques. (2021-741 and 2021-742) **Credit 4**

2021-761, 762, 763, 764 Fine Arts Studio Graduate Elective
Traditional sculptural concepts will evolve through a variety of processes and materials -- predominately clay, plaster, cement, stone, paper, and metal. The human figure is presented as a subject for study and for use as a springboard to invention. **Credit 3 per quarter**

2021-769 Art Gallery Management
The complex social and cultural role of a fine arts gallery will be explored through supportive gallery operations: the installation of experimental and traditional exhibits, promotion, and marketing for competitions, student initiatives and special events tailored to the RIT and community art audiences. (Metro site presentations and research plus arranged studio hours in a laboratory: gallery setting). **Credit 3**

2021-775 Sculpture: Assemblage Graduate Elective
One of the most basic approaches to creating Sculpture, this course involves assembling or bringing together parts/pieces to form a whole. Spontaneous and immediate contact with unique materials, creative processes and the degree of sculptural impact may all be characterized as extremely direct. This straightforward confrontation offers no flashy techniques, seductive material or process to hide behind. Instead, at the onset, basic sculptural manipulation must occur. **Credit 3**

2021-776 Sculpture: Figure Graduate Elective
This sculpture course investigates the study of human form through the development of sculpted clay figures working directly from living models. Emphasis is placed on exploring the following sculptural elements: the underlying three-dimensional structure of the human figure; proportions of the human figure; volume, mass and surface anatomy; gesture; support and balance; figurative spatial relationships; expressive qualities of human form; use and control of basic material; and processes related to figure sculpture. **Credit 3**

2021-780, 781, 782 Fine Arts Studio Graduate I
Fine Arts Studio: enter into a critical discourse and examination of ideas and relationships in the fine arts. Critiques, guest artists, lectures, and discussion along with studio production. Painting: develop painting skill in oil, acrylic, watercolor, drawing through individual studio investigation under the direction of fine art faculty. Sculpture: sculpture concepts are explored through a variety of processes and materials, including clay, plaster, cement, stone, wood, and metal. These concepts reveal themselves through separate sections devoted to the human figure, installation, public art, or other contemporary manifestations of sculpture. Printmaking: non toxic printmaking techniques and processes are the means for students to develop along independent lines and directions for contemporary fine art printmaking. **Credit 3 per quarter**

2021-790, 791, 792 Fine Arts Studio Graduate II
Fine Arts Studio: enter into a critical discourse and examination of ideas and relationships in the fine arts. Critiques, guest artists, lectures, and discussion along with studio production. Painting: develop painting skills in oil, acrylic, watercolor, drawing through individual studio investigation under the direction of fine art faculty. Sculpture: sculpture concepts are explored through a variety of processes and materials, including clay, plaster, cement, stone, wood, and metal. These concepts reveal themselves through separate sections devoted to the human figure, installation, public art, or other contemporary manifestations of sculpture. Printmaking: non toxic printmaking techniques and processes are the means for students to develop along independent lines and directions for contemporary fine art printmaking. **Credit 3 per quarter**

2021-797 Art Gallery Practicum
Operating an art gallery serving a metropolitan community provides small business opportunities in research, marketing and management. Students will learn how to attract sponsorships, manage a gallery web site, supervise office assistants, prepare guidelines for the office staff manual, as well as plan and promote a full calendar year of exhibitions and special events. This course provides each student with actual business responsibilities found in any successful art gallery setting. **Credit 4**

2021-872 Business Practices for Fine Arts
This class is devoted to business issues that artists will face which include portfolio development, pricing, and marketing strategies and public relations. Students will research exhibition venues and career support services. Professional accomplishment in the arts depends on communication skills. Artists run small creative businesses; students will study opportunities to network with others artists, review grant applications, and look at other financial supports. **Credit 3**

2021-890 Research and Thesis: Fine Arts Studio
The development of a thesis project initiated by the student and approved by a faculty committee. Primarily a creative production, the thesis must also include a written report and participation in a graduate thesis show. **Credit 3–14 (offered every quarter)**

School of Design

Graphic Design

2010-711 Design Theory and Methods Seminar
Graduate students in graphic design, computer graphics design, and industrial design will participate in this seminar to explore many cross-disciplinary principles, theories, and methods that can be used by designers. Through selected readings from current periodicals, critical writing, hands-on involvement, presentations and guest lectures, students will broaden their awareness of topics such as systems thinking, human factors, semiotic theory and visual rhetoric, and become familiar with brainstorming, problem-solving, and evaluation methods in order to sharpen their understanding of the design process. Information will be directed toward meaningful concept development and the selection and use of appropriate methodologies for design problem-solving. **Credit 3**

2010-712 Graduate Typographic Design
This course investigates typographic hierarchy- the use of typographic variables to differentiate parts of a message with attention to communication and readability. Typographic grid structure, typographic detail, and formal aspects of typographic design are explored. Project focus is on developing harmonious type and image integration within a cohesive, sequential design application. **Credit 4**

2010-713 Design History Seminar
Graduate students in graphic design, computer graphics design and industrial design will be provided with a basis in the history of design which complements the overall graduate core in the School of Design as well as specific coursework in each major field of design study. In a seminar format, the students realize the course objectives through participatory means. Interdisciplinary in nature, the course is thematic and emphasizes performance on the part of the student in dynamic dialogue on course topics. The course content focuses on subjects relative to the history of design (people, processes, products, places), critical thinking, and contextual historical issues. Students are expected to write critical essays and questions and to participate in weekly discussion groups. **Credit 3**

2010-716 **Image Forms**
This introductory course investigates formal visual aesthetics related to graphic design problem solving. Emphasis is on the process of image analysis, ideation, and synthesis. Applied use of imagery focuses upon clear message making and audience understanding. Image generating tools range from traditional to electronic media as appropriate for specific projects. Projects related to form analysis and articulation are the primary focus of this course. **Credit 4**

2010-717 **Graduate Systems Design**
This course investigates various approaches toward visually and conceptually organizing components of graphic design problems (language, typography, imagery, color, space, etc.) for the purpose of clear, unified communication. Projects may include the creation of multiple components within a common framework. An emphasis is placed on identifying connections and integrating content between this course and prior design courses taken in the MFA major. **Credit 4**

2010-718 **Graduate Information Design**
This course stresses the importance of reader and user responses to written and visually presented information. Projects stress clarity and accessibility while investigating a variety of formats (charts, diagrams, business forms, tables, maps, instructional materials, wayfinding systems, graphic user interfaces). Advanced typographic and systems design decision making are required activities in this course. **Credit 4**

2010-722 **Graduate Graphic Design Applications**
This course is tailored to the needs of the first-year students enrolled and may include formal aesthetic principles in systematically solving applied problems on thematic, content intensive topics. Actual design assignments can include both digital and/or print applications. Emphasis is placed on the relationship between form and communication. Projects are defined and structured based on specific selected opportunities. **Credit 4**

2010-724 **Graduate Graphic Design Topics**
This course is tailored to the specific needs of the second-year students enrolled. Potential topics may include: design planning, human factors, interface design, writing and design, business practices, etc. This course involves research, processes, and design applications relevant to the selected course topic. **Credit 4**

2010-726 **Design Issues Seminar**
This graduate course experience exposes first-year graduate students majoring in graphic design, computer graphics design, and industrial design within the School of Design to the range of contemporary issues that face their design professions. Topics will include, but not be limited to, issues related to human factors, accessibility, green design, ethical decision-making, audience appropriateness, educating the public about design, the democratization of design, and the role of the designer in society. Selected readings from current periodicals, critical writing, group dialogue, presentations, and guest lectures will be integrated into the course as appropriate. **Credit 3**

2010-861 **Graphic Design Thesis Planning**
This is the first in the sequence of courses focused on the initiation of the MFA thesis project. Students are exposed to strategies that establish project content, planning, scheduling, and research. The product of the course is a fully articulated thesis plan. **Credit 4**

2010-862 **Graphic Design Thesis Development**
This is the second in a sequence of courses focused on the thesis project. Students are exposed to strategies appropriate to the continuation of project content, research, concept development, ideation, and in-process evaluation planning. **Credit 4**

2010-863 **Graphic Design Thesis Implementation**
This is the final course in a sequence of courses focused on the thesis project. Students are exposed to strategies appropriate to the implementation and retrospective evaluation of an intensive design problem. Verbal/written articulation of their design process and the required public exhibition are a focus of this course. **Credit 4**

Computer Graphics Design

2014-701 **Survey of Computer Graphics**
The computer graphics profession is constantly progressing. This course will provide a conceptual framework to designing and implementing multimedia applications, game art and design, instructional multimedia, visualization, interactive animation, and Web page design. Students research ideas, concepts, uses, history, aesthetics, and design principles of computer graphics and interactive media as it relates to the ever-evolving field. The content integrates visual semiotics, information architecture, user interface guidelines, and icon design. Students will complete assigned projects and readings. (Computer graphics design major or permission of instructor) **Credit 4**

2014-711 **Digital Video**
Use of digital video cameras, lights and microphones for motion recording and the use of storyboarding, titling, editing, and software to create and format digital Quick Time movies of DVDs for multimedia productions or motion graphics. (Computer graphics design major or permission of instructor) **Credit 4**

2014-713 **Design Research**
This course will focus primarily on developing students' research skills and exposing them to a range of writing techniques. Emphasis will be placed on an exposure to a wide range of research resources including the more traditional library vehicles, newer developments on the World Wide Web, and relevant archives and special collections. This course will begin to establish each student's thesis direction in very general terms by including the development of a preliminary thesis proposal and establishing an overview of research directions. (Limited to graduates in JADG, JADU or JADC majors) **Credit 3**

2014-717 **Authoring Multimedia**
Exposure to computer graphic algorithms, design heuristics, design methodology, and program structure of two-dimensional imagery for multimedia design. Projects involve programming in an authoring language. (Computer graphics design major or permission of instructor) **Credit 4**

2014-718 **QTVR and Multimedia Design**
This course is intended to provide a foundation to QTVR (QuickTime Virtual Reality) concepts. Previous multimedia experience and skills will be extended to emphasize multimedia applications that use QTVR as a design tool to interactively explore three-dimensional virtual environments. Attention will be given not only to the mechanics of creating the movies, but also to the design, relationship to other visual elements, and visual communication effectiveness of the movies. (Computer graphics design major or permission of instructor) **Credit 4**

2014-721 **3DDG Modeling**
This course covers a contrast and comparison of various methods of creating geometry for use in three-dimensional environments including polygons, NURBS, and subdivision surfaces for various purposes. Skills learned can be applied to creating elements for computer and video games, creating virtual environments or in visualization. Students have the opportunity to work on projects of their own invention or with real world application. **Credit 4**

2014-722 **3DDG Interactive Motion**
This course covers first the use of animation in interactive environment including games, visualization, and virtual reality. Students will create animation using key frames, paths, deformation, forward, and inverse kinematics. **Credit 4**

2014-723 **Graphical User Interface**
This course provides an in-depth look at graphical user interface design. Students learn the basic components of a user interface and how to design alternative navigational solutions. (Computer graphics design major or permission of instructor) **Credit 4**

2014-731 **3DDG Lighting**
Students apply standard lighting methods to lighting three-dimensional models. The interaction of light and pigment, use of light in painting, photography, film, and computer graphics are used as examples. Students apply problem solving techniques to arrive at a lighting solution for various problems. (2014-721) **Credit 4**

2014-732 **3DDG Shading**
The course focuses on incorporating two- and three-dimensional groups of textures into realistic materials. Students learn to use texture maps instead of detail in models to increase interaction speeds. Textures are also used in order to incorporate simple models into diverse scenes. Displacement textures are used to create detail in models. Advanced techniques in the use of shading networks are incorporated into the process. (2014-721) **Credit 4**

2014-733 3DDG Character Design
This course covers first the design of characters and then the creation of them using three-dimensional software, inverse kinematics, and deformers. Students create interpretant matrices, model sheets, sketches, and maquettes of characters followed by development of the character in software. (2014-721) **Credit 4**

2014-747 3DDG Rendering
This course covers a contrast and comparison of various methods and resolutions of rendering and outputting information from three-dimensional software. (2014-721) **Credit 4**

2014-782 3-D Computer Graphics Design
This course is an introduction to desktop three-dimensional visualization. It also expands on previous visualization skills and design experiences to include fundamentals for more advanced studies in three-dimensional animation, virtual spaces, and multi-dimensional navigation spaces. (Computer graphics design or permission of instructor) **Credit 4**

2014-784 Digital Typography in Motion
A study of digital typography and, in particular, digital type in motion as used in interactive applications and motion graphics. (2014-796 or permission of instructor) **Credit 4**

2014-785 Instructional Multimedia
Interactive and other software packages will be used to create instructional programs for different age groups. Course work will include subject matter research, developing objectives, creating graphics, sound and interactivity, and program evaluation. Each student will produce an instructional multimedia program. (Computer graphics design major or permission of instructor) **Credit 4**

2014-786 2-D Computer Animation
This course will include two-dimensional computer animation techniques, linear and non-linear, and interactive storytelling methods, narrative design, character design and animation, digital sound, and both frame-based and scripting animation methods. These techniques will be used to create interactive, web, and multimedia presentations with animation. (First year computer graphics design major or permission of instructor) **Credit 4**

2014-787 Advanced Computer Graphics Design I
This course extends previous multimedia experience and skills to emphasize advanced multimedia applications that use gaming concepts, delivery systems, and software as a design tool for entertaining and informing. Students will work with two-, three-dimensional visual concepts, virtual reality, interactivity, and sound to develop games of their own. (Computer graphics design major or permission of instructor) **Credit 4**

2014-791 Advanced Computer Graphics Design II
This course provides the opportunity to expose students to the latest concepts, techniques, and skills in a quickly evolving technological and information oriented society. This course is open ended so that new information, techniques concepts, principles, software, and hardware can be introduced in a timely manner. (Computer graphics design major or permission of instructor) **Credit 3**

2014-792 Vector-based Multimedia Design
This course extends previous multimedia experience and skills to emphasize advanced multimedia applications that use vector-based concepts as a design tool for creating animation and interactive authoring while maintaining small file sizes. (Computer graphics design major or permission of instructor) **Credit 4**

2014-796 Special Effects
Exposure to the development of special effects of Quick Time Movies. Computer software and storyboarding are used to create special effects in both animation and live video. Sequencing, storyboarding, digital sounds, titling, animation, video clips, and special effects are integrated. (Computer graphics design major or permission of instructor) **Credit 4**

2014-797 Advanced Computer Graphics Design III
This course provides an in-depth look at creating an effective electronic portfolio. Students create, organize and design a portfolio based upon personal strengths and interests, with professional standards, and career expectations in mind. (Computer graphics design major or permission of instructor) **Credit 4**

2014-798 Production Pipeline
The course focuses on implementing a project from the planning stage, through implementation, to completion, and presentation. (2014-721, plus at least one other 3DDG course) **Credit 4**

2014-831 Thesis Planning
This course helps the student to research and develop a thesis related to a design problem. A thesis statement, review of the literature, construction of a timeline, and application of organizational skills are integrated into this course. Revision and refinement of the proposal are based on critique and feedback. This course is required before development of a final thesis project. (Required for second year computer graphics design majors) **Credit 2**

2014-890 Thesis: Computer Graphics Design
The development of a thesis project initiated by the student and approved by a faculty committee. Primarily a creative production, the thesis must also include a project report and participation in a graduate thesis show. (Computer graphic design majors only) **Credit 0–14**

Industrial Design

2035-706 Design Collaborative Graduate
Advanced product development involving teamwork and collaboration with an industry design group providing technical information, marketing concerns, and outside review of work. **Credit 3**

2035-708 Furniture Design Graduate
Experience in the design of furniture for a defined sector of the contract market is acquired through a project exercise involving industry collaboration. **Credit 3**

2035-711 Advanced Computer Modeling I
The first of three required graduate-level electronic media courses. The emphasis in this beginning level (Level 1) modeling course is learning software tools competency through assigned exercises and creative projects. The objective is student understanding of the nature, location, and use of all tools commonly available at the professional level for electronic surface modeling in degree three and higher B-spline curves and surfaces. Learning simple effect-of motion techniques (turntable animation, fly-around animation) is included. **Credit 3**

2035-712 Advanced Product Design Graduate
The application of design methods and skills to advanced level projects in industrial design. **Credit 3**

2035-716 Industrial Design Presentation
Industrial designers are required to give many visual presentations throughout their academic and professional careers. This course will reinforce presentation principles and skills, both verbal and visual. Students will give numerous design presentations using appropriate supporting materials and media. (Acceptance into graduate industrial design program) **Credit 3**

2035-721 Advanced Computer Modeling II
The second of three required graduate-level electronic media courses. The emphasis in this second-level (Level 2) modeling course is learning higher software competency -techniques- for modeling complex and difficult shapes through assigned exercises and creative projects. The objective is student understanding of the most efficient use of professionally-preferred tools for electronic surface modeling in degree three and higher B-spline curves and surfaces. (2035-711 or permission of instructor) **Credit 3**

2035-731 Advanced Computer Modeling III
The third of three required graduate-level electronic media courses. The goal for this third-level (Level 3) modeling course is learning higher software competency directed toward team working. The emphasis is in strategizing the process of modeling complex and difficult shapes to achieve results typically expected by professional project team members, through assigned exercises and creative projects. Included are the methods and techniques for flawless transferring of design intent of these electronic surface models to and from other professional-level surface and solids software. (2035-721 or permission of instructor) **Credit 3**

2035-732 Exhibit Design Graduate
Design of trade show and similar exhibits, including gallery exhibits, involving structure, graphics, lighting, and layout of space. Students will develop concepts through plan and elevation drawing as well as perspective renderings for presentation. **Credit 3**

2035-736 Industrial Design Problems I
This course investigates various theoretical and philosophical approaches to design and provides a basis for critical analysis of current design problems. Projects will extend these ideas into the practice of industrial design as a mode of discourse. We will design, in two- and three-dimensional form, products and artifacts through a process of iteration and reiteration. Categories of products may include: consumer goods, equipment transportation, furniture, or packaging. (Acceptance into graduate Industrial Design program) **Credit 6**

2035-737 **Industrial Design Problems II**
This course is the second in a three-part series. The design problems we address will now require a more theoretically rigorous and research-based design approach. Our focus will be on human centered, culturally based design problems with supporting projects including: universal and appropriate product design, and environmentally responsible design practices. (2035-736) **Credit 6**

2035-738 **Industrial Design Problems III**
This course is the third in a three-part series. This course continues product design activities, but broadens the scope to focus on products and their interaction within a context. This broadening will involve project management, product testing and results analysis, with projects including environment design, mass customization, and niche production. (2035-737) **Credit 6**

2035-741 **Professional Practice Graduate**
Business and ethical practices in the industrial design profession are examined through case studies and designer interviews. Students discuss matters of professional practice, debate issues of ethical professional behavior, prepare business correspondence, and analyze the function of industrial design in the business environment. **Credit 3**

2035-761, 762, 763, 764 **Industrial Design Graduate Elective**
The reasoned application of theoretical and practical background to advanced projects in industrial design. **Credit 3 per quarter**

2035-840 **Thesis Research**
Guidance in selecting and planning a thesis project, conducting a search for background material, and writing a thesis proposal. (Second-year graduate JADU major or permission of instructor) **Credit 3**

2035-890 **Thesis: Industrial Design**
The development of a thesis project initiated by the student and approved by a faculty committee. Primarily a creative production, the thesis must also include a written report and participation in a graduate thesis show. **Credit 3–14**

School of American Crafts

Ceramics

2040-761, 762, 763, 764 **Ceramic Graduate Elective**
Basic instruction and experience in ceramic design, fabrication, and production of ceramic forms is undertaken. This study provides ceramic technology and terminology and gives experience with clays along with fundamental forming techniques. The development of design awareness is encouraged through lectures and critiques. Materials fee required. **Credit 3 per quarter**

2040-781 **Graduate Ceramics Studio I**
This is the first of a four-quarter sequential courses covering the advanced aesthetics and techniques in ceramics. This program is structured on the basis of the individual student's needs, interests and background preparation as they may be determined through faculty counseling. There will be a strengthening of ceramic techniques, design fundamentals, and encouragement of personal expression. The student will be encouraged to evaluate new techniques, materials, and concepts. This sequence leads to the master's thesis, proposed by the student and approved by the faculty. Materials fee required. **Credit 9**

2040-782 **Graduate Ceramics Studio II**
This is the second of a four-quarter sequential courses covering the advanced aesthetics and techniques in ceramics. This is a continuation of the program developed on the basis of the individual student's needs, interests and background preparation techniques, design fundamentals, and encouragement of personal expression. The student will be encouraged to evaluate new techniques, materials, and concepts. This sequence leads to the master's thesis, proposed by the student and approved by the faculty. Materials fee required. **Credit 9**

2040-783 **Graduate Ceramics Studio III**
This is the third of a four-quarter sequential courses covering the advanced aesthetics and techniques in ceramics. This is a continuation of the program developed on the basis of the individual student's needs, interests and background preparation as they may be determined through faculty counseling. The student will begin to seriously experiment with issues and themes that may prove relevant to their final selection of a thesis topic. The student will be encouraged to evaluate new techniques, materials, and concepts. This sequence leads to the master's thesis, proposed by the student and approved by the faculty. Materials fee required. **Credit 9**

2040-784 **Graduate Ceramics Studio IV**
This is the fourth of a four-quarter sequential course covering the advanced aesthetics and techniques in ceramics. This is the culmination, prior to the thesis studio course, of the program developed on the basis of the individual student's needs, interests, and background preparation as they have been determined through faculty counseling. The student will seriously pursue issues and themes that are relevant to their final thesis topic. The student will be encouraged to utilize new techniques, materials, and concepts. This sequence leads to the master's thesis, proposed by the student and approved by the faculty. Materials fee required. **Credit 9**

2040-890 **Ceramics Graduate Thesis**
The development of an acceptable thesis project initiated by the student and approved by the student's thesis committee and chairperson of the school. Primarily a creative production resulting in a body of work, the thesis will include a written report, which addresses the body of work. The work will be exhibited in the graduate thesis show. **Credit 0–18**

Glass

2041-761, 762, 763, 764 **Glass Graduate Elective**
Collaborative work in the student's major area of study and glass fabrication is encouraged. Various techniques, both hot and cold, will be considered in different quarters: casting, slumping, fusing, blowing, engraving, sand carving, cutting, lamp working, and sculptural construction. Course emphasis on personal, independent development encouraging contemporary thought and concept. Materials fee required. **Credit 3 per quarter**

2041-781 **Graduate Glass Studio I**
This is the first of a four-quarter sequential courses covering the advanced aesthetics and techniques in glass. This program is structured on the basis of the individual student's needs, interests, and background preparation as they may be determined through faculty counseling. There will be a strengthening of ceramic techniques, design fundamentals, and encouragement of personal expression. The student will be encouraged to evaluate new techniques, materials, and concepts. This sequence leads to the master's thesis, proposed by the student and approved by the faculty. Materials fee required. **Credit 9**

2041-782 **Graduate Glass Studio II**
This is the second of a four-quarter sequential courses covering the advanced aesthetics and techniques in glass. This is a continuation of the program developed on the basis of the individual student's needs, interests, and background preparation techniques, design fundamentals, and encouragement of personal expression. The student will be encouraged to evaluate new techniques, materials, and concepts. This sequence leads to the master's thesis, proposed by the student and approved by the faculty. Materials fee required. **Credit 9**

2041-783 **Graduate Glass Studio III**
This is the third of a four-quarter sequential courses covering the advanced aesthetics and techniques in glass. This is a continuation of the program developed on the basis of the individual student's needs, interests, and background preparation as they may be determined through faculty counseling. The student will begin to seriously experiment with issues and themes that may prove relevant to their final selection of a thesis topic. The student will be encouraged to evaluate new techniques, materials, and concepts. This sequence leads to the master's thesis, proposed by the student and approved by the faculty. Materials fee required. **Credit 9**

2041-784 **Graduate Glass Studio IV**
This is the fourth of a four-quarter sequential courses covering the advanced aesthetics and techniques in glass. This is the culmination, prior to the thesis studio course, of the program developed on the basis of the individual student's needs, interests, and background preparation as they have been determined through faculty counseling. The student will seriously pursue issues and themes that are relevant to their final thesis topic. The student will be encouraged to utilize new techniques, materials, and concepts. This sequence leads to the master's thesis, proposed by the student and approved by the faculty. Materials fee required. **Credit 9**

2041-890 **Glass Graduate Thesis**
The development of an acceptable thesis project initiated by the student and approved by the student's thesis committee and chairperson of the school. Primarily a creative production resulting in a body of work, the thesis will include a written report, which addresses the body of work. The work will be exhibited in the graduate thesis show. **Credit 0–18**

Metals

2042-761, 762, 763, 764 **Metals Graduate Elective**
This course offers students fundamental, intermediate and advanced fabrication/forming techniques as they apply to hollow ware and jewelry design. Creative designs and innovative artistic concepts are encouraged. Individual and group instruction covers the properties of various metals, the use of the shop equipment, and safety procedures as they apply to metalsmithing. Materials fee required. **Credit 3 per quarter**

2042-781 **Graduate Metals Studio I**
This is the first of a four-quarter sequential courses covering the advanced aesthetics and techniques in metals. This program is structured on the basis of the individual student's needs, interests and background preparation as they may be determined through faculty counseling. There will be a strengthening of ceramic techniques, design fundamentals, and encouragement of personal expression. The student will be encouraged to evaluate new techniques, materials, and concepts. This sequence leads to the master's thesis, proposed by the student and approved by the faculty. Materials fee required. **Credit 9**

2042-782 **Graduate Metals Studio II**
This is the second of a four-quarter sequential courses covering the advanced aesthetics and techniques in metals. This is a continuation of the program developed on the basis of the individual student's needs, interests and background preparation techniques, design fundamentals, and encouragement of personal expression. The student will be encouraged to evaluate new techniques, materials, and concepts. This sequence leads to the master's thesis, proposed by the student and approved by the faculty. Materials fee required. (2042-781) **Credit 9**

2042-783 **Graduate Metals Studio III**
This is the third of a four-quarter sequential courses covering the advanced aesthetics and techniques in metals. This is a continuation of the program developed on the basis of the individual student's needs, interests, and background preparation as they may be determined through faculty counseling. The student will begin to seriously experiment with issues and themes that may prove relevant to their final selection of a thesis topic. The student will be encouraged to evaluate new techniques, materials, and concepts. This sequence leads to the master's thesis, proposed by the student and approved by the faculty. Materials fee required. (2042-782) **Credit 9**

2042-784 **Graduate Metals Studio IV**
This is the fourth of a four-quarter sequential courses covering the advanced aesthetics and techniques in metals. This is the culmination, prior to the thesis studio course, of the program developed on the basis of the individual student's needs, interests, and background preparation as they have been determined through faculty counseling. The student will seriously pursue issues and themes that are relevant to their final thesis topic. The student will be encouraged to utilize new techniques, materials, and concepts. This sequence leads to the master's thesis, proposed by the student and approved by the faculty. Materials fee required. (2042-783) **Credit 9**

2042-890 **Metals Graduate Thesis**
The development of an acceptable thesis project initiated by the student and approved by the student's thesis committee and chairperson of the school. Primarily a creative production resulting in a body of work, the thesis will include a written report, which addresses the body of work. The work will be exhibited in the graduate thesis show. **Credit 0–18**

Textiles

2043-761, 762, 763, 764 **Textile Graduate Elective**
This is the study and appreciation of weaving and textile techniques, soft sculpture, off-loom weaving, and printing. Design approaches are stressed. Materials fee required. **Credit 3 per quarter**

Wood

2044-761, 762, 763, 764 **Wood Graduate Elective**
This is a course in woodworking techniques and procedures. It enables the student to gain design competency through wood and an individual solution to wood projects based on suggested needs. Materials fee required. **Credit 3 per quarter**

2044-781 **Graduate Wood Studio I**
This is the first of a four-quarter sequential courses covering the advanced aesthetics and techniques in wood. This program is structured on the basis of the individual student's needs, interests, and background preparation as they may be determined through faculty counseling. There will be a strengthening of wood techniques, design fundamentals, and encouragement of personal expression. The student will be encouraged to evaluate new techniques, materials, and concepts. This sequence leads to the master's thesis, proposed by the student and approved by the faculty. Materials fee required. **Credit 9**

2044-782 **Graduate Wood Studio II**
This is the second of a four-quarter sequential courses covering the advanced aesthetics and techniques in wood. This is a continuation of the program developed on the basis of the individual student's needs, interests and background preparation techniques, design fundamentals, and encouragement of personal expression. The student will be encouraged to evaluate new techniques, materials, and concepts. This sequence leads to the master's thesis, proposed by the student and approved by the faculty. Materials fee required. (2044-781) **Credit 9**

2044-783 **Graduate Wood Studio III**
This is the third of a four-quarter sequential courses covering the advanced aesthetics and techniques in wood. This is a continuation of the program developed on the basis of the individual student's needs, interests, and background preparation as they may be determined through faculty counseling. The student will begin to seriously experiment with issues and themes that may prove relevant to their final selection of a thesis topic. The student will be encouraged to evaluate new techniques, materials, and concepts. This sequence leads to the master's thesis, proposed by the student and approved by the faculty. Materials fee required. (2044-782) **Credit 9**

2044-784 **Graduate Wood Studio IV**
This is the fourth of a four-quarter sequential courses covering the advanced aesthetics and techniques in wood. This is the culmination, prior to the thesis studio course, of the program developed on the basis of the individual student's needs, interests, and background preparation as they have been determined through faculty counseling. The student will seriously pursue issues and themes that are relevant to their final thesis topic. The student will be encouraged to utilize new techniques, materials, and concepts. This sequence leads to the master's thesis, proposed by the student and approved by the faculty. Materials fee required. (2044-783) **Credit 9**

2044-890 **Wood Graduate Thesis**
The development of an acceptable thesis project initiated by the student and approved by the student's thesis committee and chairperson of the school. Primarily a creative production resulting in a body of work, the thesis will include a written report, which addresses the body of work. The work will be exhibited in the graduate thesis show. **Credit 0–18**

School of Film and Animation

Film and Animation

2065-701, 702, 703 **History and Aesthetics of Film**
An extended comparative survey of the history and aesthetics of film that will explore the four basic forms of the medium: fiction, documentary, animated, and experimental. Emphasis is on determining the unique characteristics of the medium and how those characteristics are used as a means of interpretation and expression. **Credit 4**

2065-711, 712, 713 **Film and Animation Core**
Major emphasis is placed on the individual's learning to generate and intensify his or her personal statement through creative projects. Some of the projects are assigned, while the candidate selects others. Work is critiqued weekly by the instructor. (Restricted to JPHC major) **Credit 4 per quarter**

2065-721 **Animation and Graphic Film 1**
An introduction to the techniques and practice of graphic and animated film production. This course provides training and practical experience in a wide variety of approaches to single-frame motion picture production. Students produce a number of short film exercises utilizing both existing and original artwork. Some techniques covered in the course are: direct modification of the film surface; cel, ink and paint animation; and kinestasis. Screenings of professionally made films will illustrate each technique. Proficiency in drawing is not required. **Credit 4**

2065-727 **Scriptwriting for Animation**
This course explores the principles of dramatic structure and storytelling in both fiction and nonfiction animated film and video. Students prepare short scripts suitable for production. **Credit 4**

2065-731 Film and Video Tools and Technology
An intensive tools and technology course that will allow the student to work in the digital video format. Examines the technical concerns of single and double system portable video production and editing. Production skills in camera work, editing, and sound recording will be covered. (Must have completed required bridge work) **Credit 4**

2065-732 Basic Sound Recording
Learn the techniques of production sound recording, how to use professional recording gear and proper recording and mixing techniques to realize a fully mixed soundtrack to professional quality standards. This course includes fundamental information about sound and sound recording equipment and establishes the foundation for future sound work in advanced production classes. **Credit 3**

2065-733 Graduate Screen Writing
This course explores the writing of fiction for theatrical and non- theatrical films and television. Training concentrates on the elements of dramatic construction. A brief exploration of nonfictional writing, examining preparation, information gathering techniques, and methods of investigation will also be assessed. Both nonfiction and fiction are treated as expository, storytelling forms. Students are responsible for writing a film or television script on a subject of their own choosing and for completing several brief written exercises in areas such as character, dialogue, suspense, subtext, and plot. Class discussion is based on assigned readings, in-class exercises, and in-class reading of student work. (2065-342 or equivalent) **Credit 3**

2065-734 Graduate Screen Writing II
A workshop in writing a short film script. This course focuses on story proposal, script treatment, writing, and rewriting a short script. (2065-733 or permission of instructor) **Credit 4**

2065-736 Theory via Film and Animation
A screenings, classic theory readings, and discussion course designed to introduce MFA production and animation graduate students to themes in classic film theory. A variety of short films and videos will be employed paired with extensive readings from classic theory from the span of the past century of world cinema. **Credit 4**

2065-737 2-D Computer Animation I
Students in this course create animated sequences and projects using a commercial animation software package for a popular microcomputer. In addition to mastering specific software, students learn the principles of digital computer operation and how those principles apply to the problems of animation with computers. (2065-721) **Credit 4**

2065-738 2-D Computer Animation II
This course focuses on the integration of computer animation into film and video. Students produce a finished animated project on film or videotape with sound, which can be used as a portfolio piece. Emphasis is placed upon various postproduction strategies which involve such techniques as combining computer animation with live action, the addition of film and video special effects and combining computer animation with existing film or video imagery. (2065-721) **Credit 4**

2065-741 Graduate Drawing for Animation: Dynamics
This advanced course focuses on drawing of drawn animation. It is one of three different courses in drawing for animation offered, which do not need to be taken in sequence; each course provides a different focus. Students explore the use of acceleration and deceleration squash, and stretch, maintaining volume, anticipation, secondary action, overlapping action, paths of motion, follow through, and exaggeration. A variety of examples of drawn animation will be screened in class. Gesture drawing from live models may be included. (Figure in Motion) **Credit 3**

2065-742 Graduate Drawing for Animation: Sequence
This advanced course focuses on structuring the shots in a scene. It is one of three different courses in drawing for animation offered, which do not need to be taken in sequence; each course provides a different focus. Flexibility is provided for students at different stages of development. Students learn how to break a scene into shots and storyboard the sequence. They learn to compose the frame for action and juxtapose one shot against the next. Students learn to use exposure sheets to plan out animation, and animate short sequences using acquired skills. A variety of examples drawn animation will be screened in class. Gesture drawing from live models may be included. (Figure in Motion) **Credit 3**

2065-743 Graduate Drawing for Animation: Character
This advanced course focuses on character development for animation. It is one of three different courses in drawing for animation offered, which do not need to be taken in sequence; each course provides a different focus. Students produce character sheets. They explore different perspectives of the character drawing from imagination and use the characters in sequential frames of motion. A variety of drawn animation examples will be screened in class. Gesture drawing from live models may be included. (Figure in Motion) **Credit 3**

2065-744 Business of Animation
This class is intended to give students an understanding of studio production and freelance animation. Students will learn the basics of running a business. Production issues particularly related to animation will be studied. Methods of examining costs and projecting work timelines will be practiced. Students will draw up contracts and negotiate terms. Copyright law as it applies to distribution and contracts will be studied. A business plan will be developed by each student. **Credit 2**

2065-745 Acting for Film and Video
A course in basic acting technique with emphasis on the special problems peculiar to film and video production. The class is taught in conjunction with 2065-746, Directing the Actor. Class meetings are organized around the presentation of scenes prepared by student actors and directors. **Credit 3**

2065-746 Directing the Actor
A course in basic directorial techniques with emphasis on the special problems peculiar to film and video production. This class is offered concurrently with 2065-745. Class meetings are organized around the presentation of scenes prepared by student directors. **Credit 3**

2065-747 Introduction to 3-D Computer Animation
This course is an introduction to three-dimensional computer animation. Topics will include modeling using NURBSs and polygons, basic texture mapping and lighting, keyframe animation, forward and inverse kinematics, and rendering. Professional animation software such as Alias/Wavefront's Maya package will be used throughout. By the end of the course, students will be able to model basic characters and objects and to create a simple animation and render a sequence of frames. **Credit 4**

2065-748 Intermediate 3-D Computer Animation
This course gives students the skills to develop their own digital characters. Topics will include advanced modeling, facial expressions, character rigging, nonlinear animation, and the use of "Paint Effects" to create hair and vegetation in software such as Alias/Wavefront's Maya. By the end of the course, students will be able to create and rig their own characters, with facial expressions and hair. They create a short animation introducing their character and demonstrating a range of emotions. (2065-747) **Credit 4**

2065-750, 751, 752, 753 Special Topics-Graduate
Advanced topics of current or special interest designed to broaden and intensify the student's ability to use animation as a means of communication and expression. **Credit 9**

2065-756, 757, 758 Film and Animation Workshop
Each faculty member offers a different opportunity for students to explore the multiplicity of ways that photography or filmmaking can be used as a vehicle for expression and communication. Visual research, group critiques, field trips, studio and laboratory practice are used. **Credit 4 per quarter**

2065-761 Image Movement Music
A seminar-level course co-sponsored by the College of Imaging Arts and Sciences at RIT, the Eastman School of Music (University of Rochester), and the Graduate Department of Dance at SUNY College at Brockport. Lecture/demonstration held during the first six-weeks of the course are designed to provide all students with a basic, practical knowledge of current and experimental performance and production techniques in film, video and animation, and contemporary art, music, dance/choreography and related arts. During the latter four-weeks of this course, students will work jointly and individually, under faculty advisement, on creative or research projects involving combinations of image, movement, and sound/music. Weekly three-hour classes will be held alternately at three schools. Transportation will be provided. (Graduate status) **Credit 3**

2065-762 Stop Motion Animation
Explore techniques for producing stop motion animation. Gain familiarity with the use of a variety of materials, which may include clay, puppet, foam, latex, and more. Develop techniques for making armatures and skeletons and creating joints. Learn how to measure movement from frame to frame. Research and write about a stop motion technique or animator. (2065-331 or 2065-721) **Credit 4**

2065-763 Women's Stories, Women's Films
This course provides an introduction to women's films. Through screening films and class discussion, the course examines the themes and issues of women's narratives and how they function in the medium of film. The hero's journey and traditional narrative structure are contrasted with the heroine's journey and the more personal storytelling style of the feminine. The course also examines differences in films made by women and films made by men about women. During the course, students will have an opportunity to explore their own creativity. **Credit 4**

2065-764 Business of Film and Video
This course examines the business aspects of designing, developing, and producing film or video projects. Emphasis is on development of production projects with interactive problem solving experiences in which the instructor and students work as a production team. Special attention will be given to the role of the producer, estimation and management of production costs, problems of location productions, and the legal issues involved in filmmaking. **Credit 3**

2065-766 Advanced Modeling for Animation
Advanced Modeling for Animation takes a detailed approach to the construction of complex three-dimensional forms, object deconstruction, problem- solving, modeling methodologies, and the advantages and disadvantages of various construction methods. Lighting and texturing techniques will be incorporated into three dimensional objects as they relate to an extension of the modeling process. Each modeling solution is tested in the lab and discussed in lecture with the required notion that animation is the end goal for each model. Students will perform three-dimensional modeling exercises and create three-dimensional projects including a complex object and a humanoid character. (2065-747 or 2065-457 or instructor permission) **Credit 4**

2065-767 Directing for Animation
A seminar in solving directorial problems for animators. Topics will include character and movement development, working with actors and models, identifying and understanding scene construction, directorial responsibility, and the relationship between images in sequence. Both the application of acting techniques for creative development and the aesthetic demands of "visual music" will be emphasized. (2065-347) **Credit 3**

2065-768 Lighting for Film and Video Production
This course will present the fundamental principles of lighting for film and video production. The current methods and practices of lighting used in the motion picture industry will be explored through demonstrations, lectures, and "hands on" lab assignments. (2065-311 or 2065-431, or 2065-731) **Credit 3**

2065-769 Digital Video Post-production
Explore techniques for editing video in a non-linear technique. Students will be exposed to non-linear editing, titling, special effects, audio, and video. Students will produce a series of projects exploring different capabilities on a non-linear editing system. In addition students will be exposed to the various aesthetic theories of editing. (2065-731) **Credit 4**

2065-771, 772, 773 Graduate Seminar I, II, III
The seminar provides an opportunity for all MFA students to develop a sense of community and to openly discuss matters of concern, to discuss each other's animations or films, to meet with visiting artists on campus and to participate in a thesis sharing from time to time. (Restricted to JPHC majors) **Credit 2 per quarter**

2065-776 Dramatic Structure in Film and Television
This course explores the theories of dramatic structure from Aristotle to the present and applies these theories to current and classic dramatic works. The class also explores writing for film and television, including feature film genres, one-hour drama, mini-series, soap opera, and sitcom. A segment on the business of writing covers reader's reports, adaptation of material from other media, and acquisition of rights. **Credit 4**

2065-777 Film and Video Internship: Graduate
Provides the student with on-the-job experience in the field of film/video/animation. The student seeks and acquires a school approved internship position in a business or industry. The working environment provides the forum for learning more about the student's chosen career. A final interview with the internship coordinator assists the student in evaluating the experience. The coordinator should be the faculty member most familiar with the student's internship field. (Permission of internship coordinator) **Credit 1-6**

2065-781, 782, 783 Alternative Processes
An advanced course in the production and presentation of still or moving images using historical and contemporary visual imaging processes. Emphasis is on extending the students' experience in image making by incorporating alternatives to conventional animation or filmmaking into their work. Processes to be covered include lighting, inverse kinematics, digital cinematography, particles, procedural animation, compositing, montage, and combinations of techniques. **Credit 4 per quarter**

2065-784 DVD Authoring
This course is designed to introduce the design and practices of the DVD development with emphasis on rethinking a completed film project. The student develops a specific DVD based on a film they have completed. Class discussion and presentation is oriented towards new directions for the film story with interactivity and sequencing considerations. The student will acquire development tools to include: menu development, subtitles, audio streams, encoding principals, hybrid DVD creation, web linking (DVD@ccess), and basic scripting. **Credit 4**

2065-786, 787, 788 Contemporary Issues
A study of current issues relevant to fine art photography and filmmaking, how they relate to broader historical/cultural issues and how they might suggest future directions. **Credit 2 per quarter**

2065-791 Particle Effects
This course gives students the skills to insert three-dimensional computer special effects into animation and live action footage. The students explore three-dimensional computer particle animation and dynamic simulation using Maya software. Students will create short animations using particle effects, soft bodies, and rigid bodies to simulate nature effects like fire, rain, water and physics-based dynamic, and collision events. MEL scripting is an integral part of this course. (2065-747) **Credit 4**

2065-792 Gesture Drawing for Animators
This course will consist of intensive anatomy and quick sketch workshops using live models and references from videos, Internet, and print sources. Live models, both human and animal, will be scheduled for a portion of each class. Students will study kinesiology, the effect of movement on muscle and bone, and comparative anatomy. As a final project students will create original imaginary characters based on their class assignments. Most of the course work will be in class drawing sessions. Graduate students will create additional materials such as maquettes and animation cycles or Maya models. (2013-211) **Credit 3**

2065-793 Node-based Digital Compositing
Node-based compositing is the industry standard for film and HD video image compositing. This course, currently offered only in the spring quarter, covers the basics of node based compositing trees, color correction, garbage and hold-out mattes, keying, resolution proxies, motion tracking, macros, and expressions. (2065-731) **Credit 4**

2065-799 Independent Study
Learning experiences not provided by formal course structure may be obtained through the use of an independent study contract. (Approval required) **Credit 1–9**

2065-812 Advanced Sound Recording
This course discusses and demonstrates how to accomplish complex audio post-production procedures like ADR, foley recording, and mixing for film and video. This course is heavily based on the evaluation of the students' performance on three deadlines for a group project that the entire class participates in. (2065-732) **Credit 3**

2065-818 Advanced Storyboard and Layout
This course involves creation of in-depth storyboard, production design, and art direction for various media. Students will work on pre-designed characters as well as their own projects. Differing styles of layout, boarding, and workbook will be explained. (2065- 743) **Credit 3**

2065-822 Advanced Stop Motion Animation
Explore advanced techniques for producing stop motion animation. Gain familiarity with the use of a variety of materials, which may include clay, rubbers, aluminum, and more. Develop techniques for making armatures using wire and steel joints. Learn character performance in gesture and expression. Practice methods of miniature lighting and photography, uses digital effects. (2065-372) **Credit 3**

2065-841, 842, 843 Research Seminar
This seminar serves as a planning stage for preparing a research thesis proposal and for an ongoing critique and discussion of the research in progress. Issues related to exhibitions, publications, distribution, and gallery also are covered. (JPHC) **Credit 2 per quarter**

2065-890 **Research and Thesis: Film and Animation**
This thesis is designed and proposed by the candidate. It is considered his or her culminating experience in the program, involving research, a creative body of work, an exhibition or suitable presentation, and a written illustrated report. (Approval required) **Credit 1–12**

School of Photographic Arts and Sciences

Graduate Photography

2066-701, 702, 703 **History and Aesthetics of Photo**
This required seminar surveys and examines the development of the medium beginning with pre-history. Students will explore the first applications of photographic documentation, portraiture, art, and science and will study photography in the context of modernist and post-modernist critical discourse. **Credit 3 per quarter**

2066-711, 712, 713 **Photography Core**
Students engage in a rigorous group critique process to develop a mature body of work, combining experimental and analytical learning methods. They develop aesthetic and technical strategies for the production and presentation of artwork. They also address pendent theoretical research and contemporary art concepts and methodologies, which inform practice. This course is required each quarter in the first year of graduate studies. **Credit 4 per quarter**

2066-732 **Professional Development**
This course prepares students for their professional artistic life beyond graduate school including career opportunities such as academia, etc.. Students gain practical knowledge in portfolio preparation, visual display, grant writing, and contract negotiations for their art making practice. In preparation for academia, students also learn about and prepare teaching philosophies, resumes, and a professional portfolio. (2066-711) **Credit 4**

2066-750, 751, 752, 753 **Special Topics Workshop**
Advanced topics of current or special interest designed to broaden and advance the student's ability to use photography and related media. Recent topics include, Women and Visual Imaging, Warhol and Beuys, Art and Censorship, Digital Imaging 1, Digital Imaging 2, Moving Media 1, Moving Media 2, and Installation Art. **Credit 4 per quarter**

2066-754 **Museum Studies**
Students study advanced topics related to museum and gallery practice through internships, research and projects, which are formally proposed by the student. Emphasis is placed on the function and administration of museums, galleries and the conceptual nature of curating and planning exhibits. (Graduate Status) **Credit 1–9**

2066-756, 757, 758 **Photographic Workshop**
Each faculty member offers a different opportunity for students to explore the multiplicity of ways that photography and related media can be used as a vehicle for expression and communication. Visual research, group critiques, field trips, studio, and laboratory practice and critical readings are used. Workshops may be taught as a theme class or on an individual basis to provide students with critical feedback on projects. Recent theme classes include: Digital Media Cafe, Web Seminar, Electronic Arts Seminar, and Imaging the Self. **Credit 4 per quarter**

2066-762 **Dadaism, Surrealism, and Photography**
This seminar examines the work of a group of artists, known as the Dadaists, who rejected the social order and values that produced World War I. The student will, in turn, explore surrealism, the art movement that moved beyond the "destructive program of Dada" and replaced it with a more creative approach to human values and life. **Credit 3**

2066-763 **Beyond the Family Album**
Beyond the Family Album is a fine art photography course that balances the production of original art work with primary and secondary research, within an intensive critique and seminar format. The narrative of the conventional family album will be a core subject for discussion and study. The concept of 'album' will go beyond the conventional book form to embrace photographic imagery, installation, text, digital forms, and the use of family mementos. Interdisciplinary critical readings and visual art projects concerning issues of identity, and representation of family life in the public and private sphere will form the underpinnings of primary research, against which visual and written projects will be produced. Graduate students will create an original body of artwork on the topic and contribute written and visual material to a class research archive. (MFA or permission of instructor) **Credit 4**

2066-765 **Photography Extensions**
Strip photography, slit/scan photography and stroboscopy are used to probe and artistically manipulate spatial and temporal dimensions in order to create unseen poetic expressions of a space/time continuum. Perceptual principles and technical problems associated with the production and exhibition of such images are studied. **Credit 4**

2066-770 **Photography in the Desert Southwest**
An extended workshop for students to photograph and travel in the Four Corners region of the American southwest with an instructor leading a camping tour through New Mexico, Utah, Colorado and Arizona. Federal and state campgrounds are exclusively used. Students participate in day trips and hikes or make their own daily itinerary. No darkroom facilities are available during the trip. Maps and reading assignments introduce students to the geology, climate, history, and cultures of the Southwest. (Basic photography experience) **Credit 3–9**

2066-771 **Graduate Seminar**
Graduate Seminar is an orientation course required for the incoming graduate student. This course is also designed to engage students in dialogue with guest speakers and faculty on their professional work. Each class involves a professional presentation by a different speaker to be followed by discussion. Activities that foster the emerging career of the artist are stressed. **Credit 2**

2066-772 **Teaching Photography**
A graduate course concerned with the art and craft of teaching photography in formal and informal settings, and in accordance with accepted learning principles. **Credit 4 (not offered every year)**

2066-774 **Landscape as Photo**
This seminar surveys the major artistic, mythological, political, and economic issues influencing the development and use of landscape photography in America from the 1840s to the 1990s. The student will be introduced to a diverse group of historical and contemporary image makers. (Open as an elective pending enrollment by majors) **Credit 3**

2066-778 **Modernism: Photography, Art, and Culture**
Modernism is a term used to describe how life in Europe and America from the 1880's to the 1960's was transformed by 20th century science, technology, and principles of practices of art and culture through the past century. Students will study how pioneers Picasso and Duchamp abandoned the conventions of their perspective and construction of the figure then replaced these traditions with new methods of representation. **Credit 3**

2066-781, 782, 783 **Alternative Processes**
An advanced course in the production and presentation of still or moving images using historical and contemporary visual-imaging processes. Emphasis is on extending the students' experience in image making by incorporating alternatives to conventional photography into their work. Processes to be covered include various light sensitive emulsions and the production of the visual book. **Credit 4 per quarter**

2066-786, 787, 788 **Contemporary Issues**
A study of current issues relevant to fine art photography and related media, how they relate to broader historical/cultural issues and how they might suggest future directions. Emphasis is placed on the integration of critical theoretical discourses and studio practice. **Credit 2 per quarter**

2066-799 **Independent Study**
Learning experiences not provided by formal course structure may be obtained through the use of an independent study contract. **Credit 1–12**

2066-841, 842, 843 **Research Seminar**
The seminar serves as a planning stage and forum for preparing the research thesis proposal and for an ongoing critique and discussion of the research in progress. Additionally, this course will review the thesis process, provide guidelines, and resources for thesis preparation and presentation of the written thesis research paper. Over the course of the quarter, the research proposal will be completed and submitted to thesis advisors for critique and approval. **Credit 2 per quarter**

2066-890 **Research and Thesis**
The thesis is designed and proposed by the candidate to a committee of graduate faculty. It is considered his or her culminating experience in the program, involving the development of independent research leading to new work. There are three components to the thesis: the thesis exhibition, the thesis paper, and the public defense. This required course enables the graduate student to work closely with committee members in the realization of all components of the Thesis. **Credit 1–12**

School of Print Media

Printing Management

2080-707 **Estimating and Analyzing in Graphic Art Systems**
Course content covers the application of information from other management and technical courses to comprehensive situations in estimating. Its aim is to provide the student with an understanding of the relationships between estimation, pricing, and the supply and demand forces which occur in the marketplace and to expose students to several printing specialties so they may appreciate the various cost advantages and disadvantages involved in the use of particular technologies. Class sessions include lectures, discussions, labs, and project presentations by students. In addition to normal reading assignments, the student will be required to prepare and deliver an oral report or a written term paper on a topic related to an estimating, pricing, time-study, or some other cost-related problem of special interest to the student. **Credit 4**

2080-712 **Operations Management in Graphic Arts**
Designed to give the student a broad perspective of the many topics related to managing a printing facility. Topics include an examination of the systems approach to production management, the use of statistics and other quantitative techniques in methods and decision analysis, the cost-volume-price relationship in printing production, and the effect of organizational structure on decision making, line-staff relationships, and management personnel. **Credit 4**

2080-840 **Project Design**
This course exposes graduate students to the applications of the principles of research in the graphic media industry. This includes a systematic study of the scientific method, research statement generation, and types of research design. The students will study problems in the graphic media industry in preparation to complete a graduate level research project. Additional outside work will concentrate on problem solving, the use of the internet and the library in developing bibliographies and the form of the technical writing required for Research Project. **Credit 2**

Printing Technology

2081-701 **Research Methods and Trends**
The theory and applications of the principles of scientific research in the graphic arts will be covered, including a systematic study of the scientific method, hypothesis generation, the nature of theory, types of research design, and measurement. The study of problems in the graphic arts includes ink and paper, reproduction methods, and quality control. **Credit 4**

2081-709 **Printing Industry Trends and Issues**
This course presents a detailed analysis of the trends and issues related to the printing industry. It provides an in-depth look at key technologies as well as business and related issues which contributes to the student's fuller understanding of the technology and the issues affecting print communication. This course prepares students for successful careers by providing insights into the nature and scope of the major challenges facing industry managers and leaders. Research and survey projects help to focus the student's understanding of the industry. **Credit 4**

2081-711 **Tone and Color Analysis**
This course addresses principles and practices of color measurement for color matching and color image rendering in graphic arts imaging. Emphases are placed on the analyses and rendering of spot colors and pictorial images with the use of ICC-based color management systems. Topics include densitometry, CIE colorimetry, color management systems, graphic arts technology standards, and process control. There are lab assignments on color measurement and tone, and color analyses. A self-directed project is required. The instruction is a combination of lectures (live and video-taped), demonstrations, discussions of lab assignments, and when appropriate, guest speakers. **Credit 4**

2081-716 **Graduate Materials and Processes I**
This course presents a multi-dimensional model for comparisons of all major print reproduction processes and evaluation of their suitability for any given application. Students will learn the basic theory of image reproduction embodied in available analog and digital printing processes, and learn to identify the process origins of print samples. Additionally, students will learn which consumables are involved in the various processes. Students will need to complete a final project. **Credit 4**

2081-717 **Graduate Materials and Processes II**
This course presents a multi-dimensional model for comparisons of all major print reproduction processes. Students will develop a sophisticated understanding of the capabilities and suitable applications for each process. A press run for some of the processes will be carried out. The same test targets and images will be used for each run. Students will see how to prepare the files for the different presses. An introduction to image quality will show the students how substrates, inks, toners, and presses/printers all interact and how the final prints can be evaluated. Students will need to complete a final project. (2081-716) **Credit 4**

2081-721 **Digital Print and Publishing**
This course provides students with an opportunity to learn the principles and applications of digital printing. Technical aspects of the major digital print engines and comparison of digital printing to conventional printing processes will be presented. The strategic use of digital printing will be emphasized from a digital workflow standpoint. Variable data personalization and on-demand printing will be studied from both technical and marketing perspectives. **Credit 4**

2081-723 **Contemporary Publishing**
An overview of contemporary book, magazine, and newspaper publishing with emphasis on comparative editorial, production, circulation, and marketing strategies. Advantages and disadvantages of the various kinds of publishing are discussed relevant to meeting the needs of society. Cost structures of the various publishing industries are explored, as are strategies of new acquisitions. **Credit 4**

2081-728 **Database Publishing Applications**
This course presents the various processes, methods, and techniques related to the effective application of databases to the publishing process. Topics include the use of database output as the content for print, electronic media and on-line viewing, as well as the use of databases (such as digital asset management systems, font management systems, etc.) as enablers within the digital publishing process. Course projects range from elementary database construction to sophisticated variable data publishing. The course includes a survey of the spectrum of database applications that enable variable information printing and on-demand publishing. A final project incorporating one or more database publishing methods is required. (Basic Macintosh computer skills and competency in using page-layout applications such as InDesign or QuarkXPress) **Credit 4**

2081-740 **Technology Practicum**
This lab/lecture practicum provides students with the opportunity to participate in an on-campus experience that will familiarize them with the software and hardware associated with high-volume printing and finishing workflows. The Practicum will challenge students to design and produce cross media publishing projects with print media and new media applications. (2081-711, 2081-721 and 2081-728) **Credit 2**

2081-747 **Cross Media Workflow I**
This course is designed to expose students to all the elements needed to master a cross media workflow project. It will introduce students to concepts and laws around copyright and intellectual property and will explore ways companies create and utilize digital asset management systems. Emerging industry and ISO standards for each of the fields will be presented. Hands-on exercises, conducted outside of class, will complement lectures to broaden the understanding of the various topics. **Credit 4**

2081-748 **Cross Media Workflow II**
Lectures, demonstrations, and lab exercises will allow students to experience the workflows involved in modern cross-media publishing. Hands-on projects will give students experience in creating a large- scale, cohesive product which combines components from digital and traditional printing processes coupled with digital media. (2081-716, 2081-717 and 2081-742) **Credit 4**

2081-763 Advanced Color Management
This course will further the scientific methodology in process control for repeatable color and extend the scope of ICC-based color management practices by integrating a number of image capture devices in color-managed digital workflows. Students are expected to work in a team environment, to engage in planning, and conducting press run analyses, and to publish a technical publication using the state-of the-art printing facilities at RIT. (2081-711 or 2081-577) **Credit 4**

2081-767 Media Industry Analysis
This course provides students with an understanding of the major industries closely allied with the printing industry; advertising, publishing, and packaging. The intent is to give students in-depth knowledge of; (1) the structure of each of these industries; (2) the channels and methods through which and by which each distributes its products and services; and (3) the major customer/clients of its products and services. Particular attention will be devoted to investigating the business models for the use of print to create value in advertising, publishing, and packaging. (2081-706) **Credit 4**

2081-840 Research Projects
Individual research projects in which independent data are collected by the student, followed by analysis, and evaluation. A comprehensive written report is required. Consent of advisor is required. **Variable credit 1–5**

2081-850 Project Research
Completion of established project requirement established between student and research advisor. **Credit 0**

2081-890 Thesis
An experimental survey of a problem area in the graphic arts. **Credit 4–8**

2081-890-99 Continuation of Thesis/Research Project
Involves the completion of established thesis or research project requirement established between the student and thesis/research advisor. **Credit 0**

College of Liberal Arts

www.rit.edu/~690www/

Glenn Kist,
Interim Dean

The College of Liberal Arts offers master of science degrees in the following areas: applied experimental and engineering psychology, communication and media technologies; science, technology and public policy; and school psychology.

The master of science degree in applied experimental and engineering psychology emphasizes the role of human behavior in the use of technology, and prepares students for careers as engineering psychologists in industrial, governmental or consulting organizations.

The master of science degree in communication and media technologies prepares students to not only analyze and anticipate communication problems, but also to create and implement solutions to them. These objectives are achieved through a curriculum that combines advanced courses in communication theory, research and audiences, law and ethics, and professional or applied technologies.

Graduates of the master of science degree in science, technology and public policy will be well grounded in qualitative and quantitative theories and methodologies, as well as sound ethical principles. The curriculum is designed to provide students with the skills to collect, organize and analyze relevant science and technology policy data.

The master of science degree in school psychology is designed for graduate students who desire a career focusing on the psychological evaluation of and intervention with children in school settings. Students who complete the two-year academic program and the 1,200-hour full-year internship have excellent placement opportunities as psychologists in both school and agency settings.

Elective graduate courses complement the professional emphasis of the degree programs by exploring the broader knowledge and social implications embodied in these areas of study. By providing this humanistic perspective, these courses play an integral role in professional education, making a direct and distinct contribution to the student's preparation for a specialized career.

The college also provides a number of graduate courses that serve as electives for some of the master's degree programs offered by other RIT colleges.

Programs

Master of Science degrees in:

Applied Experimental and Engineering Psychology	p. 157
Communication and Media Technologies	p. 159
Science, Technology and Public Policy	p. 160
School Psychology	p.157

Advanced Certificate in:

School Psychology	p.157

Faculty

Members of the faculty are students' advisers as well as teachers. Their backgrounds in the field, the classroom and research are the basis for academic standards and expertise that anticipate graduates' career requirements.

Psychology Department

www.rit.edu/%7E689www/

Master of Science in Applied Experimental and Engineering Psychology

Kathleen Chen, Program Chair
(585) 475-2405, kccgss@rit.edu
www.rit.edu/%7E689www/engg.htm

The master of science program in applied experimental and engineering psychology emphasizes the role of human behavior in the use of technology. The departments of psychology, industrial and systems engineering, and information technology all contribute to the teaching of specialty courses in the program.

Engineering psychology examines the capacities and limitations of humans to sense, store and process information, and the use of this information in performance. This knowledge is applied to the design, use and maintenance of human-machine systems. Students will be trained in the application of experimental psychology to contemporary problems in industry, design and technology.

Engineering psychologists are interested in why performance might be changed through the use of technology. For instance, a new interface for controlling the radio in a vehicle may cause errors because a control is too sensitive for human-motor performance or because the driver is confused as to how to use a button. Psychological and motor processes both are involved in the operation of such an interface, and the distinction of these processes can help identify design solutions.

The MS program in applied experimental and engineering psychology prepares students to function as effective engineering psychologists in an industrial, governmental or consulting organization. The program also provides a foundation for further advanced academic study in engineering psychology, human factors or experimental psychology.

Admission requirements

Applicants to this program are expected to have 20 quarter credit hours (or 15 semester hours) of course work in undergraduate psychology, including one course in experimental psychology and another in statistics. Admission decisions will be based on:

- a minimum GPA of 3.0 for undergraduate work,
- Graduate Record Examination scores (within the last five years),
- two letters of reference from professors or supervisors,
- a biographical statement describing the applicant's experience and goals regarding the program, and
- a completed application for graduate admission to RIT.

Thesis

The thesis requires eight credit hours. A thesis adviser will be assigned to the student. Selection of a topic and research proposal must be completed in the spring quarter of the first year of the program, with the assistance of the adviser. Ongoing research activity is expected in the spring and summer quarters of the first year of the program.

At the completion of the thesis, students will present and defend their research before a thesis committee. A bound copy of the thesis and a written paper in short format suitable for publication or conference presentation will be submitted to the department.

Required Experimental Core Courses		Qtr. Cr. Hrs.
0514-784	Graduate Statistics	4
0514-785	Advanced Perception	4
0514-786	Research Methodology	4
0514-787	Advanced Cognition	4

Required Engineering Psychology Courses		
0514-788	Topics in Engineering Psychology	4
4004-745	Foundations of Human-Computer Interaction	4
0303-731	Advanced Topics: Ergonomics/Human Factors	4
0303-734	Systems Safety Engineering	4

Electives	
4002-317	Visual Basic for Programmers (4002-218 or equivalent)
4004-748	Usability Engineering (4004-745 and 4004-741)
4004-749	Usability Testing (4004-748 and Statistics)
4004-755	Advanced Topics in HCI (4004-745)
0303-530	Engineering Design
0303-732	Biomechanics (0304-331, 0304-332, 0303-730 or equivalent)
2014-701	Introduction to Computer Graphics (permission of the instructor required)
2014-717	Authoring Multimedia (permission of the instructor required)
2014-723	Graphical User Interface

Cooperative education

The MS degree program in applied experimental and engineering psychology has an optional cooperative education component. Co-op is generally completed in the summer quarter of the first year of the program. The goal of a co-op experience is to provide experiential learning that integrates with classroom education. It allows students to apply psychological principles to problems in a variety of work environments.

Master of Science in School Psychology

Scott P. Merydith, Program Chair
(585) 475-6701, spmgsp@rit.edu

The College of Liberal Arts offers a graduate program that leads to an MS degree or an advanced certificate in school psychology. The program, approved by the National Association of School Psychologists, prepares students for provisional New York state certification as school psychologists. Designed to provide students with a strong background in psychological foundations, the program develops professional skills and competencies in counseling, evaluation and consultation.

A school psychologist works with young children (birth to age five); elementary, junior high and high school students; teachers and administrators; parents; and professionals to offer services that lead to the amelioration of existing student

difficulties and attempt to prevent school problems. Through diagnostic testing, counseling, consultation and intervention, school psychologists help students deal with learning and behavioral difficulties and help improve students' adjustment to school and their community.

The Master of Science degree is awarded after students have completed all coursework and an internship, and have passed a portfolio review. The Advanced Certificate in School Psychology is awarded to students who have met all the requirements of the MS degree and have completed and defended a thesis or research project.

Admission requirements

Admission to the program is based on the following criteria:

- Successful completion of the baccalaureate degree at an accredited college or university
- An undergraduate cumulative grade point average of 3.0 or above
- Completion of at least 18 semester hours (27 quarter hours) in behavioral sciences with a grade of B or above
- Prerequisite undergraduate courses in general psychology, elementary statistics, child or developmental psychology and abnormal psychology
- Graduate Record Examination scores of 470 (Verbal) and 600 (quantitative)
- For students whose primary language is not English, scores from the Test of English and a Foreign Language (minimum score of 580 paper-based)
- Letters of reference
- An essay about the student's goals and related experience that shows evidence of a professional commitment and the potential for developing effective relationships with children, youth and adults
- An individual interview

All credentials must be submitted and reviewed before the student completes 12 quarter credit hours of graduate work in the program. Applications are due by March 1. Later applications will be reviewed on a space-available basis.

Curriculum

Required Psychological Foundation and Professional Courses (20 credits)		Qtr. Cr. Hrs.
0527-701	Advanced Developmental Psychology	4
0527-702	Psychology of Teaching/Learning	4
0527-723	Developmental Psychopathology	4
0527-739	Children and Trauma	4
0515-701	Cultural Diversity in Education	4

Required Statistics and Research Methodology (11 credits)

0527-728	Inferential Statistics I	2
0527-759	Research Methods I	2
0527-890	Thesis	
or		
0527-891	Project (1 per quarter for 3 quarters)	3
0527-810	Research Methods II	2
0527-811	Inferential Statistics II	2

Required Specialized Courses (44 credits)

0527-724	Interpersonal Intervention Skills	4
0527-726	Psychoeducational Assessment I	4
0527-730	Seminar—Professional and Legal Issues	4
0527-731	Psychoeducational Assessment II	4
0527-732	Psychoeducational Assessment III	4
0527-733	Applied Behavioral Analysis	4
0527-734	Psychoeducational Assessment IV	4
0527-742	Biological Basis of Behavior	4
0527-744	Advanced Counseling	4
0527-745	Alternative Assessment Techniques	4
0527-749	Advanced Consultation	4
0527-744	Advanced Counseling	4

Required Field Experience (21 credits)

0527-712 –717	Practicum I, II, III, IV, V, and VI	12
0527-777	Internship I, II, and III	9
Total		**96**

Proposed plan of study

First Year

Fall Quarter

0527-726	Psychoeducational Assessment I
0527-724	Interpersonal Intervention Skills
0527-733	Applied Behavioral Analysis
0527-712	Practicum I

Winter Quarter

0527-731	Psychoeducational Assessment II
0527-749	Advanced Consultation
0527-701	Advanced Developmental Psychology
0527-713	Practicum II

Spring Quarter

0527-732	Psychoeducational Assessment III
0527-744	Advanced Counseling
0527-723	Developmental Psychopathology
0527-714	Practicum III

Second Year

Fall Quarter

0527-734	Psychoeducational Assessment IV
0527-745	Alternative Assessment Techniques
0527-759	Research Methods I
0527-728	Inferential Statistics I
0527-715	Practicum IV

Winter Quarter

0527-742	Biological Basis of Behavior
0527-702	Psychology of Teaching/Learning
0527-810	Research Methods II
0527-811	Inferential Statistics II
0527-716	Practicum V

Spring Quarter

0515-701	Cultural Diversity in Education
0527-739	Children and Trauma
0527-730	Seminar—Professional and Legal Issues
0527-717	Practicum VI
	Project/Thesis

Third Year

Fall Quarter

0527-777	Internship I
	Project/Thesis

Winter Quarter

0527-777	Internship II
	Project/Thesis

Spring Quarter

0527-777	Internship III

Degree requirements

A minimum of 96 quarter credit hours are required for completion of the program. Before registering for the internship, students must pass a portfolio review. A cumulative grade point average of 3.0 or above is required.

Department of Communication

Master of Science in Communication and Media Technologies

Rudolph R. Pugliese, Graduate Coordinator
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www.rit.edu/cmt

Communication and the technologies for message creation and dissemination are at the center of dramatic economic, social and cultural changes occurring as a result of technological development and global connectedness. The master of science degree in communication and media technologies is an interdisciplinary advanced program of study combining liberal arts courses in communication with course work in an applied or professional program. Graduates will be adept at the analysis of communication problems, the development of solutions and the creation of messages as a result of their combined training in the social sciences, humanities and applied technologies.

Communication courses rooted in the humanities and social sciences provide students with the opportunity to gain a broad, historical understanding of issues in communication, including the ethical, legal and social dimensions. Additional courses give students advanced guidance in the creation of written and visual message content. Courses in applied technologies or professional programs provide opportunities for implementation and application. The required thesis combines knowledge, practice, original research and application under the guidance of a graduate advisement committee.

Graduates are prepared for careers as communication experts in such venues as commerce, industry, education, entertainment and government, as well as for graduate work toward a doctoral degree.

Admission requirements

Applications for admission are accepted for all four academic quarters, but most full-time students begin their program of study in the fall. Admission to the program is based on the following criteria:

- A graduate application
- The successful completion of the baccalaureate degree at an accredited college or university, accompanied by official transcripts
- A cumulative undergraduate grade point average of 3.0 or above
- Submission of scores from the Test of English as a Foreign Language (minimum score of 600 paper-based or 200 computer-based is required)
- Three letters of reference from academic advisers, major professors and/or supervisors or managers
- The submission of a writing portfolio consisting of at least three writing samples, such as academic papers written for class, work-related brochures and pamphlets or newspaper or magazine articles

All credentials must be submitted and reviewed before the student completes 16 quarter credit hours of graduate work in the program.

Curriculum

Earning the degree requires completion of a minimum of 45 quarter credit hours of graduate course work, distributed as follows: four required communication courses (16 quarter credit hours) plus three or four communication electives (12–16 quarter credit hours) offered by the department of communication, three or four courses (12–16 quarter credit hours) in applied professional or technical course work from one of RIT's other colleges and five to nine thesis/project credit hours earned in the department of communication.

A full-time student will create a graduate advisement committee by the end of the first quarter of study. The committee will be comprised of at least one faculty member from the department of communication and one faculty member from an appropriate applied technical program from another RIT college. The committee advises and guides the student's elective course selection and course sequencing. With the guidance and approval of the graduate advising committee, students design and conduct a thesis/research project appropriate to their course of study and their career goals.

Required communication courses (16 credits)		Qtr. Cr. Hrs.
0535-701	History of Media Technologies	4
0535-702	Communication Theory	4
0535-703	Research Methods in Communication	4
0535-704	Communications Law and Ethics	4
0535-800	Project/Thesis	5–9

Communication electives (12–16 credits)

Students are required to select three communication electives from the choices below; a fourth elective is optional. History of Media Technologies and Industries (0535-701) and Communi-

cation Theory and Audiences (0535-702) are prerequisites for all communication electives.

		Qtr. Cr. Hrs.
0535-705	Electronic Communication and Society	4
0535-706	Crafting the Message	4
0535-707	International Media	4
0535-708	Teaching and Training Technologies	4
0535-709	Online Advertising and Public Relations	4
0535-710	Visual Communication	4
0535-725	Special Topics in Communication	4

Applied professional or technical courses (12–16 quarter credit hours)

Students are required to select three applied professional or technical courses from the choices below; a fourth applied or technical course is optional.

College of Imaging Arts and Sciences		Qtr. Cr. Hrs.
2081-709	Trends in Printing Technology	4
2081-723	Contemporary Publishing	3
2081-742	Document Processing Languages	4

College of Computing and Information Sciences		Qtr. Cr. Hrs.
4002-718	Current Themes in Information Technology	4
4002-733	Fundamentals of Computer Communication	4
4002-741	Fundamentals of Web-Based Multimedia	4

College of Business		Qtr. Cr. Hrs.
0105-761	Marketing Concepts	4
0105-766	Marketing in Global Business	4
0105-767	Marketing Communications	4
0105-772	Marketing on the Internet	4
0102-740	Organizational Behavior and Leadership	4
0102-741	Leading Change in a Quality Organization	4
0102-742	Introduction to Technology Management	4
0102-762	Managing New Process and Product Development	4

Master's thesis/project

A thesis or project is required of all students in the program. The thesis/project topic should complement the student's academic graduate interests and scholarly training. Topic selection and method(s) for implementing the thesis/project occur in consultation with the student's graduate advisement committee.

Proposed plan of study

Fall Quarter

0535-701	History of Media Technologies and Industries
0535-702	Communication Theory and Audiences
	Communication elective or applied professional/technical course

Winter Quarter

0535-703	Research Methods in Communication
	Communication elective
	Communication elective or applied professional/technical course

Spring Quarter

0535-704	Communications Law and Ethics
	Communication elective
	Communication elective or applied professional/technical course

Summer Quarter

0535-800	Communications Thesis and Project
	Communication elective or applied professional/technical course

Science, Technology and Society/ Public Policy Department

Master of Science in Science, Technology and Public Policy

James J. Winebrake, Department Chair
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www.rit.edu/~ppolicy

RIT's public policy program offers an innovative, interdisciplinary master of science degree in science, technology and public policy, with an emphasis on engineering, science and technology policy. The program builds on RIT's strengths as a technological university, enabling students to interact with faculty members and researchers who are working on scientific developments and technological innovations that drive new public policy considerations.

The program is located in the College of Liberal Arts but draws significantly from disciplines and courses of study located in the other colleges, especially the E. Philip Saunders College of Business, the College of Science, the Kate Gleason College of Engineering and the College of Applied Science and Technology. The program is geared toward graduates who will make significant contributions in the private, public and not-for-profit sectors.

All students take a set of policy core courses that emphasize analysis, problem solving and interdisciplinary approaches. Students work with an adviser to choose electives that focus their policy studies in a particular area, such as environmental policy, telecommunications policy or energy policy. Typical students include those with science or engineering backgrounds looking to broaden their career opportunities in government or business settings, as well as those with liberal arts undergraduate degrees (e.g., economics) interested in science, technology and policy issues. Full-time students can typically finish the program in one to two years. The program prides itself on working one-on-one with students to ensure that their educational needs and academic goals are attained.

Admission requirements

Two options are available to students interested in the MS degree in science, technology and public policy.

Students may enter the program from the public policy BS program and earn a combined BS/MS in five years. To be admitted into the graduate portion of the BS/MS track, a student must receive permission of the department and meet the following criteria:

- Completion of all requirements of the BS curriculum
- A GPA of at least 3.0

Students seeking admission to the MS program from other

RIT programs, or from outside the university, should meet the following requirements:

- Successful completion of the baccalaureate degree at an accredited college or university
- Minimum 3.0 overall GPA
- Two writing samples, one of which should be a statement of interest
- Graduate Record Examination scores
- Calculus and statistics courses (students may be required to take a data analysis or statistics course and an introductory calculus course, if not taken previously)
- Two formal letters of reference
- Test of English as a Foreign Language with a minimum score of 570 (paper-based) or 230 (computer-based) for students whose primary language is not English
- Fulfillment of general criteria for graduate admission as listed in this bulletin

Curriculum

A minimum of 48 quarter credit hours is required for completion of the MS in science, technology and public policy.

The BS/MS student may obtain 12 quarter credit hours of graduate work in the fourth year of the BS curriculum. Thus, a BS/MS student would need to take only 36 hours in the fifth year.

Students transferring into the MS program from other BS degree programs at RIT or from outside the university may be required to complete an additional three-course policy analysis sequence (Policy Analysis I, II and III) or demonstrate that they have equivalent skills for completion of the degree.

The graduate curriculum has a required five-course core: Readings in Public Policy (0521-700), Advanced Theory and Methods in Policy Analysis (0521-701), Evaluation Research (0521-702), Public Administration and Management (0521-709) and Science, Technology and Policy (0508-740). In addition, students will choose five courses within their area of specialization.

Students also are required to successfully complete a master's thesis. The thesis allows students to work with a faculty adviser on an independent research project in their area of interest.

Course offerings

Required core courses:

0521-700	Reading in Public Policy
0521-701	Advanced Theory and Methods in Public Policy
0521-702	Evaluation Research
0508-740	Science, Technology and Policy
0521-709	Public Administration and Management

Elective courses

Students choose five elective courses based on their interests and career goals. Courses may be offered in various colleges throughout the university, including the E. Philip Saunders Colleges of Business, the Kate Gleason College of Engineering, the College of Science and the College of Applied Science and Technology. Course selection is done jointly with a faculty adviser and typically is aimed at developing a specialized area of interest for the student (e.g., biotechnology policy, environmental policy, energy policy, communications policy). Example elective courses include:

0521-708	Technological Innovation and Public Policy
0521-751	Energy Policy
0521-710	Information and Communications Policy
0521-706	Qualitative Policy Analysis
0521-749	Special Topics in Public Policy
0102-749	Introduction to Technology Management
0614-780	Telecommunication Policy and Issues
0508-484	Environmental Policy
4002-873	Information Technology and Strategic Opportunity
0630-770	Environmental Risk Assessment, Management and Communications
0307-772	Applied Survey Design and Analysis
0102-745	Social and Political Environment of Business
0511-711	Microeconomics for Graduate Students
0511-750	Benefit-Cost Analysis
0511-757	Applied Econometrics
0511-766	Health Care Policy
0511-781	Environmental Economics
0511-784	Natural Resource Economics

Graduate Faculty

Applied Experimental and Engineering Psychology

Kathleen C. Chen, BA, Rangoon University; MA, Bryn Mawr College; Ph.D., Pennsylvania State University—Department Chair; Professor

Nicholas DiFonzo, MA, Rider College; MA, Ph.D., Temple University—Professor

Andrew M. Herbert, BS, McGill University; MA, Ph.D., University of Western Ontario—Associate Professor

Department of Communication

Bruce A. Austin, BA, Rider College; MS, Illinois State University; Ph.D., Temple University—Professor, Communication

Susan Barnes, BFA, Pratt Institute; MFA, Ph.D., New York University—Associate Professor, Communication

Grant C. Cos, BA, University of Massachusetts; MA, Emerson College; Ph.D., Kent State University—Associate Professor, Communication

Diane S. Hope, BS, State University of New York at Brockport; MS, Ph.D., State University of New York at Buffalo—Professor, Communication

Keith B. Jenkins, BA, University of Arkansas; MA, Ph.D., Florida State University—Associate Professor, Communication

David R. Neumann, BA, Ithaca College; MA, Ph.D., Bowling Green State University—Professor, Communication

Rudolph R. Pugliese, BA, State University of New York at Oneonta; MA, State University of New York at Brockport; Ph.D., Temple University—Professor, Communication

Patrick M. Scanlon, BA, State University of New York at Albany; Ph.D., University of Rochester—Professor, Communication

Humanities

Bruce A. Austin, BA, Rider College; MS, Illinois State University; Ph.D., Temple University—Professor, Communication

Charles D. Collins, AB, Rutgers University; MA, Ph.D., University of Iowa—Professor, Fine Arts

Rebecca O. Edwards, BA, College of the Holy Cross; Ph.D., University of Rochester—Associate Professor, History

Timothy H. Engström, BA, MA, Ph.D., University of Edinburgh—Professor, Philosophy

David B. Suits, BA, Purdue University; MA, Ph.D., University of Waterloo—Assistant Professor, Philosophy

Public Policy

James J. Winebrake, BS, Lafayette College; MS, Massachusetts Institute of Technology; Ph.D., University of Pennsylvania—Department Chair; Professor, Science, Technology, and Public Policy

Franz Foltz, BS, MS, Pennsylvania State University; Ph.D., Rensselaer Polytechnic Institute—Associate Professor, Science, Technology, and Public Policy

Ron Hira, BS, Carnegie Mellon University; MS, Ph.D., George Mason University—Assistant Professor, Science, Technology and Public Policy

M. Ann Howard, BS, Cornell University; JD, Rutgers University—Associate Professor, Science, Technology, and Public Policy

William A. Johnson, Jr., BA, MA, Howard University—Distinguished Professor, Science, Technology and Public Policy

School Psychology

Suzanne Graney, AA, Finger Lakes Community College; BA, State University of New York at Geneseo; Ph.D., University of Oregon—Assistant Professor, School Psychology

Jennifer Lukomski, BA, Williams College; MA, Gallaudet University; Ph.D., University of Arizona—Assistant Professor, Psychology

Scott P. Merydith, BA, M.Ed., Ph.D., Kent State University—Associate Professor, Psychology

Vincent Pandolfi, BA, Lafayette College, MA, Ph.D. Hofstra University—Assistant Professor

Note: Prerequisites are within parentheses at the end of the course descriptions

History

0507-701 History of Deaf Educational Thought
A historical analysis of change and continuity in educational history from colonial through contemporary America. Special emphasis will be given to the development of the field of deaf education in the United States. Lectures, seminar discussions, and readings offer comprehensive coverage of the salient intellectual themes of American deaf educational history. **Class 4, Credit 4 (offered annually)**

Science, Technology and Society

0508-740 Graduate Science and Technology Policy Seminar
Students in this course will apply basic policy skills, concepts, and methods to a contemporary science and technology policy topic. Topics may vary from year to year or term to term. (Graduate standing in science, technology and public policy; or 0508-441, 0508-484 or 0521-400; or permission of the instructor) **Class 4, Credit 4 (offered annually)**

0508-770 Graduate Environmental Studies Seminar
This course explores a specific, in-depth environmental issue, problem, or topic from multidisciplinary perspectives. Students will read pivotal texts appropriate to the topic with the goal of formulating reasonable and appropriate responses; experiential learning activities such as field trips may also be included. (Graduate standing in science, technology and public policy or environmental science or permission of instructor) **Class 4, Credit 4 (offered annually)**

0508-790 Graduate Biodiversity and Society
This course explores the problems, issues, and values stemming from the current massive loss of biodiversity. This course also explores why preserving or conserving biodiversity is considered to be important, and what mechanisms have been identified for its maintenance. (Graduate standing in science, technology and public policy or environmental science; or permission of instructor) **Class 4, Credit 4**

0508-791 Graduate Sustainable Communities
The purpose of this course is to broaden students' understanding of the concept of sustainability, particularly as it applies to local communities. We will focus on sustainability as a way to bring light to the connections between natural and human communities, between nature and culture, and the connections between environmental, economic, and social systems. We will explore these concepts to an urban neighborhood. We will determine how locally developed information and data can inform the process of measuring sustainability in this context. Graduate students will be responsibible for leading class discussions and will be required to prepare an in-depth, community-based research paper on a topic selected in consultation with the instructor. **Class 4, Credit 4 (offered annually)**

Philosophy

0509-705 Seminar in Art/Aesthetics
The four-hour meetings of this seminar are discussion-driven, and participation of all students is required. Since the theories and examples discussed are mostly from the Western canon, familiarity with the history of Western art is recommended. The questions discussed are philosophical questions about art and aesthetic experience: What is the relationship between art and beauty, art and truth, art and knowledge, art and judgment, art and politics, art and interpretation, art and contemporary philosophical theory? What makes an interpretation of an artwork valid or invalid? How is aesthetic value related to other values? **Class 4, Credit 4 (offered annually)**

0509-706 Philosophy of Mind
Philosophy of mind is the philosophical discipline that explores what a mind is and how it fits in the natural world. In doing this, philosophy of mind raises further questions such as: What do we mean by the mind? How do we attribute mentality? How are mental and physical properties related? What is consciousness? Can computers think? How is rationality connected to mental states like beliefs and desires? In this course we discuss and critically assess answers to these and related philosophical questions. **Class 4, Credit 4 (offered annually)**

0509-707 Philosophy of Vision and Imaging
Appeals to sight, to the rhetoric of seeing, and to various media and technologies of imaging have had an enormous impact on philosophy and on human culture generally. This course will introduce students to the philosophy of vision and imaging by critically investigating four interrelated sets of concerns: (1) The relation between appeals to vision and the imaging technologies that mediate what and how we see; (2) the relation between imaging technologies and the acquisition and representation of knowledge; (3) the relations between imaging technologies and human identity and agency; (4) and the relations between imaging theories/practices and ethical, political, ideological, and social contexts. No prerequisite. **Class 4, Credit 4 (offered occasionally)**

Economics

0511-711 Microeconomics for Graduate Students
This course develops the tools that are commonly used to study the allocation of resources in a mixed economy of private and public enterprises. This course provides an intensive overview of the microeconomic models underlying the actions of consumers and households, firms, regulators, and other public institutions. These models will be applied to current issues in policy (as it arises in all fields of inquiry). **Class 4, Credit 4**

0511-750 Benefit-Cost Analysis
Most programs of governmental agencies are now normally evaluated using the techniques of benefit-cost analysis and debates about the usefulness of alternate projects often draw on benefit-cost findings. Yet, the application of benefit-cost analysis is controversial, in part because of disagreements about the goals of such analysis and about the way in which such analysis ought to be conducted. Therefore, this graduate level course will explore the use and the abuse of benefit-cost and related analytical techniques commonly encountered in economic policy analysis. Specifically, the mechanics, the power, and the shortcomings of this kind of analysis will form the primary elements of this course. **Class 4, Credit 4**

0511-757 Applied Econometrics
This course provides students with an opportunity to develop their skills in applied regression analysis. It covers the various regression models, estimation techniques, data preparation and transformation, and the interpretation of regression results. There is particular emphasis on the dangers of misuse of regression techniques. **Class 4, Credit 4**

0511-766 Health Care Policy
Examines the economics of health care, the organization of its delivery and financing, and analyzes access to care issues, the role of insurance, the regulation of hospitals, physicians, and the drug industry, the role of technology, and limits on health care spending. Calculus, intermediate or accelerated microeconomics, statistics and regression analysis are necessary tools for reading health care policy research and conducting economic modeling. **Class 4, Credit 4**

0511-781 Environmental Economics
Examines the relationship and apparent conflict between economic growth and environmental quality, the economics of environmental issues and policy, the environment as a resource and a public good, and the ability and lack of ability of free markets and the government to deal adequately with pollution and other environmental problems. **Class 4, Credit 4**

0511-784 Natural Resource Economics
This course develops an economic perspective on one of the most important and challenging issues facing global society—the allocation, use, and preservation of natural resources. The course presents and discusses the methodology economists use to inform natural resource managers and policy makers. Economic thought and analysis are used to evaluate a variety of issues in this area. The course concludes with a brief discussion of the interdisciplinary aspects of natural resource management. **Class 4, Credit 4**

Psychology

0514-784 Graduate Statistics
This course introduces students to advanced inferential parametric and non-parametric data-analysis techniques commonly used in psychological research. The focus is on the conceptual understanding of these statistics, how different statistical procedures are applied in different research methods, how to perform analyses, how to interpret the results in the context of the research question, and how to communicate these results. **Class 3, Lab 1, Credit 4 (offered in fall quarter)**

0514-785 **Advanced Perception**
This course will be organized such that students will work in groups on various projects as well as covering topics through readings and classroom instruction. The course is designed to provide students with a deeper understanding of topics in perception. The course will examine: temporal and spatial frequency perception; after effects, visual illusions and their relationship to cortical function and pattern perception; color perception; depth and motion perception; higher order perception such as face and object recognition; and music and speech perception. The goal is to cover current research and theories in perception, looking at current developments and their antecedents. There will be lab time for students where they will examine empirical findings in perception and develop their research skills in the field. **Class 3, Lab 1, Credit 4 (offered fall quarter)**

0514-786 **Research Methodology**
This course is a hands-on approach to research methodology and scientific writing in the field of psychology with a focus on experimental design. The goal of the class is to provide students with a sufficient background to be able to conduct their own psychological research. One objective is to assist students in finalizing their thesis research proposal. Students will gain experience as both participants and investigators. They will participate in brief instructor-run experiments as well as design, execute, and analyze experiments in class, and present their findings to the group. Students will also discuss and critique current research papers. Finally, students will develop their thesis research proposal during the course. Fellow students along with the instructor will critique each proposal, allowing students to generate a feasible and promising research plan for their thesis. **Class 4 (offered winter quarter)**

0514-787 **Advanced Cognition**
This course will survey theoretical and empirical approaches toward understanding the nature of the mental processes involved in attention , learning and memory, problem solving and decision making, language, planning, and motor control. The course attempts to present a balance between historically significant findings and current "state-of-the- art" research. Toward this end, fundamental readings and modern arguments have structured the nature and direction of scientific debate in these fields will be discussed. Critical evaluation of the research at the crux of each debate will be emphasized. Students will be guided in critical thinking about possible new cognitive experiments that would put current theories to the test and provide grounds for supporting, modifying, or rejecting them. The course also interweaves material on laboratory research and practical applications in these areas. **Class 3, Lab 1, Credit 4 (offered in winter quarter)**

0514-788 **Topics in Engineering Psychology**
This course will do critical examinations of current problems in a selected area of engineering psychology. Areas may include time sharing and workload assessment, product design, usability, human computer interaction, accidents and safety, and task analysis. Areas may vary each time the course is offered. Students may register for this course more than once. No prerequisite. **Class 3, Lab 1, Credit 4 (offered in fall quarter).**

Science, Technology and Public Policy

0521-700 **Seminar: Readings in Public Policy**
This course provides an in depth inquiry into the seminal literature influencing key contemporary public policy debates. Students engage in critical reflection and original thought on theoretical and applied public policy problems. Emphasis is placed on policy issues in selected science and technology fields. (Matriculation in the science, technology and public policy master's program or permission of the instructor is required) **Class 4, Credit 4 (offered fall quarter)**

0521-701 **Seminar: Advanced Theory and Methods**
This course will cover the major theoretical and applied analytical methods and techniques in both quantitative and qualitative analysis. An emphasis will be placed on integrating empirical and normative concerns. Methods covered vary by quarter, but may include optimization, cost-benefit analysis, systems modeling, and multi-criteria decision analysis. (Matriculation in the science, technology and public policy master's program or permission of the instructor is required) **Class 4, Credit 4 (offered winter quarter)**

0521-702 **Seminar: Evaluation Research**
The focus of this course is on evaluation of program outcomes. Students will explore the questions and methodologies associated with meeting programmatic outcomes, secondary or unanticipated effects, and an analysis of alternative means for achieving program outcomes. Critique of evaluation research methodologies will also be considered. (Matriculation in the science, technology and public policy master's program or permission of the instructor is required) **Class 4, Credit 4 (offered spring quarter)**

0521-703 **Thesis Research**
The master's thesis in science, technology, and public policy requires the student to select a thesis topic, advisor and committee; prepare a written thesis proposal for approval by the faculty; present and defend the thesis before a thesis committee; and submit a bound copy of the thesis to the library and to the program chair. (Matriculation in the science, technology and public policy master's program, acceptance of a thesis proposal, and satisfactory completion of a minimum of 16 graduate credits are required) **Class 4, Credit 8 (offered quarterly)**

0521-706 **Qualitative Policy Analysis**
This course examines multiple methodologies and techniques used for the qualitative analysis of public policy. The course examines methods known for their descriptive richness, interpretive insights, heightened concern for research subjects' views, and sociocultural relativism. Specific techniques include: interviewing, field methods, participant observation, ethnography, focus groups, Delphi panels, and case studies. (Graduate standing) **Class 4, Credit 4**

0521-708 **Technological Innovation and Public Policy**
Technological innovation, the incremental and revolutionary improvements in technology, has been a major causal factor for economic growth and social and political change. This course will introduce generic models of innovation that span multiple sectors including: energy, environment, biotechnology, and information technologies. The course will then analyze how governments choose policies to spur innovation. (Graduate standing) **Class 4, Credit 4 (offered annually)**

0521-709 **Public Administration and Management**
This course provides an introduction to the fields of public administration and public management. This survey course covers topics such as bureaucratic behavior, program implementation, and recent innovations in management of public organizations. (Graduate standing) **Class 4, Credit 4 (offered annually)**

0521-710 **Information and Communications Policy**
This course examines how federal and international policies are developed to influence innovation of Information and Communication Technology. In particular the course will examine such topics as privacy, freedom of speech, intellectual property rights, access to information technology, and regulation of the Internet. (Graduate standing) **Class 4, Credit 4 (offered occasionally)**

0521-749 **Special Topics**
This course will examine current topics in public policy and may be used with consent of advisor as a policy elective for the public policy MS degree. The course will examine a special problem or area relevant to the other courses in the degree. **Class 4, Credit 4 (offered occasionally)**

0521-751 **Energy Policy**
This course provides an overview of energy resources, technologies, and policies designed to ensure clean, stable supplies of energy for the future. The course evaluates the impacts of fossil fuel, renewable energy, and hydrogen technologies and how public policies can be used to influence their development. The development of U.S. energy policy is of particular concern, although a global perspective will be integrated throughout the course. No prerequisite. This course is a professional elective for the science, technology, and public policy MS degree program and students in other graduate programs looking for policy electives (e.g., environmental science). **Class 4, Credit 4 (offered annually)**

School Psychology

0527-701 **Advanced Developmental Psychology**
This course is designed to examine a variety of topics that pertain to the social and emotional development of children/adolescents. During the first part of the course we will focus on attachment issues and resiliency. We will then examine children's play and children's cognitive, social and emotional development. Lastly we will reflect on the adolescents cognitive, social and emotional development. Students will learn how to wear developmentally appropriate glasses when working with children and adolescents. Students must be matriculated in school psychology program or have permission of instructor. **Class 4, Credit 4 (offered winter quarter)**

0527-702 **Psychology of Teaching and Learning**
Most of the referrals to school psychologists are the result of some sort of learning problem. Yet, most of us know little about the causes of school learning. We will examine theories and the basic psychological principles that apply to teaching and learning. This will be accomplished through the examination of the role of teachers, which includes their respon-

sibility for teaching curriculum, classroom management, and the social and emotional growth of students. Emphasis will be placed on obtaining an understanding of learning disorders including diagnosis and intervention strategies. Student must be matriculated in school psychology program or have permission of instructor. **Class 4, Credit 4 (offered winter quarter)**

0527-703 Cultural Diversity in Education
The aim of this course is to understand the historical and structural origins of the present schooling system in the US. The function of schools, from an ideological as well as technical viewpoint will be analyzed. Different forms of school organizations will be compared, as in the public vs. private dimensions. The functionalist theoretical approach will be presented as well as the conflict perspective to frame the discussion and analysis of opposing sociological systems of thought. The role of education in promoting or inhibiting socio-economic mobility will also be analyzed. This course attempts to understand how role expectations are actually carried within the school system and how its different actors react to technical as well as value constraints. Student must be matriculated in school psychology program or have permission of instructor. **Class 4, Credit 4 (offered spring quarter)**

0527-712 Practicum I
For the first year practicum the activities that you participate in will enable you to obtain first-hand knowledge and familiarity with: a) schools as systems, b) the role and function of the school psychologist, c) collaborative problem solving, d) counseling, e) teaching processes, and f) other relevant professional legal issues. More specifically in the first quarter you will be doing functional assessments, classroom observations, possibly some achievement testing. In the second quarter you will do more teacher consultation and by the third quarter you will be doing more counseling. The learning goals will fall within the eleven NASP domains of training and will provide you with the fundamental building blocks. Student must be matriculated in the school psychology program. **Class 2, Credit 2 (offered fall quarter)**

0527-713 Practicum II
For the first year practicum the activities will enable you to obtain first-hand knowledge and familiarity with: a) schools as systems, b) the role and function of the school psychologist, c) collaborative problem solving, d) counseling, e) teaching processes, and f) other relevant professional and legal issues. You will be doing functional assessments, classroom observations, possibly some achievement testing. In the second quarter you will do more teacher consultation and by the third quarter you will be doing more counseling. The learning goals will fall within the eleven NASP domains of training and will provide you with the fundamental building blocks. Student must be matriculated in school psychology program and have a grade of B or better in preceding practicum course. **Class 2, Credit 2 (offered winter quarter)**

0527-714 Practicum III
For the first year practicum the activities will enable you to obtain first-hand knowledge and familiarity with: a) schools as systems, b) the role and function of the school psychologist, c) collaborative problem solving, d) counseling, e) teaching processes, and f) other relevant professional and legal issues. You will be doing functional assessments, classroom observations, possibly some achievement testing. In the second quarter you will do more teacher consultation and by the third quarter you will be doing more counseling. The learning goals will fall within the eleven NASP domains of training and will provide you with the fundamental building blocks. Student must be matriculated in school psychology program and a grade of B or better in preceding practicum courses. **Class 2, Credit 2 (offered spring quarter)**

0527-715 Practicum IV
In the second year of practicum experience students will continue to participate in supervised field experiences in school settings along with integrative on-campus seminars. Trainees will advance from observational experiences to hands-on-experiences. These active learning activities will enable you to obtain first-hand knowledge and familiarity with schools as systems, the role an functioning of the school psychologist, collaborative problem solving, counseling, teaching process, consultation, and other relevant, professional and legal issues. You will be expected to gain a better understanding and sensitivity to the diverse cultural student populations in the Greater Rochester Area. Many of you will be working with inner city youth of Rochester as well as with the special programs administered by BOCES personnel. Student must be matriculated in school psychology program. **Class 2, Credit 2 (offered fall quarter)**

0527-717 Practicum VI
In the second year of practicum experience students will continue to participate in supervised field experiences in school settings along with integrative on-campus seminars. Trainees will advance from observational experiences to hands-on-experiences. These active learning activities will enable you to obtain first-hand knowledge and familiarity with schools as systems, the role and functioning of the school psychologist, collaborative problem solving, counseling, teaching process, consultation, and other relevant, professional and legal issues. You will be expected to gain a better understanding and sensitivity to the diverse cultural student populations that we have in the Greater Rochester Area. Many of you will be working with inner city youth of Rochester as well as with the special programs administered by BOCES personnel. Student must be matriculated in the school psychology program. **Class 2, Credit 2 (offered spring quarter)**

0527-723 Developmental Psychopathology
This course focuses on maladaptive behavior of children and youth. Models of deviant behavior are presented with attention to physiological, learned, and environmental bases of behavior. Assessment and treatment approaches are discussed. Student must be matriculated in school psychology program or have permission of instructor. **Class 4, Credit 4 (offered spring quarter)**

0527-724 Interpersonal Intervention Skills
This course will concentrate on the development of individual counseling and consultation skills for the school psychologist. Students will acquire an understanding of the basic models and states of the counseling and consultation processes. Emphasis will be on building fundamental skills (e.g. attending, empathy, and probing) an on helping clients/consultees identify an clarify problem situations. There will be an emphasis on collaborative problem solving. Extensive laboratory work will involve role-play. Readings will focus on pertinent skills and approaches. They have been designed to insure that students will not view counseling and consultation as haphazard processes, but as systematic ones that involve effective listening, problem identification, decision making, and problem solving skills. Student must be matriculated in the school psychology program. **Class 4, Credit (offered fall quarter)**

0527-726 Psychoeducational Assessment I
This introductory course in a series of assessment courses will study assessment generally, types of tests and their uses, strengths and weaknesses of specific instruments, principles of reliability and validity, scales, and norms. Students will acquire an understanding of the quantitative and qualitative aspects of measurements. There will be extensive laboratory experience with a variety of instruments that measure academic an sensory-motor perception. Emphasis will be placed on the clinical use of tests in schools and other settings. Student must be matriculated in the school psychology program. This course serves as the foundation for subsequent courses in the assessment sequence. **Class 4, Credit 4 (offered fall quarter)**

0527-728 Inferential Statistics I
This course will train students in understanding and using inferential statistical concepts. Special attention will be placed on use of computer applications, conceptual understanding of statistical tests, proper selection of statistical tests, and proper interpretation and reporting of results. Topics include a brief review of descriptive statistics, confidence intervals, hypothesis testing, power, effect size, one-sample z- and t-tests, and one-way ANOVA. Student must be matriculated in school psychology program or have permission of instructor. **Class 2, Credit 2 (offered fall quarter)**

0527-730 Seminar: Professional and Legal Issues
Historic foundations and current critical professional issues, roles and functions of the school psychologist are emphasized in the course. Legal and ethical issues that bear on the role of the psychologist in the school are considered. Student must be matriculated in school psychology program plus have 32 quarter credit hours successfully completed in the program or permission of instructor. **Class 4, Credit 4 (offered spring quarter)**

0527-731 Psychoeducational Assessment II
This course concentrates on the development of theory and applied skills in intellectual assessment. Students learn to select and administer individual intelligence tests, to interpret results, to form test-based recommendations for intervention, and to provide written and oral reports. Assessment of persons who are culturally different or disabled is emphasized. Student must be matriculated in school psychology program and have a grade of B or better in Psychoeducational Assessment I. **Class 4, Credit 4 (offered winter quarter)**

0527-732 Psychoeducational Assessment III
The primary focus of this course is on the use of various social emotional assessment techniques employed by school psychologists for an evaluation of a child or adolescent suspected of having an emotional disturbance. Further, this course will also emphasize the use of adolescent personality tests used in conjunction with career interests as part of facilitating their transition from school to work or to post secondary education. Students will gain experience in the administration, interpretation, and communication of assessment results. Special emphasis is placed on proficient report writing. Student must be matriculated in school psychology program. **Class 4, Credit 4 (offered spring quarter)**

0527-733 **Applied Behavior Analysis**
This course offers training in the behavioral assessment of students in educational settings. Students apply various techniques for recording and analyzing behavior and programs for behavior management. Student must be matriculated in the school psychology program or have permission of the instructor**. Class 4, Credit 4 (offered fall quarter)**

0527-734 **Linking Assessment to Intervention**
This is an applied course in linking the diagnostic assessment of exceptional children and adolescents to recommendations for appropriate interventions. Students learn to select and develop a plan of assessment for a variety of referral questions. Students continue to learn and expand their skills in administering tests. Students primarily learn to interpret and integrate test data and report the results and recommendations for parents, teachers and multi-disciplinary evaluation teams. The understanding goal threads are: 1) What makes a good report, 2) How to differentiate essential from non-essential information, and 3) How does this information inform us. Student must be matriculated in school psychology program. **Class 4, Credit 4 (offered fall quarter)**

0527-742 **Biological Bases of Behavior**
This course is designed to review the neurophysiological and neuropsychological bases of behavior and learning as it pertains to developmental disorders. Students will identify functional neuroanatomy, neuroimaging techniques, and various neuropsychological concerns. Students will apply findings and research to contemporary problems and issues facing school psychologists. Student must be matriculated in School Psychology Program or have permission of instructor. **Class 4, Credit 4 (offered winter quarter)**

0527-744 **Advanced Counseling**
This course focuses on the development of counseling skills used with children and adolescents in individual and group counseling. Students will be given the opportunity to integrate theory, research, and processes relative to individual and group work. We will examine how to create treatment plans. Cognitive behavior therapy and solution-focused orientations will be examined. Techniques for facilitating group counseling will be emphasized—especially group behavior management. Crisis intervention will be reviewed. Student must be matriculated in school psychology program. (0527-701 and 724) **Class 4, Credit 4 (offered spring quarter)**

0527-745 **Alternative Assessment Techniques**
The prime focus is on the assessment of academic problems in the classroom with special emphasis on the collection of data that allow the planning of interventions. Students will learn alternative direct methods of academic or behavioral assessment for both performance and skill deficits. Emphasis will be on the integration of these assessment techniques, collaborative problem solving, systematic observation, the principles of applied behavior analysis and the psychology of learning for the purpose of intervention development. Student must be matriculated in school psychology program. (0527-733, 749, 726, 731, 732) **Class 4, Credit 4 (offered fall quarter)**

0527-749 **Advanced Consultation**
This course will concentrate on the development of consultation skills for the school psychologist. Students will acquire an understanding of the basic models of consultation and the stages of the consultation process. Emphasis will be on the collaborative problem solving process where the skills of relationship building, problem identification, intervention implementation, and outcome evaluation will be well-honed. Extensive laboratory work will involve role play activities and first-hand experience through real case consultation. Readings will focus on the pertinent research in school-based consultation. Student must be matriculated in school psychology program or have permission of instructor. (0527-724) **Class 4, Credit 4 (offered fall quarter)**

0527-752 **Children and Trauma**
This course examines the nature, incidence, demographic distribution, sequelae and appropriate treatment of trauma in children's lives. After defining trauma, it explores how experiences such as parental or sibling death, serious illness or injury, familial alcoholism, emotional, physical and sexual abuse, divorce or parental abandonment, community violence and natural disasters affect children. Student must be matriculated in school psychology program or have permission of instructor. **Class 4, Credit 4 (offered spring quarter)**

0527-759 **Research Methods I**
This course explores various types of research methods as well as important methodological issues and concepts. Methodologies studied include experimentation, quasi-experimentation, participant observation, archival methods, content analysis, surveys, interviews, and simulations. Methodological issues covered include philosophical paradigms, research ethics, reliability, threats to internal validity, external validity, demand characteristics, the volunteer subject problem, issues in sampling, and realism. Students will read original and contemporary works on research methodologies, as well as examples of such methodologies, and will write weekly summaries, applications, and criticisms. Course activities rely heavily on seminar-style discussions and presentations. Student must be matriculated in school psychology program or have permission of the instructor. **Class 2, Credit 2 (offered fall quarter)**

0527-777 **Internship I, II, and III**
The 1200 hour internship is the culminating experience. It provides an intensive, supervised training experience in which interns put the knowledge, skills and attitudes learned during their training program into practice while continuing to develop and expand upon those abilities. The internship year is a broad-based, individualized experience that provides an opportunity to work with a variety of children, parents, teachers, support staff an administrators. Interns are exposed to a variety of educational meetings, programs, workshops, resources, and conferences through their internship sites. Monthly class seminars supplement the supervised training experience. Student must be matriculated in the school psychology program; satisfactory completion of 84 hours in graduate program; a passing portfolio; a grade of B or better in Internship I and II to proceed to Internship III. **Class 4, Credit 4 (offered quarterly)**

0527-810 **Research Methods II**
This course assists graduate students in the school psychology program in beginning their masters' theses or projects. Students will write a thesis/project proposal and give a presentation of this proposal. The proposal will consist of an abstract, a preliminary introduction that includes a literature review, a proposed methods (thesis students) or description of activities (project students) section, a proposed data analysis (thesis students) or product summery/outline (project students) section, a preliminary discussion section, a reference section, and appendices (if applicable). The proposal will be presented at the end of the term. Course activities will consist of library research, thesis/project planning, and writing under the supervision of the instructor. Student must be matriculated in the school psychology program or have permission of instructor and/or a passing grade in 0527-759. **Class 2, Credit 2 (offered winter quarter)**

0527-811 **Inferential Statistics II**
This course will train students in understanding and using inferential statistical concepts. Special attention will be placed on use of computer applications, conceptual understanding of statistical tests, proper selection of statistical tests, and proper interpretation and reporting of results. Topics include two-way ANOVA, repeated measures ANOVA, MANOVA, correlation, simple regression, reliability analysis, and non-parametric statistics. Student must be matriculated in school psychology program of have permission of instructor. **Class 2, Credit 2 (offered winter quarter)**

Communication and Media Technologies

0535-700 **Film and Society**
An inquiry concerning the relationship between motion pictures and society that will use historical, humanistic, and social science research to achieve an understanding of movies as a social force, industry and art form. **Class 4, Credit 4 (offered occasionally)**

0535-701 **History of Media Technology**
An introduction to the history of media technologies including print, telephone, broadcasting, and digital media. The course will also cover the inventors, landmark events, regulations and ethics of communication media along with their effects on and relationships with people and culture. **Class 4, Credit 4**

0535-702 **Communication Theory**
This course focuses on theories of communication as they relate to technology. Theories based in both the humanities and in the social sciences that explain or predict the effects of communication technology on audiences will be presented. **Class 4, Credit 4**

0535-703 Research Methods in Communication
An introduction to and overview of the methods and ethics of scholarly communication research including quantitative and qualitative approaches. The course focuses on methods of locating, critically analyzing and conducting communication research, and leads to the development of a research proposal suitable for a thesis or project. (0535-701, 702) **Class 4, Credit 4**

0535-704 Communication Law and Ethics
This course focuses on issues presented by communication technologies to the practice of law and study of standards of ethics. Legal challenges presented by communication technologies will be examined in the following contexts: intellectual property, technology rights, patents, privacy and information networks, access to information, defamation, indecency, obscenity, and pornography. Special attention will be paid to the difficulty of applying national laws to international media. (0535-701 and 0535-702) **Class 4, Credit 4**

0535-705 Electronic Communication in Society
An inquiry about the Internet and how it exerts a powerful influence on communicative practices and society. Positioned at the intersection of technology, identity, and culture, the Internet has altered the ways in which people communicate in a wide range of contexts, including education, marketing, civic discourse, politics and popular culture. Utilizing theories about the relationship between communication technology and culture, this course will explore the current and potential future impact of electronic communication in social settings. **Class 4, Credit 4**

0535-706 Crafting the Message
This course will focus on the creation of written and visual messages appropriate to a targeted audience and a specific medium including print, broadcast, interactive, digital and on-line technologies. Case studies of effective and unsuccessful messages from advertising, politics, public service, education, entertainment and development will be examined. Students will have the opportunity to create and execute a variety of messages using various writing styles and images, and with varying purpose. (0535-701, 702) **Class 4, Credit 4**

0535-707 International Media
This course will evaluate media technology use in the international setting and in various countries and regions of the world. Major theories about the media, international communication developments, and governmental challenges and restrictions are considered. Comparative and cross-cultural studies of the uses and effects of media technologies within various countries with special focus on global implications of the world wide web and computer technologies on international cooperation, trade and culture will be explored. (0535-701, 702) **Class 4, Credit 4**

0535-708 Communication Education
This course examines various aspects of teaching communication in higher education. Students will explore teaching and learning styles, the role of technology in higher education, and assessment methods. Students will create teaching resources and gain experience teaching in a college classroom. **Class 4, Credit 4**

0535-709 Online Public Relations and Advertising
This course is a study of the practices in public relations and advertising. Topics include identification of publics and selection of media, planning and evaluating campaigns, designing promotional materials, as well as employee, member, community and media relations. Special attention will be paid to online advertising including the creation, measurement, accounting and targeting of internet advertisements, e-newsletters, e-mail, sponsorships, interactive advertising and consumer tracking. (0535-701, 702) **Class 4, Credit 4**

0535-710 Visual Communication
This course focuses on the use of still or moving images in mediated communication. Examples from print, television, internet, photography and film will be examined in light of traditional and emerging media. Rhetoric of image based technologies is examined. **Class 4, Credit 4**

0535-712 Computer-Mediated Communication
A graduate seminar examining the evolving forms and functions of computer-mediated communication, including e-mail, discussion groups, newsgroups, chat, instant messenger, and web pages. Grounded in rhetorical, mass media, and interpersonal theory the seminar explores electronically-mediated communication in its many contexts and manifestations in an effort to understand the evolving forms and functions of CMC and its impact on communicative behaviors and public discourse. Course objectives are met through readings, written papers, online observations, lectures, and class discussions. **Class 4, Credit 4 (offered occasionally)**

0535-725 Special Topics: Masters Level
This course is a focused, in-depth study and analysis of a selected advanced topic in communication and associated issues. Specific topics vary according to faculty assigned and are published when the course is offered. This course is an elective for Communication and Media Technology majors. **Class 4, Credit 4**

0535-800 Communication Thesis and Project
The graduate thesis/project will be guided and approved by the student's graduate advisement committee. Students may elect to conduct original research reported in a graduate thesis or to apply theory and research in an applied project. A minimum of 5 credits and no more than 9 credits can be earned as thesis/project credits.

College of Science

www.rit.edu/~670www/

Ian Gatley, Dean

The College of Science offers a unique complement of graduate programs, featuring curricula designed with sufficient flexibility to prepare students for direct entry into a career or further study toward a more advanced degree in a chosen discipline. Whether the focus is on the foundations of matter, applications of mathematics, the role of the chemist in the health care environment, the specialized properties of advanced materials or the science and technology of advanced imaging systems, the College of Science graduate faculty provide a valuable and integrated understanding of today's biological, environmental, clinical, industrial and research issues.

Programs

Master of Science degrees in:

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Chemistry	p. 172
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Doctor of Philosophy degree in:

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⇆ *Online learning option available*

School of Life Sciences
Department of Biological Sciences

Richard L. Doolittle, Department Head
www.rit.edu/672www/

Master of Science in Bioinformatics

Gary Skuse, Director
(585) 475-2532, grssbi@rit.edu
http://bioinformatics.rit.edu/

The master of science degree in bioinformatics is offered on a full- and part-time basis, to fulfill the needs of traditional students as well as those currently employed in the field. Graduates develop a strong foundation in biotechnology, computer programming, computational mathematics, statistics and database management, and will be prepared for careers in the biotechnology, bioinformatics, pharmaceutical and vaccine industries. For those who obtain bachelor's and master's degrees, the job market is rich with opportunities.

Most of the individuals now employed in bioinformatics were not specifically trained in this field. Instead, they chose it because the shortage of people with both biology and computer science/information technology expertise offered unusual opportunities for career growth and rewards. At present, most bioinformatics employees have formal training in biology or biotechnology and only limited familiarity with computational tools.

Based on consultation with individuals within the industry nationwide, the credential most in demand in the future will be the master of science degree, particularly when coupled with industry-sponsored research as thesis work. That research will provide exposure to real-world problems—and their solutions—not otherwise attainable in an academic setting.

The objective of the program is to provide students with the capability to enter the bioinformatics workforce and become leaders in the field. This objective is addressed through a curriculum designed to fulfill the needs of students with diverse educational and professional backgrounds. Individuals entering an MS program in bioinformatics typically have degrees in biology, biotechnology, chemistry, statistics, computer science, information technology or a related field. The MS program accommodates this diversity in two ways. First, there is a comprehensive bridge program for students who need to supplement their education before entering the MS program. Second, the MS program itself consists of two tracks, one for students with backgrounds in the life sciences and one for those with backgrounds in the computational sciences. Regardless of the track pursued, students will be prepared to become professional bioinformaticists upon graduation.

Admission

Individuals with baccalaureate degrees in biology, biotechnology, biochemistry, chemistry, computer science, information technology, statistics or related disciplines are invited to apply. Admission decisions will be based on a composite of prerequisites, including an undergraduate grade point average of 3.2 or higher, with an average of 3.4 in the field of study. Graduate Record Examination scores may be required in some cases.

English language requirement

All applicants who do not speak English as their primary language are required to take the Test of English as a Foreign Language. Applicants should have a minimum score of 570 (paper-based) or 230 (computer-based).

Degree requirements

A minimum of 48 quarter credit hours, including seven core courses, is required for completion of the program. A choice of professional graduate electives is available so that each student may pursue areas of personal or professional interest. In addition, every student is required to complete a research project that addresses a relevant and timely topic in bioinformatics, culminating in a thesis. Graduate electives may be chosen from any relevant RIT graduate courses.

Curriculum

Computational science degrees track		Qtr. Cr. Hrs.
1001-700	Cell and Molecular Genetics	3
1001-701	Cell and Molecular Genetics II	3
4002-762	Introduction to Bioinformatics Computing	4
4002-763	Advanced Bioinformatics Computing	4
1001-722	Bioinformatics Seminar	2
1001-725	Ethics in Bioinformatics	3
1001-794	Molecular Modeling and Proteomics	4
1016-715	Statistical Models for Bioinformatics	4
	Graduate electives	11
1001-890	Thesis	10
Total		**48**

Life science degrees track		Qtr. Cr. Hrs.
4003-709	Programming Language Concepts	4
4002-720	Data Object Development	4
4002-762	Introduction to Bioinformatics Computing	4
4002-763	Advanced Bioinformatics Computing	4
1001-722	Bioinformatics Seminar	2
1001-725	Ethics in Bioinformatics	3
1001-794	Molecular Modeling and Proteomics	4
1016-715	Statistical Models for Bioinformatics	4
	Graduate electives	11
1001-890	Thesis	10
Total		**50**

Master of Science in Environmental Science

Karl Korfmacher, Director
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www.rit.edu/~envsci/

Habitat loss, global climate change, water and air pollution, ozone depletion, loss of biodiversity and the accumulation of toxic wastes are outcomes of human behaviors that stem from a general belief that the environment is infinitely renewable. It is not.

Environmental science careers focus on environmental sustainability and sustainable development, which, according to a 1987 United Nations report titled Our Common Future, is defined as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs." Environmental scientists must understand the complexity of problems that pit environmental limits against economic development, diverse cultures, ethics, values and social stability. They must use integrated and holistic approaches to find solutions to these problems.

Built on the concept that environmental issues are inherently interdisciplinary, the program is offered jointly by the department of biological sciences in the College of Science and the department of science, technology and society in the College of Liberal Arts. The curriculum is designed to provide students with a deep understanding of the complex set of circumstances that impact environmental issues, and how environmental decisions and policies attempt to find a balance between environmental conservation and economic development. The program offers students a unique opportunity to prepare for careers in environmental science. Students combine their hands-on classroom work with experiential learning experiences (co-op, research, internships). These experiences give students the chance to work on real-world environmental problems under the guidance of talented and skilled environmental scientists.

Admission requirements

Admission to the program will be granted to qualified graduates who hold a bachelor's degree in environmental science, the biological sciences or a related field of study. The admission decision is based on:

- minimum GPA of 3.0 (overall and in science/math),
- a minimum Test of English Language score of 550 (paper-based) or 213 (computer-based),
- a statement outlining research interests, career goals and suitability to the program and
- three letters of recommendation.

Curriculum

The master's program includes a core curriculum and electives chosen to reflect the student's background and career goals. A minimum of 51 quarter credit hours beyond the bachelor's degree is required. Required courses include*:

		Qtr. Cr. Hrs.
1001-475	Conservation Biology	4
1006-450	Raster Applications of GIS	4
1006-711, 712, 713	Environmental Science Graduate Study I, II, III	5
1006-710	Environmental Science Graduate Readings Seminar	3
1015-720	Environmental Chemistry	3
0307-712	Fundamentals of Statistics II	4
1006- 879	Environmental Science Graduate Research	5
	Environmental science core graduate elective	4
	Environmental policy core graduate elective	4
	Environment and society core graduate elective	4
	Graduate professional elective	4-8
1006-890, 891	Thesis/Project	5-9

**Changes to the curriculum are pending NYS approval.*

Five-year combined BS/MS programs

The combined BS/MS program in environmental science allows undergraduate environmental science students to acquire an MS degree with only one extra year of study. Undergraduate majors are considered for entrance into the BS/MS program at the end of their third year of undergraduate study.

External research credit

The employment experience of a number of environmental scientists employed in the environmental community includes independent, creative research. This experience may be applied toward the completion of the MS degree in environmental science on either a full- or part-time basis.

Thesis or project

All students enrolled in the environmental science graduate program must propose, conduct and report on an original research project.

Equipment

Monitoring, mapping and field equipment

ArcGIS 9.2 and IDRISI Kiliminjaro/Andes GIS software, Garmin and Trimble GPS receivers, pocket PCs with ArcPad software, soil sampling equipment, soil analysis equipment, water sampling devices, multisonde water quality probes, wet labs for water quality analysis, ponar dredges, plankton samplers, macro-invertebrate nets/samplers and a library of field reference texts

Other equipment

Fluorimeter, Raman Spectrometer, UV-Vis, GC-MS, ICP, atomic absorption, polarimeter, TGA's Micro-extruder, centrifuge, electrochem equipment, gas chromatography, HPLC detectors, viscometer, ESR (built in-house), incubators, infrared spectrophotometers, capillary electrophoresis, DSCs, DMA, Asher, 300 MHZ NMR, drying oven, leaf area index meter, digital clinometer and a Wiley mill

Facilities for research

The environmental science program provides a wide range of research opportunities. Many environmental science faculty members are engaged in field-based projects. We also have excellent laboratory facilities in support of field research, including wet laboratories and computer facilities (traditional and geographic information systems). For a list of past and present projects and faculty research interests, please see the program website at www.rit.edu/~envsci/ro/index.php.

Additional information

More information may be obtained by contacting Karl Korfmacher, environmental science program director, (585) 475-5554, or the department website, www.rit.edu/~envsci/.

Department of Medical Sciences

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www.rit.edu/~676www

Master of Science in Clinical Chemistry

James C. Aumer, Interim Director,
Clinical Chemistry Program
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The program is designed to provide a focused educational experience for individuals preparing for careers in clinical chemistry. The program provides technical and managerial proficiencies in either the diagnostic laboratory or a related industry.

The clinical chemistry program is designed for full- or part-time graduate study. Required courses are offered regularly during the late afternoon or evening in order to accommodate the work schedules of part-time students.

Admission requirements

Individuals holding a bachelor's degree in chemistry, biology, medical technology, nuclear medicine technology or a related field from an accredited college or university are invited to apply.

All students who do not speak English as their primary language are required, upon arrival at RIT, to take the Michigan Test of English Proficiency, administered by RIT's English Language Center. If a student's score is below standard, the center will make recommendations for additional course work. Successful completion of this work is a program requirement for the master of science degree. This may mean students will need additional time and financial resources to complete the degree program.

Curriculum

The master's program includes a core curriculum and electives that are chosen to reflect the student's background and career goals. A minimum of 50 quarter credit hours beyond the bachelor's degree is required. Required courses include:

1009-702	Biochemistry: Biomolecular Conformation and Dynamics
1009-703	Biochemistry: Metabolism
1013-736	Spectrometric ID of Organic Compounds
1023-705	Mechanisms of Disease
1023-820, 821, 822	Advanced Clinical Chemistry I, II, III
0102-740	Organizational Behavior and Leadership
1016-715	Statistical Models for Bioinformatics
1023-877	External Clinical Chemistry Research
or	
1023-879	Internal Clinical Chemistry Research

All students are required to carry out and defend original research as part of the program requirements. Research is carried out under the direction of a faculty member and is reviewed and defended before a graduate committee appointed by the program director.

Students in the clinical chemistry program come from diverse educational backgrounds and have a variety of professional goals. The program focuses on the activities of the diagnostic clinical laboratory, developmental research in pathology and diagnostic testing, as well as industrial activities related to clinical laboratory products and instruments.

Additional information

For more information, see our website or contact the Office of Graduate Enrollment Services.

School of Mathematical Sciences

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Master of Science in Applied Mathematics

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The ideas of applied mathematics pervade several applications in a variety of businesses and industries, as well as government. Sophisticated mathematical tools are increasingly used to develop new models, modify existing ones and analyze system performance. This includes applications of mathematics to problems in management science, biology, portfolio planning, facilities planning, control of dynamic systems and design of composite materials. The goal is to find computable solutions to real-world problems arising from these types of situations.

The School of Mathematical Sciences offers an interdisciplinary master of science degree in applied mathematics. The objective of the program is to provide students with the capability to apply mathematical models and methods to study various problems that arise in industry and business, with an emphasis on developing computable solutions that can be implemented. Since this is an interdisciplinary program, students have the opportunity to choose from a wide variety of courses.

Admission requirements

Applicants should have a baccalaureate degree with a cumulative grade point average of 3.0 or above (or its equivalent) from an accredited institution. The degree could be in mathematics or any related field. The prerequisite courses are multivariable calculus, differential equations, matrix theory, probability and statistics. Knowledge of a programming language is required.

A student also may be granted conditional admission and be required to complete "bridge" courses selected from among RIT's existing undergraduate courses, as prescribed by the student's adviser. Until these requirements are met, he or she is considered a nonmatriculated student. The graduate coordinator evaluates the student's qualifications in order to determine eligibility for conditional and provisional admission.

All students who do not speak English as their primary language are required to take the Test of English as a Foreign Language. Applicants must achieve a minimum score of 550 (paper-based) or 213 (computer-based). Those who cannot take the TOEFL will be required to take the Michigan Test of English Proficiency at RIT and obtain a score of 80 or higher. Although Graduate Record Examination scores are not required, submitting them enhances the chances of a student's acceptance into the program.

Student's advisory committee

Upon admission to the program, the student chooses an adviser and forms an advisory committee. This committee will oversee the academic aspects of the student's program, including the selection of a concentration and appropriate courses to fulfill the program's requirements.

Curriculum

The master's degree program in applied mathematics consists of 48 quarter credit hours of study. There are four core courses that total 16 quarter credit hours. These courses, usually taken by the student in the first two quarters of the program, provide a focus on some of the ideas of applied mathematics. They are determined by the department to provide a foundation for further study and cover numerical linear algebra, stochastic processes, boundary value problems and combinatorics. Core courses are offered every year.

The concentration and the corresponding course of study are formulated by the student in consultation with his or her advisory committee. The student completes a total of 24 quarter credit hours by taking a set of six specialized courses offered in the School of Mathematical Sciences, as well as other departments. Some of the possible concentrations are dynamical systems, operations research, imaging science, biomathematics,

bioinformatics and discrete mathematics.

The program of study culminates in thesis or project work. The thesis option requires that the student present original ideas and solutions to a specific mathematical problem. The project option involves applying or adapting existing methodologies to solve a problem or an expository paper on the methodology in a particular area. A proposal for the thesis or project work and the results must be presented and defended before the advisory committee.

Cooperative education option

The optional cooperative education program enables the student to alternate periods of study on campus with periods of full-time, paid professional employment. Students may pursue a co-op position after their first quarter.

Part-time study

The program is ideal for practicing professionals who are interested in applying mathematical methods in their work and enhancing their career options. All courses are scheduled in the late afternoon or early evening. The graduate program may normally be completed in two years (six quarters) of part-time study.

Nonmatriculated students

A student with a bachelor's degree from an approved undergraduate institution, and with the background necessary for specific courses, may take graduate courses as a nonmatriculated student with the permission of the graduate coordinator and the instructor. Courses taken for credit may be applied toward the master's degree if the student is formally admitted to the graduate program at a later date. However, the number of credits that will be transferred to the degree program from courses taken at RIT as a nonmatriculated student will be limited to a maximum of 12 quarter credits.

School of Physical Sciences
Department of Chemistry

Terence C. Morrill, Department Head
(585) 475-2497, tcmsch@rit.edu
www.rit.edu/chemistry

Master of Science in Chemistry

Thomas Smith, Chair, Chemistry Graduate Committee
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www.rit.edu/chemistry

The master of science degree in chemistry is offered on a full- or part-time basis. The program is designed to fill the needs of both the full-time graduate student or the practicing chemist who is employed full time and wishes to pursue a graduate degree on a part-time basis.

The department of chemistry has research- and teaching-oriented faculty, as well as excellent equipment and facilities. These attributes enable full-time graduate students to carry on a program of independent study and develop the ability to attack scientific problems at the fundamental level. The research can result in either a thesis or a project report.

Through course work and research activities, the program strives to increase the breadth and depth of the student's background in chemistry. Students in the program will develop the ability to attack scientific problems with minimal supervision.

Admission requirements

Admission to the program will be granted to qualified graduates who hold a bachelor's degree in chemistry from an accredited college or university. Applicants with a bachelor's degree in another scientific discipline and the equivalent of a full year's course work in analytical chemistry, organic chemistry, physical chemistry, physics and calculus also will be considered for admission.

The admission decision will be based on:

- College transcripts
- Graduate Record Exam scores (chemistry exam is recommended)
- Letters of reference

As a supplement to the normal application process, it is strongly recommended that students visit RIT. All candidates for teaching assistantships must have a personal interview with the department head. International students can complete the interview by phone. An applicant with a bachelor's degree from an approved undergraduate institution and the background necessary for specific courses is permitted to take graduate courses as a nonmatriculated student. If the student is subsequently admitted to the graduate program, courses taken for credit usually can be applied toward the master's degree. A maximum of 9 credits can be transferred from courses taken as a nonmatriculated student at RIT.

Any applicant who wishes to register for a graduate course as a nonmatriculated student must obtain permission from the chair of the graduate program and the course instructor.

All students who do not speak English as their primary language are required to submit scores from the Test of English as a Foreign Language. Foreign students may be required to take the Michigan Test of English Language Proficiency, given by the RIT English Language Center. If a student's score is below standard, additional course work may be recommended. Successful completion of this work is a program requirement for the master of science degree in chemistry. This may mean that the student will need additional time and financial resources to complete the degree program.

Curriculum

The program offers concentrations in the traditional disciplinary areas of organic, analytical, inorganic and physical chemistry. In addition, interdisciplinary concentrations in polymer chemistry, materials science, biochemistry and environmental chemistry are available. Customized program options are available to accommodate specific student interests and needs relating to graduate study in chemistry.

Each student, together with an adviser, will arrange a program best suited to his or her interests and needs. This program will be subject to the approval of the department head and the chair of the graduate committee.

A deliberate effort will be made to strengthen any areas of weakness indicated by the student's undergraduate records and placement examinations. To qualify for the MS degree, a candidate must satisfy the following requirements:

1. **A minimum of 45 quarter credit hours beyond the bachelor's degree**
   Courses in chemistry will generally be chosen from 700- and 800-level courses and should include one or more courses in analytical, organic and physical chemistry. The core requirement is one course each in organic, physical and analytical chemistry plus one course in inorganic chemistry, if an appropriate undergraduate course was not taken. Specifically, each student must select core courses (subject to approval by the student's adviser and the graduate committee) that include the following: analytical chemistry, 1008-621 and 1008-711; organic chemistry, 1013-737 or 1013-739; and physical chemistry, 1014-741, 1014-742, 1014-743 or 1014-744. The inorganic core course is 1012-764. As part of the required credits, each student must have one or two quarter credit hours in seminar 1010-870 and three to four quarter credit hours from outside of the department of chemistry. A maximum of nine quarter credits may be taken in undergraduate-level courses.

2. **Nine credit hours in research (minimum) for the MS thesis option**
   A minimum of 4 and a maximum of 8 credit hours are required with the project option. The program also offers a course-work-only MS option. With this option, the student must complete a 4 credit hour capstone course.

3. **Passage of an oral defense of the MS thesis**
   Students enrolled in the program full time are expected to complete 45 credit hours of course work, including up to 21 quarter credit hours of research leading to the submission of an independent research thesis. They also must pass an oral defense of the thesis. A full-time student normally takes 6 to 9 graduate credits per quarter, including thesis work. Typically, all requirements are met within two years. No more than 8 credit hours of research are allowed in the nonthesis MS option.

Part-time study

The department of chemistry encourages practicing chemists to pursue a master of science degree in chemistry without interrupting their employment. Consequently, many of the courses in the graduate program in chemistry are scheduled in the late afternoon or early evening.

Part-time students in the program may take the course-work-only option with the capstone project, 1010-800. Students employed full time normally take one course each quarter. At this pace, course work can be completed within four to five years.

Five-year combined BS/MS programs

The BS/MS program combines the BS programs in chemistry, biochemistry or polymer chemistry with the MS chemistry program, enabling undergraduates to acquire an MS degree with only one extra year of study. Undergraduate chemistry majors may be considered for entrance into the combined BS/MS chemistry program after completion of their sophomore year. Students in the combined program take graduate-level electives and typically complete an MS thesis or project. Students in the combined BS/MS chemistry program receive both the BS and MS degrees after five years of full-time study.

Equipment

The department of chemistry has modern instrumentation in the areas of spectroscopy (NMR, IR, UV-vis, fluorescence, atomic absorption, fluorimetry), chromatography (gas chromatography, high-performance liquid chromatography, capillary electrophoresis, etc.), mass spectrometry (high-performance lc- and gc-mass spectrometry and electrospray mass spectrometry) and materials characterization (rheometry, thermal gravimetric analysis, differential scanning calorimetry, hot-stage microscopy and contact angle goniometry). A full listing of departmental instrumentation is available on the chemistry department's webpage at www.rit.edu/~chemwww/resources/instrumentation/instruments.html.

External research credit

The department of chemistry recognizes that the experience of a number of chemists employed in local industry includes independent, creative research. A maximum of 16 hours of credit for research, conducted during employment, may be applied toward the completion of the master of science degree in chemistry on either a full- or part-time basis.

Cooperative education option

The cooperative education option accommodates students at the master's level who have, or are able to obtain, industrial employment. Quarters of work can be interspersed with quarters of full-time academic work. If industrial employment permits research, up to 16 of the 45 required credits may be obtained through the external research credit option.

If industrial employment does not permit research, then research credits may be obtained within the department of chemistry.

Additional information

More information may be obtained from the chair of the graduate committee, (585) 475-7982, the department of chemistry, (585) 475-2497, or the website, www.rit.edu/chemistry.

Center for Materials Science and Engineering

www.rit.edu/~670www/CMSE/

Master of Science in Materials Science and Engineering

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The master of science degree in materials science and engineering, offered under the joint auspices of the College of Science and the Kate Gleason College of Engineering, is designed with a variety of options to satisfy individual and industry needs in the rapidly growing field of materials. The objectives of the program are threefold:

With the advent of new classes of materials and instruments, the traditional practice of empiricism in the search for and selection of materials is rapidly becoming obsolete. Therefore, the program offers a serious interdisciplinary learning experience in materials studies, crossing over the traditional boundaries of such classical disciplines as chemistry physics and electrical, mechanical and microelectronic engineering.

The program provides extensive experimental courses in diverse areas of materials-related studies.

The program explores avenues for introducing greater harmony between industrial expansion and academic training.

Admission requirements

The program is open to individuals with a bachelor's degree in chemistry, physics, chemical engineering, electrical engineering, mechanical engineering or a related field from an accredited college or university. Any student who wishes to study at the graduate level must first be admitted to the program. However, an applicant may be permitted to take graduate courses as a nonmatriculated student if he or she meets the general requirements mentioned above.

A person not meeting the general requirements may petition for admission to the program. In such cases, the necessary background courses will be taken at the undergraduate level. However, undergraduate credits that make up deficiencies may not be counted toward the master's degree.

To be considered for admission, it is necessary to file an application for admission to graduate study, accompanied by the appropriate transcripts of previous study and two letters of recommendation.

All applicants for whom English is not the primary language are required to take both the Test of English as a Foreign Language and the Test of Written English examinations. Minimum scores of 575 (paper-based) or 230 (computer-based) on the TOEFL and 4.0 on the TWE are required. In addition, upon arrival at RIT, these students are required to take the Michigan Test of English Language Proficiency, administered by the RIT English Language Center. Individuals scoring below an established minimum will be referred to the English Language Center for further evaluation and assistance. These students are required to follow the center's recommendations regarding language course work. It is important to note that this may require additional time and financial resources to complete the degree requirements. Successful completion of this course work is a requirement for the master of science degree in materials science and engineering.

Curriculum

The program consists of five required core courses. These courses are specially designed to establish a common base of materials-oriented knowledge for students with baccalaureate degrees in chemistry, chemical engineering, electrical engineering, mechanical engineering, physics and related disciplines, providing a new intellectual identity to those involved in the study of materials. The core courses are:

1028-701	Introduction to Materials Science
1028-702	Introduction to Polymer Science
1028-703	Solid State Science
1028-704	Introduction to Theoretical Methods
1028-705	Introduction to Experimental Techniques

These core courses are offered every year.

The program has an emphasis on experimental techniques, with one required experimental course as part of the core. Additional experimental courses are available for students who wish to pursue course work in this area. These courses are organized into appropriate units covering many aspects of the analysis of materials. This aspect of the program will enhance a student's confidence when dealing with materials-related problems.

A minimum of 45 quarter credit hours, which includes the five core courses and the seminar course (1028-890), is required for completion of the program. The remaining 24 quarter credit hours may be completed in one of three ways: as a combination of the research thesis and elective courses, a combination of external research and elective courses or as elective courses. The elective courses may be selected from advanced courses offered by the Center for Materials Science and Engineering or, upon approval, from courses offered by other RIT graduate

programs. Elective courses are scheduled on a periodic basis. Transfer credit may be awarded based on academic background beyond the bachelor's degree or by examination, based on experience.

The required credits for the master's degree must be completed within seven years of the oldest credits applied toward the degree.

Part-time study

Practicing scientists and engineers are encouraged to pursue the program on a part-time basis. For students who are employed, all of the courses are offered in the early morning, late afternoon or early evening. This may not apply to courses offered off campus at selected industrial sites. Students employed full time are normally limited to a maximum of two courses, or 8 credit hours, each quarter. A student who wishes to register for more than 8 credit hours must obtain the permission of his or her adviser.

Advanced certificate

An advanced certificate in materials science and engineering is available primarily for part-time students. It requires the completion of 24 quarter credit hours of course work.

Five-year combined BS/MS programs

The Center for Materials Science and Engineering offers several combined BS/MS programs: a BS in chemistry and an MS in materials science and engineering, a BS in microelectronic engineering and an MS in materials science and engineering, a BS in electrical engineering and an MS in materials science and engineering and a BS in physics and an MS in materials science and engineering are available. These degree programs may be completed in five years. Consult with the director of the Center for Materials Science and Engineering for more details.

Thesis and external research options

The inclusion of a research thesis as a formal part of the master of science degree program in materials science and engineering is optional. The research thesis option carries a minimum of 9 and a maximum of 16 quarter credit hours, subject to the review and approval of the project. In the place of a thesis, a project option is available that carries a minimum of 4 and a maximum of 8 credit hours.

The external research option allows participants to continue their studies in their work environment, thus enhancing job satisfaction. In-plant work experience in materials-related areas may include independent study and creative research. This external research option may be applied toward the completion of the master of science degree for a minimum of 4 and a maximum of 8 quarter credit hours.

Chester F. Carlson Center for Imaging Science

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The Chester F. Carlson Center for Imaging Science was established in 1985 for the interdisciplinary study of all aspects of imaging. The center offers bachelor of science, master of science and doctoral degrees in imaging science, and master of science and doctoral degrees in color science. The Chester F. Carlson Building contains extensive laboratories supporting the center's teaching and research mission. The Color Science Building houses the Munsell Color Science Laboratory and the Franc Grum Color Science Learning Center.

Master of Science in Color Science

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Color science encompasses physics, chemistry, physiology, statistics, computer science and psychology. The curriculum, leading to a master of science degree in color science, educates students using a broad interdisciplinary approach. This is the only graduate program in the country devoted to this discipline, and it is designed for students whose undergraduate majors are in physics, chemistry, imaging science, computer science, electrical engineering, experimental psychology, physiology or any discipline pertaining to the quantitative description of color.

Graduates are in high demand and have accepted industrial positions in electronic imaging, color instrumentation, colorant formulation and basic and applied research. Companies that have hired RIT graduates include Benjamin Moore, Canon Corp., Eastman Kodak Co., Hallmark, Hewlett Packard Corp., Microsoft Corp., Pantone, Qualcomm Inc., Ricoh Innovations Inc., Samsung and Xerox Corp.

The color science degree provides graduate-level study in both theory and practical application. The program gives students a broad exposure to the field of color and affords them the unique opportunity of specializing in an area appropriate for their background and interest. This objective will be accomplished through the program's core courses, selection of electives and completion of a thesis or graduate project.

The degree program in color science revolves around the activities of the Munsell Color Science Laboratory within the Center for Imaging Science (www.cis.rit.edu/research/mcsl). The Munsell Laboratory is the preeminent academic laboratory in the country devoted to color science. Research is currently under way in color appearance models; image-quality, data-visualization and color-tolerance psychophysics; spectral-based image capture, archiving and reproduction of artwork; analytical and empirical multi-ink printing models; spectral color rendering, color management and computer graphics; and consumer digital camera and digital-cinema camera optimization.

Since the inauguration of the program in 1984, a number of conferences have drawn participants from around the world. Industrial seminars are held each summer on a wide range of color topics, including color perception and appearance, colorimetry, color-difference equations, instrumental tolerances, spectrophotometry, instrument-based color matching, color- and image-appearance models, color management, psychophysics, visualization and rendering and spectral imaging. The Munsell Laboratory has many contacts that provide students with summer and full-time job opportunities across the United States and abroad.

Admission requirements

Prior to being admitted to the master of science degree program, the coordinator of the program must be satisfied that an applicant's previous education, ability and practical experience indicate a good chance of success. Scientific reasoning, technical writing and oral communication skills are particularly important. Admission requirements include:

- Graduate application
- Earned baccalaureate degree
- Graduate Record Examination
- Official undergraduate transcript
- Two professional recommendations
- An on-campus interview (when possible)
- GPA of 3.0 or higher
- Foundation course work with GPA of 3.0 or higher (if required)
- Minimum scores from the Test of English as a Foreign Language of 587 (paper-based), 240 (computer-based) or 94 (Internet-based); for international students whose primary language is not English.

Financial aid

The scholarships and assistantships available for qualified color science applicants include the Macbeth-Engel Fellowship, Grum Memorial Scholarship, Saltzman Memorial Scholarship, Munsell Color Science Laboratory Assistantship and research assistantships associated with ongoing grants and contracts. Students receiving fully funded assistantships tend to have undergraduate cumulative grade point averages of 3.5 or higher and exceptional GRE scores. Applicants whose native language is not English must have TOEFL scores above 600 (paper-based), 250 (computer-based) or 100 (Internet-based) and TSEA scores above 250. Partial assistantships also are awarded. Applicants seeking financial assistance from the center must submit all application documents to the Office of Graduate Enrollment Services by January 15 for the next academic year.

Prerequisites: The foundation program

The color science program is designed for the candidate with an undergraduate degree in a scientific or nonscientific discipline. Candidates with adequate undergraduate work in related sciences start the program as matriculated graduate students.

Candidates without adequate undergraduate work in related sciences must take foundation courses prior to matriculation into the graduate program. Such students may be required to take as many as 36 credits in these subjects. A written agreement between the candidate and the program coordinator will identify the required foundation courses.

Foundation courses must be completed with an overall B average before a student can matriculate into the graduate program. A maximum of 9 graduate-level credit hours may be taken prior to matriculation into the graduate program.

The foundation courses listed below are representative of those often required:

- One year of calculus
- One year of college physics, with laboratory
- One course in computer programming
- One course in matrix algebra
- One course in statistics
- One course in introductory psychology

Curriculum

All students must earn 45 credits as a graduate student, 36 of which must be taken at RIT, to earn the master of science degree. For full-time students, the program requires four to six quarters of study at the graduate level. Part-time students generally require two to four years of study at the graduate level. The curriculum is a combination of required courses in color science, elective courses appropriate for the candidate's background and either a research thesis or graduate project. Students must enroll in either the research thesis or graduate project option at least one year before completion of required course work.

Core courses

All graduate students in the MS program are required to complete the following core courses:

		Qtr. Cr. Hrs.
1051-720	Vision	4
1050-702	Applied Colorimetry	4
1050-721	Color Measurement Laboratory I	3
1050-703	Color Appearance	3
1050-722	Color Measurement Laboratory II	3
1050-813	Color Modeling	4
1050-801	Color Science Seminar	3

Elective courses

Appropriate elective courses should be selected to bring course work to 36 credit hours for the research thesis option or 41 credit hours for the graduate project option. Approval by the color science coordinator is required. (Some courses might require special permission for enrollment.) The following is a partial list:

		Qtr. Cr. Hrs.
0307-801, 802	Design of Experiments I, II	6
0307-834	Multivariate Statistics for Imaging Science	4
4005-761	Fundamentals of Computer Graphics	4
1051-728	Design and Fabrication of Solid State Cameras	4
1051-739	Principles of Solid State Imaging	4
1051-749	Color Reproduction	4
1051-782	Introduction to Digital Image Processing	4
1051-790	Image Rendering	4
1051-816	Color Systems	4

Typical full-time schedule of courses

Fall		Qtr. Cr. Hrs.
1051-720	Vision	4
1050-721	Color Measurement I Lab	3
1050-801	Color Science Seminar	1
	Graduate elective	4
Winter		
1050-702	Applied Colorimetry	4
1050-722	Color Measurement II Lab	3
1050-801	Color Science Seminar	1
	Graduate elective	4
Spring		
1050-703	Color Appearance	3
1050-813	Color Modeling	4
1050-801	Color Science Seminar	1
	Graduate elective	4

During the second year, full-time students enroll in research and thesis, to total 9 credits.

Research thesis option

Students without research experience are encouraged to select the research thesis option (9 credits). The thesis is performed during the second year of study. Topics are chosen that complement the candidate's undergraduate education and career interests. The technical advisory board of the Munsell Color Science Laboratory, as well as the program coordinator, can aid in the selection of a thesis topic. Full-time students receiving full-time assistantships are required to perform a research thesis.

Graduate project option

Students with research experience may select the graduate project option (4 credits). The project has the same intellectual level as a research thesis but is less lengthy. It might take the form of an experiment, demonstration, research project or critical review. The graduate project is normally performed during the last quarter of study. Part-time students often select this option.

Doctor of Philosophy in Color Science

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Color has been a topic of intense interest and inquiry for hundreds, if not thousands, of years. Philosophers (Aristotle), poets (Goethe), physicists (Newton) and mathematicians (Schrödinger) all have contributed to our understanding of color. As a generalization, color science can be defined as the quantification of our perception of color. Its mastery requires an interdisciplinary educational approach encompassing physics, chemistry, physiology, statistics, computer science and psychology. Color science is used in the design and control of most man-made colored materials, including textiles, coatings and polymers, and to specify such diverse materials as soil and wine. It is used extensively in color reproduction, including digital photography, desktop and projection display, and printing.

Color science research at RIT encompasses such diverse fields as medical data visualization, computer graphics and animation, art conservation, spectral and spatial measurements of materials, color printing, digital photography and motion pictures and television. Research also encompasses modeling of our perceptions for use in defining color quality. RIT has a long history of scholarship in this area through its MS degree in color science, begun in 1984; MS and Ph.D. degrees in imaging science; and MS degrees in electrical engineering, quality and applied statistics, and printing management and sciences.

The program is designed for students whose undergraduate majors are in physics, chemistry, mathematics, computer science, engineering, experimental psychology, imaging or any applied discipline pertaining to the quantitative description of color; for example, textiles, graphic arts, animation, material science and polymer science. All students must earn 99 credits as a graduate student. For full-time students entering the program with a baccalaureate degree, the program requires three or more years of study at the graduate level. The curriculum is a combination of required courses in color science, elective courses appropriate for the candidate's background and interests, a three-quarter research project during the second year of study and a research dissertation. Students must pass a qualifying examination during their second year of study and a candidacy examination at least one year before completing their dissertation. Candidates who wish to enter the program but lack adequate preparation might have to take as many as 36 credits of undergraduate foundation courses in mathematics, statistics, computer science and general science before matriculating with graduate status.

Admission requirements

The goal of the admissions process is to select students whose previous education, ability and practical experience indicate a good chance of success. Scientific reasoning, technical writing and oral communication skills are particularly important.

The specific requirements are as follows:

- Graduate application
- Earned baccalaureate degree
- Graduate Record Examination
- Official undergraduate transcript
- Two professional recommendations
- An on-campus interview, when possible
- GPA of 3.0 or higher
- Foundation course work of 3.0 or higher (if required)
- Minimum scores from the Test of English as a Foreign Language of 240 (computer-based), 587 (paper-based) or 94 (Internet-based); for international students whose primary language is not English.

Students receiving fully funded assistantships tend to have undergraduate cumulative grade point averages of 3.5 and higher and exceptional GRE scores. International applicants, who must submit TOEFL scores, must have scores above 250 (computer-based), 600 (paper-based) or 100 (Internet based). Applicants seeking financial assistance from the center must submit all application documents to the Office of Graduate Enrollment Services by January 15 for the next academic year.

Candidates without adequate undergraduate work in related sciences must take foundation courses prior to matriculation into the graduate program. Such students may be required to take as many as 36 credits in these subjects. A written agreement between the candidate and the program coordinator will identify the required foundation courses. Foundation courses must be completed with an overall B average before a student can matriculate into the graduate program. A maximum of 9 graduate-level credit hours may be taken prior to matriculation into the graduate program.

The following is a list of the required undergraduate-level foundation courses:

- One year of calculus
- One year of college physics
- One year of college physics laboratory
- One course in computer programming
- One course in matrix algebra
- One course in statistics
- One course in introductory psychology

Credit hour requirements

The degree requires 99 credit hours of course work and research. A minimum of 60 credit hours of course work, including the core curriculum, is required. A minimum of 27 credit hours of research, including the second-year research project, is required. Three years of full-time study or the equivalent in part-time study are required.

Curriculum

Core courses (24 quarter credit hours), completed during the first year of study:

1051-720	Vision
1050-702	Applied Colorimetry
1050-703	Color Appearance
1050-721	Color Measurement Laboratory I
1050-722	Color Measurement Laboratory II
1050-801	Color Science Seminar
1050-813	Color Modeling

Elective courses (36 quarter credit hours) are selected to suit the student's interests and background. The color science graduate coordinator or the student's dissertation research adviser must approve all electives. Typically, 4 credit hours of electives are taken each quarter in years one through three, until 36 quarter-credits hours are completed. The following are samples of electives:

0301-753	Optimization Techniques
0307-834	Multivariate Statistics for Imaging Science
0307-851	Nonparametric Statistics
4005-757	Introduction to Computer Vision
4005-761	Computer Graphics I
4005-769	Topics in Computer Graphics
1008-711	Advanced Instrumental Analysis
1013-736	Spectrometric Identification of Organic Compounds
1051-728	Design and Fabrication of Solid State Cameras
1051-782	Introduction to Digital Imaging Processing
1051-784	Spatial Pattern Recognition
1051-786	Advanced Digital Image Processing
1051-790	Image Rendering
1051-816	Color Systems

Second-year project

During the second year, students engage in graduate-level research. The topic may or may not be the same as the dissertation topic. Nine credit hours are normally taken. One of the purposes of this research project is to evaluate the student's research capabilities and suitability for doctoral level research.

Qualifying examination

All students must pass a qualifying examination, the purpose of which is to determine whether they have a sufficient depth of knowledge in color science and the ability to perform research at the doctoral level. A committee appointed by the color science graduate coordinator administers the examination.

One component of the examination is a written test, which in some cases could be given orally. The written test is given twice each year, during the first and sixth weeks of spring quarter. The written test is ordinarily taken after completing the core curriculum and is based on the core curriculum in color science and any material deemed appropriate by the committee. Note that the required readings for these courses include textbooks and current literature.

The second component of the examination is an evaluation of the second-year research project. Criteria include depth of research, productivity, quality, analytical skills and the ability to communicate results.

The student must successfully pass the qualifying examination to continue in the Ph.D. program. Students who do not pass the qualifying examination may request of the color science graduate coordinator, in writing, that they be allow to change their program to the MS program. Requests must be received before the end of the quarter in which the second written test is taken. Students with permission to enter the MS program will use their second-year research project as the required MS research thesis topic. Note that they will have completed the identical degree requirements as students matriculated into the MS program, except for having taken additional elective courses.

Dissertation research adviser and committee

After the student passes the qualifying examination, a dissertation research adviser will be selected based on the student's research interests, faculty research interests and discussions with the color science graduate coordinator.

Also after the student passes the qualifying examination, a dissertation committee of four members is appointed for the duration of the student's tenure in the program. The committee will include the dissertation research adviser, one member of the color science faculty and an external chair appointed by the provost. The external chair must be a member of the RIT faculty who is not a current member of the color or imaging science faculty, preferably with tenure. The fourth member may be an RIT faculty member or a professional affiliated with industry or another institution. The color science graduate coordinator must approve prospective committee members who are not part of the RIT faculty.

The dissertation committee will prepare and administer the examination for admission to candidacy, assist in planning and coordinating research, provide research advice, supervise the writing of the dissertation and conduct the final examination of the dissertation.

Study plan

During the first quarter of study, the student and the color science graduate coordinator will develop a study plan. This plan may be revised as necessary, subject to approval by the color science graduate coordinator. For example, the dissertation research adviser or the dissertation committee may recommend a revised study plan to include specific graduate electives.

Admission to candidacy

When the student thoroughly understands the dissertation research topic, the dissertation committee will administer an examination to determine if the student can be admitted to candidacy for the doctoral degree in color science. The purpose of the examination is to ensure the student has the necessary intellectual skills and background knowledge to carry out their specific doctoral-level research project. The dissertation research adviser will define the type of examination and any requirements prior to the examination. Requirements include a dissertation proposal and may additionally include a review of literature, preliminary experiments and the preparation of an oral presentation. The examination must be administered no later than one year prior to defending the dissertation.

Residency

All students in the program must spend at least three consecutive quarters (summer quarter may be excluded) as resident full-time students to be eligible to receive the Ph.D. A full-time academic load is defined as a minimum of 9 academic credits per quarter or an equivalent amount of research as certified by the color science graduate coordinator.

Time limitations

All candidates for the Ph.D. must maintain continuous enrollment during the research phase of the program. The maximum number of research credits that apply to the degree does not limit such enrollment. Normally, full-time students complete the course of study for the doctorate in approximately four to five years. Requirements for the degree must be completed within seven years of the date students pass the qualifying examination.

Final examination of dissertation

Once the dissertation has been written and distributed to the dissertation committee, and the committee agrees to administer the final examination, the doctoral candidate can schedule the final examination.

The final examination of the dissertation is open to the public and is primarily a defense of the dissertation research. The examination consists of an oral presentation by the student, followed by questions from the audience. The dissertation committee may also elect to privately question the candidate following the presentation. The dissertation committee will immediately notify the candidate and the color science graduate coordinator of the result of the examination.

Teaching and presentation experience

All candidates for the Ph.D. must serve as a teaching assistant for a minimum of one course in color science. Candidates are encouraged to serve as a teaching assistant for two courses.

All candidates for the Ph.D. also must present research in a public forum to be eligible to receive the Ph.D. The preferred public forum is a technical conference.

Color science MS graduates

Graduates from RIT's MS program in color science interested in the doctoral program in color science should contact the color science graduate coordinator to discuss their suitability for doctoral-level research. Before matriculating into the program, students must pass the qualifying examination. The written portion of the examination can be taken remotely using the same testing procedures as distance-learning students.

Once the examination has been passed successfully, students can be admitted into the doctoral program. Up to 45 credits can be

applied toward the degree, including 24 credits of core courses, 12 credits of graduate elective courses, and 9 credits of MS-level research. The doctoral degree can be completed on a full- or part-time basis, as long as the residency requirements are met.

MS and MA graduates from related disciplines

Because of the interdisciplinary nature of color science, it is anticipated that students with MS and MA graduate degrees will apply to the Ph.D. program. Graduate courses in related disciplines can be used as elective courses toward the degree. Furthermore, for degrees that require a research thesis, the second-year research project may be waived. Thus, it may be possible for students with graduate degrees in a related discipline to take the qualifying examination during their first year of study at RIT. The total number of graduate credits that can be applied to the Ph.D. in color science cannot exceed 45 credit hours, limited to 36 credit hours of course work and 9 credit hours of MS-level research. The color science graduate coordinator determines the specific courses and credit hours that can be applied toward the Ph.D. in color science.

Program Scheduling - Year One

	Course Title	Credits
Fall	Vision	4
	Color Measurement Lab	3
	Color Science Seminar	1
	Graduate Elective	4
	Course Credits	12
	Research Credits	0
	Total Credits	12
Winter	Applied Colorimetry	4
	Color Measurement Lab II	3
	Color Science Seminar	1
	Graduate Elective	4
	Course Credits	12
	Research Credits	0
	Total Credits	24
Spring	Color Appearance	3
	Color Modeling	4
	Color Science Seminar	1
	Graduate Elective	4
	Course Credits	12
	Research Credits	0
	Total Credits	**36**

Program Scheduling - Year Two

	Course Title	Credits
Fall	Research and Thesis	3
	Graduate Elective	4
	Course Credits	4
	Research Credits	3
	Total Credits	43
Winter	Research and Thesis	3
	Graduate Elective	4
	Course Credits	4
	Research Credits	3
	Total Credits	50
Spring	Research and Thesis	3
	Graduate Elective	4
	Course Credits	4
	Research Credits	3
	Total Credits	**57**

Program Scheduling - Year Three

	Course Title	Credits
Fall	Research and Thesis	3
	Graduate Elective	4
	Course Credits	4
	Research Credits	3
	Total Credits	64
Winter	Research and Thesis	3
	Graduate Elective	4
	Course Credits	4
	Research Credits	3
	Total Credits	71
Spring	Research and Thesis	3
	Graduate Elective	4
	Course Credits	4
	Research Credits	3
	Total Credits	**78**

Years four and beyond

Student will follow their study plan consisting of research and thesis credits and elective courses.

Munsell advisory board

The Munsell Color Science Laboratory advisory board ensures that research activities surrounding the degree program are relevant to current industrial needs. The board's members have expertise in color vision, color measuring instrumentation, psychophysics, color imaging, instrument-based color matching, lighting, art and applied color technology. The advisory board is an excellent resource for students in the selection of both a thesis topic and future employment opportunities.

Master of Science in Imaging Science

Joel Kastner, Coordinator
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www.cis.rit.edu/content/view/36/61/

The objective of this program is to prepare students holding a bachelor's degree in science or engineering for research positions in the imaging industry, or in the application of various imaging modalities to problems in engineering and science. Formal course work includes consideration of the physics and chemistry of radiation-sensitive materials and processes, the applications of physical and geometrical optics to electro-optical systems, the mathematical evaluation of image forming systems and the statistics of experimental design and quality control. Technical electives at the graduate level may be selected from courses offered in imaging science, color science, engineering, computer science, science and mathematics.

Both thesis and project options are available. In general, full-time supported students are required to pursue the thesis option, with the project option targeted to part-time students who can demonstrate that they have sufficient practical experience through their professional activities.

Faculty within the Center for Imaging Science supervise thesis research in areas of the physics and chemistry of radia-

tion-sensitive materials and processes, digital image processing, remote sensing, nanoimaging, electro-optical instrumentation, medical imaging, color imaging systems and astronomical imaging. Interdisciplinary efforts are possible with the colleges of Engineering and Science.

The degree requirements can be completed on a full- or a part-time basis. An online version of the MS program is available in the areas of color science, remote sensing and digital image processing. Interested students should consult the website (www.cis.rit.edu) or contact the graduate coordinator.

Admission requirements

Admission will be granted to graduates of accredited degree-granting institutions whose undergraduate studies have included at least courses in the major areas of study—mathematics, through calculus and including differential equations, and a full year of calculus-based physics, including modern physics. It is assumed that students can write a common computer program.

Applicants must demonstrate to the graduate admissions committee of the Center for Imaging Science that they have the capability to pursue graduate work successfully. Normally this will include the submission of a statement of purpose, presentation of undergraduate academic records, letters of recommendation from individuals familiar with the applicant's capabilities and any other pertinent data furnished by the applicant. While previous high academic achievement does not guarantee admission, such achievement or other unusually persuasive evidence of professional promise is expected.

Applicants seeking financial assistance from the center must have all application documents submitted to the Office of Graduate Enrollment Services by January 15 for the next academic year. Those seeking funding from the center are also required to take the Graduate Record Exam. Students whose native language is not English must submit scores from the Test of English as a Foreign Language. Minimum TOEFL scores of 600 (paper-based), 250 (computer based) or 100 (Internet-based) are required. Students whose native language is not English are advised to obtain as high a TOEFL score as possible if they wish to apply for a teaching or research assistantship. These candidates also are encouraged to take the Test of Spoken English in order to be considered for financial assistance.

Grades

The grade point average for all courses taken at the university and credited toward a master's degree must be at least a B (3.0). Research thesis credits do not carry a letter grade and are not included in the average.

Curriculum

Imaging science is available as a full- or part-time master's degree program. All students must earn 45 credits as a graduate student, 37 of which must be taken at RIT, to earn the master of science degree.

The curriculum is a combination of required core courses in imaging science and elective courses appropriate for the candidate's background and interests. Seven tracks (concentrations) have been established: digital imaging processing, medical imaging, electro-optical imaging systems, remote sensing, color imaging, hard copy materials and processes, and nanoimaging. Additional tracks may be created for interested students. Students must enroll in either the research thesis or graduate paper/project option at the beginning of their studies.

Candidates who wish to enter the program but lack adequate preparation may have to take bridge courses in mathematics, chemistry or physics before matriculating with graduate status. All graduate students in the MS program are required to complete five of the seven doctoral program core courses, with the only required course being Fourier Methods for Imaging (1051-716).

All nonimaging science courses must be approved by the graduate program coordinator as acceptable for credit.

Research thesis option

Full-time students who elect this option begin their thesis work during the first year of study. Part-time students may defer the beginning of their thesis work until their second or subsequent years. Full-time students receiving funding assistance are required to choose the research thesis option. Students who elect this option will take 36 credit hours of course work (including the core) and nine credit hours of thesis/research, three of which are associated with the graduate research seminar course (1051-706, 707, 708).

The thesis is to be based on experimental evidence obtained by the candidate in an appropriate field, as arranged between the candidate and his or her adviser. A minimum of 9 thesis credits is required. The thesis requirement may be fulfilled by experiments in the university's laboratories. In some cases, the requirement may be fulfilled by work done in other laboratories. An example might be the candidate's place of employment, under the following conditions:

1. The results must be fully publishable.
2. The candidate's adviser must be approved by the graduate coordinator.
3. The thesis must be based on the candidate's independent, original work, as it would be if the work were done in the university's laboratories.

A student's thesis committee is composed of a minimum of three people: the student's adviser and two additional members who hold at least an MS in a field relevant to the student's research. Two committee members must be from the graduate faculty of the center.

Graduate paper/project option

Students with demonstrated practical or research experience, approved by the graduate coordinator, may choose the graduate

project option (5 credit hours) in addition to 40 hours of core and elective courses. This option takes the form of a systems course and an associated project/paper. The graduate paper is normally performed during the final quarter of study. Both part- and full-time students may choose this option, with the approval of the graduate coordinator.

Typically, two years is required for the master of science if the degree is pursued on a full-time basis. Whether a student pursues the thesis or project/paper option, all degree requirements must be completed within seven years of the first course taken for the degree.

Doctor of Philosophy in Imaging Science

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The doctor of philosophy degree in imaging science signifies high achievement in scholarship and independent investigation in the diverse aspects of imaging science. Candidates for the doctoral degree must demonstrate proficiency by:

- successfully completing course work, including a core curriculum, as defined by the student's plan of study;
- passing a series of examinations; and
- completing an acceptable dissertation under supervision of the student's research adviser and dissertation committee.

Admission requirements

Because imaging science encompasses a wide variety of scientific disciplines, students with diverse backgrounds are accepted into the program. Undergraduate preparation leading to a bachelor of science degree in engineering, computer science, applied mathematics or one of the natural sciences is usually required, but exceptional students from other fields may be accepted. All students admitted to the doctoral program in imaging science must have completed courses in the following areas:

- Calculus
- University physics (one year)
- Modern physics
- Computer language

Admissions decisions are made by a committee comprised of graduate faculty of the Center for Imaging Science. To be admitted, students must have a record of academic achievement from their undergraduate institutions, as indicated by official transcripts; demonstrate proficiency on the Graduate Record Examination; and request letters of recommendation from two people well-qualified to judge their abilities for graduate study.

Graduate assistantships and tuition remission scholarships are available to qualified students. Applicants seeking financial assistance from the center must have all application documents submitted to the Office of Graduate Enrollment Services by January 15 for the next academic year.

Students whose native language is not English must demonstrate proficiency in English by taking the Test of English as a Foreign Language. A minimum TOEFL score of 600 (paper-based), 250 (computer-based) or 100 (Internet-based) is required. Students whose native language is not English are advised to obtain as high a TOEFL score as possible if they wish to apply for a teaching or research assistantship. These candidates also are encouraged to take the Test of Spoken English in order to be considered for financial assistance.

Due to the variety of backgrounds of incoming students, it is recognized that some will not have the requisite preparation in all areas and will have to complete some undergraduate requirements during the course of their graduate study.

Students with a master of science degree in a related field (e.g., physics, chemistry, electrical engineering or computer engineering) may be granted up to 36 quarter credits toward the doctoral degree in imaging science based on their earlier studies. These credits may be granted after successful completion of the comprehensive examination and approval of their study plan. The required research credits may not be waived by experience or examination.

Curriculum

All students must complete a minimum of 72 credit hours of course work. The courses are defined by the student's study plan and must include the completion of the core sequences, plus at least two three-quarter sequences in topical areas. Some examples of topical areas are remote sensing, digital image processing, digital graphics, electro-optical imaging systems, medical imaging and microlithographic imaging technologies.

Students may take a maximum of 16 credits in other departments and also must complete 27 credits of research, 3 credits of which are associated with the research seminar course (1051-706, 707, 708), with a maximum of 9 credits per quarter.

The core curriculum includes courses that span and integrate a common body of knowledge essential to an understanding of imaging processes and applications. The core courses are:

Core Courses		Qtr. Cr. Hrs.
1051-706, 707, 708	Imaging Science Research Seminar	3
1051-716	Fourier Methods for Imaging	4
1051-718	Digital Imaging Mathematics	4
1051-719	Radiometry	4
1051-720	Vision	4
1051-733	Optics	4
1071-713	Probability, Noise and System Modeling	4
1051-782	Digital Image Processing	4

Admission to candidacy

Admission to candidacy will proceed through the following steps:

- Adviser selection
- Submission and approval of preliminary study plan
- Passing a written comprehensive exam
- Study plan revision, based on outcome of comprehensive exam and adviser recommendation

- Research committee appointment
- Candidacy exam based on thesis proposal

If the faculty decision, following the comprehensive exam, is not to permit the candidate to continue in the doctoral track, the adviser and graduate coordinator will counsel the student about options that may include pursuit of an MS degree. If the faculty decision is to permit the candidate to continue in the doctoral track, the program continues with the study plan revision, research committee appointment, candidacy/proposal exam and, finally, dissertation defense.

Research committee

By the end of the quarter following admission to candidacy, the student, in consultation with the adviser, must present a request to the graduate coordinator for the appointment of a research committee. The committee will include the adviser, one member of the faculty, a person competent in the field of research and an external chair. The external chair must be a tenured member of the RIT faculty who is not a faculty member of the center and who is appointed by the dean. The research committee will supervise the student's research, beginning with a review of the research proposal and concluding with the dissertation defense.

Research proposal

The student and the research adviser select a research topic for the dissertation. The proposed research must be original and publishable. Although the topic may deal with any aspect of imaging, the research is usually concentrated in an area of current interest within the center.

Residency

All students in the program must spend at least three consecutive quarters (summer quarter excluded) as resident full-time students to be eligible to receive the doctoral degree. A full-time academic workload is defined as a minimum of 9 academic credits per quarter or an equivalent amount of research, as certified by the graduate coordinator.

Time limitations

All candidates for a doctoral degree must maintain continuous enrollment during the research phase of the program. Such enrollment is not limited by the maximum number of research credits that apply to the degree. Normally, full-time students complete the course of study for the doctorate in approximately three to five years. A total of seven years is allowed to complete the requirements after the first attempt of the comprehensive exam.

Exceptions to residency requirement and time limitations

If circumstances warrant, the residency requirement may be waived via petition to the graduate coordinator, who will decide on the student's petition in consultation with the adviser and graduate faculty. The request must be submitted at least nine months prior to the thesis defense. The time limitation may be waived only via petition to the dean and graduate council.

Final examination of the dissertation

The research committee must notify the graduate coordinator requesting permission to administer the final examination of the dissertation. The letter must indicate that each member has received the dissertation and concurs with the request. The examination is scheduled by the graduate coordinator but may not be held sooner than two weeks after permission has been granted.

The final examination of the dissertation is open to the public and is primarily a defense of the dissertation research. The examination consists of an oral presentation by the student, followed by questions from the audience. The research committee may also elect to privately question the candidate following the presentation. The research committee will immediately notify the candidate and the graduate coordinator of the examination result.

Graduate Faculty

Ian Gatley, BSc, University of London; Ph.D., California Institute of Technology—Dean

School of Life Sciences

Department of Biological Sciences

Larry Buckley, BA, University of Missouri; MS, Southern Illinois University at Edwardsville; Ph.D., Southern Illinois University at Carbondale—Associate Professor, Biology

Jean A. Douthwright, BA, Skidmore College; MS, Pennsylvania State University; MS, Ph.D., University of Rochester—Professor, Biology: DNA repair and mutagenesis in microbial organisms

Irene Evans, AB, University of Rochester; MS, Wesleyan University; Ph.D., University of Rochester—Professor, Biology

Maureen Ferran, BA, Fordham University; MS, Ph.D., University of Connecticut—Associate Professor, Biology: virus-host interactions, viral genetics

G. Thomas Frederick, BS, MS, Ph.D., Ohio State University—Professor, Biology

Shuba Gopal, BA, Sarah Lawrence College; Ph.D., Rockefeller University—Assistant Professor, Bioinformatics: computational genomics and sequence analysis

Elizabeth Hane, BA, Rice University; MA, University of Kansas; Ph.D., Brown University—Assistant Professor, Biology: plant community ecology, ecosystem biology, conservation biology

Karl F. Korfmacher, BA, Carleton College; MS, School of Forestry and Environmental Studies, Duke University; Ph.D., Duke University—Associate Professor, Environmental Sciences: remote sensing of marine seagrass beds, environmental applications of GIS

David A. Lawlor, BA, University of Texas; MS, Ph.D., University of Texas Health Science Center at San Antonio—Associate Professor, Biology

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Douglas Merrill, BS, Ph.D., State University of New York College of Environmental Science and Forestry, Syracuse University—Professor, Biology

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Hyla Sweet, BS, Union College; Ph.D., University of Texas at Austin—Associate Professor

John M. Waud, BS, Lehigh University; MS, University of Pennsylvania; Ph.D., Lehigh University—Professor: migrant bird studies, water quality measurements, distribution of persistent organic toxins, wetland restoration

Department of Medical Sciences

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Adjunct Faculty

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School of Mathematical Sciences

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School of Physical Sciences

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Christopher Collison, BS, Ph.D., Imperial College of London—Assistant Professor, Physical Chemistry: polymer chemistry

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Peter A. Cardegna, BS, Loyola College; Ph.D., Clemson University—Professor, Physics: experimental solid state physics: transport phenomena in solids, amorphous (glassy) materials, silver halide physics, superconductivity, ceramics

Tracy A. Davis, BA, BS, Wofford College; Ph.D., Clemson University—Associate Professor, Physics: experimental solid-state physics, optics, low temperature physics, computer models of chaotic systems

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Scott V. Franklin, BA, University of Chicago; Ph.D., University of Texas—Associate Professor, Physics: theoretical and experimental investigations of nonlinear dynamics, granular materials and dislocation phenomena, physics education research (PER) and curriculum development, especially for non-science majors

Edwin Hach, III, BS, MS, St. Bonaventure University; Ph.D., University of Arkansas—Lecturer, Physics: theoretical quantum optics

Ian Hodge, BS, MS, University of Auckland; Ph.D., Purdue University—Lecturer, Physics: nonlinear kinetics of the glass, polymers, electrical conductivity in solid electrolytes (glass, crystalline and polycrystalline)

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James R. Kern, BS, Indiana University of Pennsylvania; MA, Indiana University; Ph.D., Clemson University—Professor, Physics: acquisition and analysis of the light curves of eclipsing binary stars, imaging and surface photometry of galaxies and comets, asteroid photometry and astrometry, automated telescopes, computer modeling of physical systems

Michael Kotlarchyk, BS, MS, Ph.D., Massachusetts Institute of Technology—Professor, Physics: characterization of structure and phase transitions in surfactant systems (micelles, microemulsions and liquid crystals) using scattering techniques; mass and surface fractals in condensed matter systems, theories of liquids; chaos in simple non-linear physical systems

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David L. Morabito, BS, MS, Rochester Institute of Technology; MA, University of Rochester; Ph.D., State University of New York at Buffalo—Lecturer, Physics: theoretical condensed matter physics, superconductivity, quantum statistical mechanics, quantum field theory, computational physics, theoretical high-energy physics, the general theory of relativity and the philosophy of physics

Christopher O'Dea, BS, Massachusetts Institute of Technology; Ph.D., University of Massachusetts—Associate Professor, Physics: astronomy, active galactic nuclei (Seyfert galaxies, radio galaxies, quasars), clusters of galaxies, cooling flows

Ryne Raffaelle, BS, MS, Southern Illinois University; Ph.D., University of Missouri at Rolla—Professor, Physics: nanophysics and materials science: thin films synthesis and characterization, superlattices in high-efficiency photovoltaic solar cells

Michael W. Richmond, BA, Princeton University; MA, Ph.D., University of California at Berkeley—Associate Professor, Physics: observational astronomy, supernovae, variable stars, reduction of optical data, automatic telescopes

Andrew Robinson, BSc, Ph.D., University of Manchester—Associate Professor, Physics: astronomy, active galactic nuclei, supermassive black holes, radio galaxies, high redshift quasars

Robert B. Teese, BS, North Carolina State University; MA, Ph.D., University of Texas—Professor, Physics: physics education research and curriculum development

George M. Thurston, AB, Oberlin College; Ph.D., Massachusetts Institute of Technology—Associate Professor, Physics: biophysics

Greg Trayling, BSc, Simon Fraser University; MSc, University of Victoria; Ph.D., University of Windsor—Visiting Assistant Professor, Physics: Clifford algebra, particle physics, physics beyond the Standard Model, quantum field theory

Jerome Wagner, BS, Case Institute of Technology; MS, Ph.D., University of Wisconsin—Professor, Physics: solid state physics, nuclear physics, medical physics, diagnostic nuclear medicine, defect properties in insulating materials, radiation-induced defects, color centers

Anne G. Young, BA, Bryn Mawr College; MS, Ph.D., Cornell University—Professor, Physics: science education, astronomy and astrophysics, student misconceptions in physics and astronomy, curriculum development using hands-on activities

Center for Materials Science and Engineering

(College of Science and Kate Gleason College of Engineering)

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Linda Barton, BS, Massachusetts Institute of Technology; MS, Ph.D., University of Illinois—Associate Professor, Physics: magnetic materials and magnetic measurements, calorimetry, bulk transport measurements, properties of materials at or near phase transitions, critical phenomena

David A. Borkholder, Ph.D., Stanford University—Assistant Professor, Electrical Engineering

Robert J. Bowman, Ph.D., University of Utah—Professor, Electrical Engineering

Peter Cardegna, BS, Loyola College; Ph.D., Clemson University—Professor, Physics: superconductivity, low temperature physics, photographic materials

Robert A. Clark, BS, Massachusetts Institute of Technology; Ph.D., University of Maryland—Professor Emeritus, Chemistry: plasma modification of organic polymers, polymer science, chemistry of microlithographic imaging systems, kinetics and thermodynamics of thermal and photochemical transformations of small hydrocarbon molecules

Tracy Davis, BA, BS, Wofford College; Ph.D., Clemson University—Associate Professor, Physics: experimental solid-state physics, optics, low temperature physics, computer models of chaotic systems

Alan B. Entenberg, AB, Washington University; Ph.D., University of Rochester—Professor, Physics: stress and adhesion in thin films; surface modification by glow discharge plasma and/or ion bombardment

Thomas Gennett, BA, State University of New York at Potsdam; Ph.D., University of Vermont—Professor, Chemistry: electroanalytical chemistry, HPLC detectors, biosensors, ion-exchange partition coefficient

Surendra K. Gupta, B.Tech., India Institute of Technology; MS, University of Notre Dame; Ph.D., University of Rochester—Professor, Mechanical Engineering: dislocation theory, x-ray diffraction, sintering, numerical modeling, digital image analysis, computer-integrated manufacturing, micromechanics of heteroepitaxial structures, morphological filters in image processing of microstructures

Richard K. Hailstone, BS, Northern Illinois University; MS, Indiana University—Associate Professor, Imaging Science: silver halide materials and processing, imaging materials

Joseph P. Hornak, BS, Utica College of Syracuse University; MS, Purdue University; Ph.D., University of Notre Dame—Professor, Chemistry: physical chemistry, magnetic resonance spectroscopy and imaging

Marvin L. Illingsworth, BS, Lafayette College; Ph.D., University of Massachusetts—Professor, Chemistry: inorganic polymers, synthesis and characterization of coordination polymers, ferroelectric thin films, specialty materials

Michael A. Jackson, BS, MS, Ph.D., State University of New York at Buffalo—Associate Professor, Microelectronic Engineering: microelectronic device design, fabrication and test; material characterization techniques, surface analytical instrumentation; vacuum processing, including CVD, plasma and ion beam techniques, micromachining, ferroelectric thin films, amorphous silicon and polysilicon film deposition and characterization

Ronald Jodoin, BS, Worcester Polytechnic Institute; Ph.D., University of Rochester—Professor, Physics: optical properties of photoreceptor materials, experimental physics, electronics, microcomputer interfacing

Michael Kotlarchyk, BS, MS, Ph.D., Massachusetts Institute of Technology—Professor, Physics: characterization of structure and phase transitions in surfactant systems (micelles, microemulsions and liquid crystals) using scattering techniques; mass and surface fractals in condensed matter systems, theories of liquids; chaos in simple non-linear physical systems

Santosh Kurinec, BS, MS, Ph.D., University of Delhi—Department Head, Professor, Microelectronic Engineering: electronic materials, amorphous and semicrystalline materials, solid-state devices

Andreas Langner, BS, Ph.D., State University of New York at Buffalo—Professor, Chemistry: physical chemistry, polymer chemistry, theoretical chemistry and chemical engineering, transient spectroscopy, charge and energy transfer, diffusion and flow in polymeric gels and blends

Vern Lindberg, BS, University of Alberta; MS, Ph.D., Case Western Reserve University—Professor, Physics: deposition of metals onto polymeric substrates, effects of surface modification of polymer substrates on growth of PVD (physical vapor deposited) films, glow discharge and ion bombardment, stress in sputtered thin films, adhesion of PVD thin films, multilayer optical filters

Massoud Miri, BS, MS, Ph.D., University of Hamburg—Associate Professor, Chemistry: polymerization mechanisms, polymer properties, catalysis

Ali Ogut, B.Ch.E., Hacettepe University; MS, Ph.D., University of Maryland—Associate Professor, Mechanical Engineering: polymer processing, heat and mass transfer, rheology, transport phenomena

Ryne P. Raffaelle, BS, MS, Southern Illinois University; Ph.D., University of Missouri at Rolla—Professor, Physics: experimental solid state physics, chemically deposited thin film solar cells, thin film lithium batteries, EBIC, STOS, electrical and optical characterization of thin film semiconductors, semiconductor junctions and devices

Sannasi Ramanan, BS, BE, M. Tech., Ph.D., Indian Institute of Technology—Associate Professor, Electrical Engineering: semiconductor materials, IC processing, epitaxial growth of semiconductors, quantum-well heterostructures, simulation and design of solid state devices

Andrew Robinson, BSc, Ph.D., University of Manchester—Associate Professor, Physics: astronomy, active galactic nuclei, supermassive black holes, radio galaxies, high redshift quasars

K. S. V. Santhanam, BSc, MA, Ph.D., Sri Venketaswana University—Director, Center for Materials Science and Engineering; Professor, Analytical Chemistry: organic conducting polymers, electrochemistry, sensors and carbon nanotubes

Bruce Smith, BS, MS, Ph.D., Rochester Institute of Technology—Professor, Microelectronic Engineering: 193 nm lithography, multilayer resist processing, attenuated phase shift mask materials

Thomas W. Smith, BS, John Carroll University; Ph.D., University of Michigan—Professor, Chemistry: synthesis and device applications of block copolymer systems and nano composites

David A. Sumberg, BA, Utica College of Syracuse University; MS, Ph.D., Michigan State University—Associate Professor, Electrical Engineering: fiber optics and applications of fiber optics (polarization properties, microwave transmission on optical fiber, sensors, couplers); integrated optics (couplers, materials for integrated optics)

Gerald A. Takacs, BS, University of Alberta; Ph.D., University of Wisconsin—Professor, Chemistry: physical chemistry, chemical kinetics, photochemistry, atmospheric chemistry, plasma etching and modification of materials

I. R. Turkman, MS, Ph.D., Institute National des Sciences Appliquées—Associate Professor, Electrical and Microelectronic Engineering: susceptibility of microelectronic devices to damage from electrostatic discharges, CVD, sputtering, plasma-assisted etching processes

Jayanthi Venkataramn, Ph.D., Indian Institute of Science—Professor, Electrical Engineering: electromagnetic fields

Jerome Wagner, BS, Case Institute of Technology; MS, Ph.D., University of Wisconsin—Professor, Physics: solid state physics, nuclear physics, medical physics, diagnostic nuclear medicine, defect properties in insulating materials, radiation-induced defects, color center

Adjunct Faculty

John E. Carson, MS, Massachusetts Institute of Technology—Eastman Kodak Company, Rochester, N.Y.

Dennis H. Feduke, MS, P.E., Syracuse University—IBM, Endicott, N.Y.

Henry J. Gysling, Ph.D., University of Delaware—Eastman Kodak Company, Rochester, N.Y.

J. Raymond Hensler, Ph.D., Pennsylvania State University—Director of Manufacturing Technology, Bausch and Lomb, Inc., Rochester, N.Y.

Merle N. Hirsh, Ph.D., The Johns Hopkins University—Plasma Resources

Robert Lord, MS, Syracuse University—Manager, IBM-Endicott, Endicott, N.Y.

Gerald F. Meyers, BS, University of Pittsburgh—Plant Metallurgist, Delco Products, General Motors Corporation, Rochester, N.Y.

J. William Sexton, BS, University of Rochester—Coordinator of Optics Contracts and New Opportunities Development, Eastman Kodak Company, Rochester, N.Y.

E. Wayne Turnblom, Ph.D., Columbia University—Manager, Materials Development and Manufacturing, Technical Operations, Graphics Imaging Systems Division, Eastman Kodak Company, Rochester, N.Y.

Edward G. Williams, MS, University of Rochester—Manager of Plastics Technology, Xerox Corporation, Rochester, N.Y.

Chester F. Carlson Center for Imaging Science

Jonathan S. Arney, BS, Wake Forest University; Ph.D., University of North Carolina—Associate Professor, Imaging Science: characterization of optical and physical interactions between links and substrates in printing processes; image analysis applications in the conservation of works of art on paper and of photographs; image analysis of Paleozoic sedimentary layers

Stefi Baum, BA, Harvard University; Ph.D., University of Maryland—Director and Professor, Imaging Science: astrophysics, astronomical imaging and astronomical mission development, including radio, optical, UV and X-ray observations; active galaxies, black holes, galaxies and cluster of galaxies

Roy S. Berns, BS, MS, University of California; Ph.D., Rensselaer Polytechnic Institute—Richard S. Hunter Professor, Color Science: spectral-based digital-image capture, digital archiving and reproduction of works of art; art conservation science including pigment identification for in painting and quantifying the optical properties of painting varnishes; spectral models and color profiles for multi-ink printing; colorimetry

Roger L. Easton, BS, Haverford College; MS, University of Maryland; MS, Ph.D., University of Arizona—Associate Professor, Imaging Science: application of imaging technologies to manuscripts of cultural importance; optical holography; digital and optical signal/image processing

Mark D. Fairchild, BS, MS, Rochester Institute of Technology; Ph.D., University of Rochester—Director, Munsell Color Science Laboratory, Xerox Professor, Imaging Science and Color Science: color appearance perception and modeling; image quality metrics and models; image rendering; cross-media color reproduction

Donald F. Figer, BA, Northwestern University; MS, University of Chicago; Ph.D., University of California—Professor

Richard Hailstone, BS, Northern Illinois University; MS, Indiana University—Associate Professor, Imaging Science: interaction between electromagnetic radiation and matter, photochemistry, computer simulation of imaging processes

Maria Helguera, BS, National Autonomous University of Mexico; MS, University of Rochester; Ph.D., Rochester Institute of Technology—Assistant Professor, Imaging Science: medical imaging, ultrasound tissue characterization, digital image processing

Joseph P. Hornak, BS, Utica College of Syracuse University; MS, Purdue University; Ph.D., University of Notre Dame—Professor, Joint Appointment with Department of Chemistry: physical chemistry, magnetic resonance spectroscopy and imaging

Joel Kastner, BS, University of Maryland; MS, Ph.D., University of California—Professor, Imaging Science: astronomical imaging, including x-ray, infrared and radio spectroscopy; young stars and planet formation; evolved stars and planetary nebulae

John P. Kerekes, BS, MS, Ph.D., Purdue University—Associate Professor, Imaging Science: multi-spectral remote sensing systems, multidimensional imaging system, pattern recognition

David W. Messinger, BS, Clarkson University; Ph.D., Rensselaer Polytechnic Institute—Research Assistant Professor, Imaging Science: remote sensing image exploitation, gaseous effluent detection in LWIR hyperspectral imagery, target detection in hyperspectral imagery

Zoran Ninkov, BSc, University of Western Australia; MS, Monash University; Ph.D., University of British Columbia—Professor, Imaging Science: detector array development and characterization, development of novel astronomical instrumentation, studies of young stellar clusters, planetary detection

Noboru Ohta, BS, MS, Ph.D., Tokyo University—Visiting Research Professor, Imaging Science: color science, digital color imaging, color reproduction

Jeff Pelz, BFA, MS, Rochester Institute of Technology; Ph.D., University of Rochester—Professor, Imaging Science: visual perception and cognition, understanding high-level visual processing by examining eye movements in the execution of complex tasks in natural environments

Navalgund Rao, MS, Banaras Hindu University; Ph.D., University of Minnesota—Associate Professor, Imaging Science: industrial and medical applications of ultrasound imaging, digital signal processing; modeling and analysis of medical imaging systems

Harvey E. Rhody, BS, University of Wisconsin; MS, University of Cincinnati; Ph.D., Syracuse University—Professor, Imaging Science: imaging algorithms

Carl Salvaggio, BS, MS, Rochester Institute of Technology; Ph.D., State University of New York College of Environmental Science and Forestry, Syracuse University—Associate Professor: novel techniques for the measurement of spectral optical properties, quantitative reflective and emissive remote sensing, digital image processing and scene simulation and modeling

John Schott, BS, Canisius College; MS, Ph.D., Syracuse University—Frederick and Anna B. Wiedman Professor, Imaging Science: quantitative radiometric remote sensing, synthetic image generation, spectroscopy, calibration and atmospheric correction of satellites imaging systems, remote assessment of the Great Lakes water resources

Anthony Vodacek, BS, University of Wisconsin; MS, Ph.D., Cornell University—Associate Professor, Imaging Science: applications of passive hyperspectral and active laser remote sensing for environmental characterization and monitoring; in-water radiometric measurements for characterizing water quality parameters; non-thermal techniques for wildland fire detection, monitoring and prediction; model-based algorithms for inverting remote sensing data

Extended Graduate Faculty

David John Axon, BSc, Ph.D., University of Durham—Professor, Physics: astronomy, active galactic nuclei

Peter Bajorski, BS, MS, University of Wroclaw; Ph.D., Technical University of Wroclaw—Associate Professor, Nonparametric Methods, Categorical Data Analysis, Visualization Methods, Exploratory Data Analysis

Sohail A. Dianat, BS, Aria-Mehr University, Iran; MS, Ph.D., George Washington University—Professor, Control Systems, Signal Processing

Marcos Esterman, BS, MS, Massachusetts Institute of Technology; Ph.D., Stanford University—Assistant Professor, Systems Engineering, Product Development

Franziska Frey, Ph.D., Swiss Federal Institute of Technology—Associate Professor, Materials and Digital Imaging

Lynn F. Fuller, BS, MS, Ph.D., State University of New York at Buffalo—Professor, Microelectronic Engineering

Roger S. Gaborski, BS, MS, State University of New York at Buffalo; Ph.D., University of Maryland—Professor, Computer Science

Michael Kotlarchyk, BS, MS, Ph.D., Massachusetts Institute of Technology—Professor, Physics

Raghuveer Rao, BS, Mysore University (India); ME, Indian Institute of Science (India); Ph.D., University of Connecticut—Professor, Electrical Engineering

Ryne P. Raffaelle, BS, MS, Southern Illinois University; Ph.D., University of Missouri at Rolla—Professor, Physics: experimental solid state physics, chemically deposited thin film solar cells, thin film lithium batteries, EBIC, STOS, electrical and optical characterization of thin film semiconductors, semiconductor junctions and devices

Eli Saber, BS, State University of New York at Buffalo; MS, Ph.D., University of Rochester—Associate Professor, Electrical Engineering: signal, image and video processing; communications

Andreas Savakis, BS, MS, Old Dominion University; Ph.D., North Carolina State University—Associate Professor, Digital Image Processing, Computer Vision

Bruce Smith, BS, MS, Ph.D., Rochester Institute of Technology—Professor, Microelectronic Engineering

Thomas W. Smith, BS, John Carroll University; Ph.D., University of Michigan—Professor, Analytical/ Polymer Chemistry: synthesis and device applications of block polymer systems and nano composites

Carlson Associate

Robert MacIntyre, BS, Boston University; MA, University of Rochester

Note: Prerequisites are within parentheses at the end of the course description

Biological Sciences

1001-700 Cell and Molecular Genetics I
This course will introduce cellular and molecular biology to graduate students with limited background in the biological sciences. The approach taken entails the use of empirical data to support the basic concepts presented. Upon completion of this course, students will not only be familiar with cellular and molecular biology, but will also be acquainted with the theoretical foundations of modern laboratory techniques. Topics covered in this course include cellular evolution, small molecules, energy and biosynthesis, macromolecules, protein functions, genetic mechanisms, recombinant DNA technologies, the nucleus, regulation of gene expression, membrane structure and function, and intracellular protein trafficking. (1001-251, 252, 1011 211-213, 1011-205-207, or equivalent) **Class 3, Credit 3 (F)**

1001-701 Cell and Molecular Genetics II
This course will introduce cellular and molecular biology to graduate students with limited background in the biological sciences. The approach to be taken entails the use of empirical data to support the basic concepts presented. Upon completion of this course, students will not only be familiar with cellular and molecular biology, but will also be acquainted with the theoretical foundations of modern laboratory techniques. Topics covered in this course include energy conversion in mitochondria and chloroplasts, cell signaling, the cytoskeleton, the cell cycle, cell division, intercellular interactions, germ cells and development, cellular differentiation, immunity and cancer. (1001-700) **Class 3, Credit 3 (W)**

1001-703 Animal Behavior
This course is a comparative study of animal behavior from an evolutionary perspective. Lectures examine the physiological organization of behaviors, survival behaviors, social dynamics, and human behavior. Discussion section focuses on analysis of primary literature. (Graduate standing, one year of introductory biology or equivalent, 1001-365, 1016-319, or permission of instructor) **Class 4, Credit 4 (S)**

1001-722 Bioinformatics Seminar
Sufficient opportunities will be afforded for students and faculty to develop and share professional interests while discussing current trends and developments in bioinformatics. Material for this course will be drawn from the current scientific literature including, but not limited to, journals such as *Bioinformatics, Genome Research,* and the *Journal of Computational Biology,* among others. Students from outside the bioinformatics MS program may take this course with permission of the instructor. **Class 2, Credit 2 (F)**

1001-724 Advanced Data Management
Data management in bioinformatics requires sophisticated methodologies in order to maximize the value of laboratory generated data. This course aims to introduce students to some of the bioinformatics methodologies traditionally used in biomedical research and now being used to manage and analyze other large biological data sets, advanced database architectures, data/process interoperability, and the use of vocabularies/ontologies. Readings and discussions will explore how these methods have been used in real projects through the use of seminal, primary literature. (Permission of instructor) **Class 3, Credit 3 (W)**

1001-725 Ethics in Bioinformatics
This course will be focused on individual and organizational responsibilities in bioinformatics research and product development and commercialization. Students from outside the bioinformatics MS program may take this class with permission of the instructor. **Class 3, Credit 3 (W)**

1001-755 Modeling Population Genetics for Programmers
This course focuses on the mathematical modeling of population genetics and the implications for studies of human genetic diversity. Emphasis is placed on the use of these models in medical research, forensics, and pharmacogenomics. Labs apply the lecture material in computer simulation models. (4003-233 or equivalent, 1001-421 or equivalent, or permission of instructor) **Class 3, Lab 3, Credit 4 (F)**

1001-794 Molecular Modeling and Proteomics
This course will explore two facets of protein molecules: their structure and their expression. The structure component will build upon information from the bioinformatics course and will add further sophistication with analysis of intermolecular interactions and ligand/receptor pairing. Software that permits molecular docking experiments will be employed. Tissue-specific protein expression will be addressed in lectures with description of microarray technology and, in the laboratory, with two-dimensional protein gel electrophoresis. Each student will be assigned a project designed to integrate salient principles in each course and provide an opportunity for each student to give an oral presentation to his or her peers. (4002-763) **Class 3, Lab 3, Credit 4 (S)**

1001-890 Bioinformatics MS Thesis
Each student's experience in this course will be different. The individual student's thesis project will be tailored to fit his or her interests under the guidance of a faculty mentor. That mentor will be identified as the individual within our faculty who has professional interests most closely aligned with those of the student. Typically a mentor will be identified and a thesis proposal will be prepared and approved by the student's thesis advisory committee before the start of the second year of study. Thesis work and the preparation and defense of the written thesis will take place during the second year of study. **Credit variable (F, W, S)**

Environmental Science

1006-711 Environmental Science Graduate Study I
This is the first course of a three course sequence (1006-711, 712, 713) designed to introduce new graduate students in the Environmental Science program to the entire process of graduate study that will culminate in their completion of all required coursework as well as a research project under the direct supervision of a member of the faculty. This first course will introduce students to careers in environmental science, to graduate studies in environmental science at RIT and to the process of proposing, conducting, presenting, and defending a research project in partial fulfillment of the requirements for the Master of Science degree in environmental science. (Graduate status in Environmental Science) **Class 2, Credit 2 (F)**

1006-712 Environmental Science Graduate Study II
This is the second of a three course sequence (1006-711, 712, 713) designed to introduce new graduate students in the Environmental Science program to the entire process of graduate study that will culminate in their completion of all required coursework as well as a research project under the direct supervision of a member of the faculty. This course will focus on the creation of a carefully researched and written draft of their thesis or project proposal. Students will learn modern conventions for analyzing and reporting scientific data. Peer review and editing of scientific writings will be emphasized. (1006-711) **Class 2, Credit 2 (W)**

1006-713 Environmental Science Graduate Study III
This is the third course of a three course sequence (1006-711, 712, 713) designed to introduce new graduate students in the Environmental Science program to the entire process of graduate study that will culminate in their completion of all required coursework as well as a research project under the direct supervision of the program faculty. This course will focus on developing and practicing techniques for making oral presentations of research proposals to an audience of peers in environmental science, and to providing peer review of oral presentations. (1006-712) **Class 2, Credit 1 (S)**

1006-710 Graduate Readings Seminar
This course helps graduate and upper-level undergraduate students learn how to assess journal articles, government reports, whitepapers, and essays as well as other relevant sources of information. Students will also refine their discussion and presentation skills and gain experience in clarifying their comments and responding to questions by an audience. **Class 3, Credit 3 (W)**

1006-750 Ecological and Environmental Applications of GIS
Aerial photography, satellite imagery, Global Positioning Systems (GPS), and Geographic Information Systems (GIS) are extremely useful tools in ecological and environmental applications such as biological monitoring, environmental assessment, habitat restoration, change analysis, resource management, and risk assessment. This course will: 1) introduce students to spatial analysis, theories, techniques and issues associated with ecological and environmental applications; 2) provide hands-on training in the use of spatial tools while addressing a real problem; 3) provide experience linking GIS analyses to field assessments and monitoring activities; and 4) enable students to solve a variety of spatial and temporal ecological and environmental problems. (1006-350 or 1006-450, or permission of instructor) **Class 3, Lab 3, Credit 4 (S)**

1006-759 Special Topics: Environmental Science
Special topics courses are courses that are of current interest and/or logical continuations of courses already offered. These courses are structured as ordinary courses and may have specified prerequisites, contact hours, and examination procedures. **Variable class, Variable credit (F, W, S, SU)**

1006-799 Independent Study
Independent study is a faculty directed study of appropriate topics on a tutorial basis. Independent study enables an individual to pursue studies of existing knowledge available in literature. **Variable class, Variable credit (F, W, S, SU)**

1006-870 Graduate Seminar
Students are required to participate in a weekly environmental science seminar. **Class 1, Credit 1 (F, S)**

1006-879 Environmental Science Research
This course is taken by graduate students in the Environmental Science MS and BS/MS programs to begin the process of developing an environmental research (thesis or project) plan under the guidance of an RIT faculty mentor, who will become the student's graduate thesis/project advisor. This process will culminate with the completion and defense of a graduate research proposal. Graduate students are required to complete a total of 3 quarter credit hours of this course to fulfill the requirements of the Master of Science degree in Environmental Science. (Graduate status in the Environmental Science MS program.) **Variable credit 1–3 (F, W, S, Su)**

1006-890 Environmental Science Graduate Thesis
The thesis option will be available to environmental science graduate students only with prior written approval of program faculty. Students will submit a proposal to a faculty member who agrees to serve as the student's thesis committee chair. The proposal will describe the basic research question to be investigated and the experimental protocols to be employed. Proposals will be reviewed by the program faculty who will give permission to register for thesis credit. This course may be taken several times over the course of a student's graduate program, for variable credits totaling no fewer than 5 credit hours and no more than 9 credit hours as determined by the program faculty. A written thesis and oral defense are required at the completion of the thesis research. **Variable credit 1–9 (F, W, S, Su)**

1006-891 Environmental Science Graduate Project
This course is used to fulfill the project requirement under the non-thesis option in environmental science. The project may take the form of original research designed to address a specific environmental issue or a paper on some important or controversial topic in environmental science. Students will submit a proposal to a faculty member who agrees to serve as the student's project committee chair. Proposals will be reviewed by the program faculty who will give permission to register for project credit. This course may be taken several times over the course of a student's graduate program, for variable credits totaling no fewer than 5 credit hours and no more than 9 credit hours as determined by the program faculty. A written report and oral presentation are required at the completion of the project. **Variable credit 1-9 (F, W, S, Su)**

Chemistry

1008-711 Instrumental Analysis
Theory, applications and limitations of selected instrumental methods in qualitative, quantitative and structural analysis are discussed. Possible topics include electrochemistry, surface analysis, NMR spectroscopy, mass spectroscopy, ICP, and other modern instrumentation. A term paper and oral presentation will be required based on an analytical technique agreed upon by instructor and student. (1014-441) **Class 3, Credit 3 (F, W-X*)**

1008-780 Theory of Microsensors and Actuators
This course gives a broad background to the theory and development of sensors at molecular and ionic levels. The mechanistic details of operation of the sensors and actuators limited to selected examples will be considered. Fundamental aspects related to chemical, biochemical, piezo resistive, magnetic, thermal and luminescent sensors will be discussed with an orientation towards development of innovative products. Control systems based on ion selectivity for biomedical applications will be dealt with rigorously. Special topics to be covered will be neuro transmitters, neural network and directional selectivity using conducting polymers. (Baccalaureate degree in chemistry or permission of instructor) **Class 4, Credit 4 (F, W)**

1008-785 Lab Techniques for Microsensors and Actuators
This course is designed on practical aspects of fabrication measurement. It will discuss the construction and characterization of a few sensors and actuators. The practical limitation of the microsensors will be evaluated. (Baccalaureate degree in chemistry or permission of instructor) **Variable lab, Credit 2–4**

1009-702 Biochemistry: Biomolecular Conformation and Dynamics
This is the first course in our graduate sequence in biochemistry. Molecular transport and enzymatic catalysis are related to the three dimensional structures of biomolecules and the laws of thermodynamics. Also provides an introduction to membrane structure as preparation for the next course in the sequence 1009-703 Biochemistry: Metabolism. Also offered in distance-learning format. (Baccalaureate degree or permission of instructor) **Class 3, Credit 3 (F-X*, W-X*)**

1009-703 Biochemistry: Metabolism
Metabolic processes involved in energy consumption and production as well as the synthesis and degradation of biomolecules are discussed. Metabolic pathways are described in terms of thermodynamic principles, cellular localization and regulation mechanisms. Finally, the metabolic basis of several diseases is presented. Also offered in distance-learning format. (Baccalaureate degree or permission of instructor. **Class 3, Credit 3 (W, S-X*)**

1009-704 Biochemistry: Nucleic Acids
Nucleic acid structures, including the classical Watson-Crick model for DNA are introduced. The flow of genetic information by replication (DNA to DNA), transcription (DNA to RNA) and translation (RNA to protein) as well as gene expression and regulation in prokaryotes are discussed. The methodology of new techniques, such as DNA sequencing and recombinant DNA, and their role in medicine and forensics are presented. The genetic aspects of viruses and oncogenes are also reviewed. Also offered in distance-learning format. (Baccalaureate degree or permission of instructor) **Class 3, Credit 3 (F, S-X*)**

1009-705 Biochemistry: Experimental Techniques
An introduction to the theory and practice of modern experimental biochemical laboratory techniques and concepts. The weekly one-hour lecture provides a theoretical framework for the various experimental techniques and includes a discussion of the properties of biomolecules and how those properties are exploited in the separation and characterization of the molecules. Practical laboratory techniques include the preparation of buffers, centrifugation, gel exclusion chromatography, electrophoretic methods, and UV/visible and fluorescence spectrophotometry as applied to the isolation and characterization of proteins and nucleic acids, the manipulation of genetic material in *E. coli* will also be examined. (Baccalaureate degree or permission of instructor) **Class 1, Lab 3, Credit 2 (F, W)**

1009-794 Molecular Modeling and Proteomics
The course will explore two facets of protein molecules: their structure and their expression. The structure component will build upon information from the biochemistry pre-requisite course and will add further sophistication with analysis of inter-molecular interactions and ligand/receptor pairing. Software that permits molecular docking experiments will be employed. Tissue-specific protein expression will be addressed in lectures with description of micro-array technology and, in the laboratory, with two-dimensional protein gel electrophoresis. The course will include student initiated discussions and presentations on late-breaking developments in molecular visualization and proteomics. Course cannot be taken by students who have credit for 1009-594, 1001-494 or 1001-794. (1009-702, 1009-503 or 1009-703, or equivalent) **Class 3, Lab 3, Credit 4 (S)**

1010-772 Special Topics
Advanced courses which are of current interest and/or logical continuations of the courses already being offered. These courses are structured as ordinary courses and have specified prerequisites, contact hours and examination procedures. Recent courses taught as Special Topics have included nuclear chemistry, polymer morphology, advanced chromatographic methods and applications of computer interfacing. **Variable class, Variable credit**

1010-800 Capstone Project
A capstone course for non-thesis students that fulfills the graduate project requirement of the MS chemistry program. Guidance and credits to be arranged with faculty project advisor before approval by the department will be given for registration. **Variable credit 1–8 (F, W, S, SU)**

1010-870 Chemistry Seminar
Matriculated students are required to attend the weekly chemistry seminar series and to present one-hour seminars on their thesis or project research. **Credit 1**

1010-877 External Research
Industrial internship research. **Credit 1–16**

1010-879 Research and Thesis Guidance
Hours and credits to be arranged. Chemical research in a field chosen by the candidate, subject to approval of the department head and advisor. (1010-879-99 Continuation of Thesis, Credit 0) **Credit 1–16**

1010-899 Chemistry Independent Study: Grad
Variable credit

1012-764 Modern Inorganic Chemistry
This course introduces the more sophisticated tools with which an inorganic chemist investigates inorganic molecules and materials. These physical methods are applied to inorganic reactions that distinguish the chemistries of the elements and to current research directions in the field. An oral presentation is required. Literature project required for graduate credit. (1014-441) **Class 4, Credit 4 (offered every year) (S)**

1012-765 Preparative Inorganic Chemistry Laboratory
In this laboratory, the chemistries of different elements in the periodic table are examined, and advanced synthetic and characterization methods are utilized. (Inorganic chemistry or permission of instructor) **Class 1, Lab 7, Credit 3 (W)**

1013-736 Spectrometric Identification of Organic Compounds
This course discusses the theory and application of proton, carbon and 2-D nuclear magnetic resonance, infrared and mass spectrometry as applied to organic structure determination. (1013-433) **Class 4, Credit 4 (W-X*)**

1013-737 Advanced Organic Chemistry
Advanced topics in organic synthesis, novel reagents and synthetic strategies such as retrosynthetic analysis are covered. In addition, previously studied reactions will be revisited with the added focus on stereospecificity. Protecting groups are covered in depth as well as sigmatrophic rearrangements. Several classics in total synthesis are included with a strong emphasis on syntheses published in the current chemical literature. Time permitting, a survey of the most widely used organo-palladium couplings will be introduced. (1013-433) **Class 4, Credit 4 (F-X*)**

1013-739 Advanced Organic Chemistry
This course covers topics in physical organic chemistry including techniques for elucidation of mechanism: kinetics, linear free, energy relationships, isotope effects, thermodynamics, molecular orbital theory, electrocyclic reactions. (1013-433, 1014-443) **Class 4, Credit 4 (offered alternate years) (S)**

1014-730 Magnetic Resonance Imaging
This course is an introduction to the principles of magnetic resonance imaging (MRI). The course covers spin physics, Fourier transforms, basic imaging principles, Fourier imaging, imaging hardware, imaging techniques, image processing, image artifacts, safety and advanced imaging techniques. (1008-311, 1014-442, Calculus) **Class 4, Credit 4 (S-X*)**

1014-740 Basics of Pulsed NMR
This course is an introduction to the principles of pulsed nuclear magnetic resonance (NMR) spectroscopy. Lectures on instrumentation, pulse sequences, Fourier transforms and artifacts are presented. (1008-311) **Class 1, Credit 1 (F)**

1014-741 Advanced Chemical Thermodynamics
This course is a study of the basic fundamentals of thermodynamics, including an introduction to statistical mechanics and their use in deriving the interrelationships of thermodynamic functions. Thermodynamic properties of gases are calculated based on spectroscopic data. Theory of solutions and phase equilibria are discussed. (1014-443, 1016-306) **Class 4, Credit 4 (offered alternate years) (W-X*)**

1014-742 Survey of Physical Chemistry
This course is a study of the fundamental principles of physical chemistry. Kinetic molecular theory, quantum mechanics, spectroscopy, thermodynamics and kinetics are presented. This course provides a high-level, comprehensive survey of essential topics in physical chemistry. **Class 3, Credit 3 (W-X*)**

1014-743 Advanced Chemical Kinetics
Methods of investigating the kinetics of chemical reactions and the theories used to interpret their results are presented with a focus on homogeneous reactions in gas and liquid phases. Discussions of references from recent chemical literature are provided. (1014-443) **Class 4, Credit 4 (offered alternate years) (W-X*)**

1014-744 Advanced Quantum Mechanics
This course provides a review of basic quantum theory and models; variation and perturbation methods, atomic and molecular orbital theory, emphasis on relationship of spectroscopy and quantum chemistry. (1014-442) **Class 4, Credit 4 (offered alternate years) (S, X*)**

1014-747 Principles of Magnetic Resonance
This course is a series of lectures designed to introduce the principles of magnetic resonance spectroscopies with emphasis on pulsed nuclear magnetic resonance (NMR) spectroscopy. Topics covered include classical and quantum mechanical theory, Fourier transform techniques, pulse sequences, instrumentation, instrumental techniques and modern applications such as 2-D NMR and solid-state NMR. (1014-443; 1014-740) **Class 4, Credit 4 (offered alternate years) (W-X*)**

1015-720 Environmental Chemistry
Environmental sources, reactions, transport, effects and fate of chemical species in air, soil, water and living systems are studied. (1014-443) **Class 3, Credit 3 (offered alternate years) (S-X*)**

1015-721 Atmospheric Chemistry
The chemical composition of the Earth's atmosphere with emphasis on the role of the biosphere and the changes induced by human activity will be studied. Special emphasis will be placed on urban pollution, acid rain, stratospheric ozone depletion, and climate change. (1014- 443) **Class 3, Credit 3 (offered alternate years) (S)**

1029-701 Organic Chemistry of Polymers
The synthesis and chemistry of high molecular weight organic polymers is broadly surveyed. Chemistry relating to the formation of carbon chain polymers and polymers containing heteroatoms in-chain is detailed. Kinetics, thermodynamics and mechanisms of step growth and chain growth polymerization reactions are reviewed with particular attention being given to stereospecific and living polymerization processes, block and graft copolymers, functional polymers and polymeric reagents. (1013-433) **Class 4, Credit 4 (F-X*)**

1029-702 Polymer Chemistry: Chains and Solutions
Although most polymeric materials find utility as solids, polymer fabrication and characterization techniques are generally liquid phase processes. This course is concerned with the fundamental physical chemistry of polymers in liquid solutions. Topics to be addressed include: polymerization kinetics and chain structure, molecular weight distributions and determination, polymer solution thermodynamics and transport phenomena, and solution phase transitions. The study of polymeric solids is the focus of 1029-703. (Baccalaureate degree in science or engineering, or permission of instructor) **Class 4, Credit 4 (S-X*)**

1029-703 Polymer Chemistry: Properties of Bulk Materials
This course is designed to give the student with a chemistry or materials science background a thorough grounding in the main concepts which describe bulk polymer structure, behavior and properties and to give the student practical tools to predict them. Basic to the understanding of polymer behavior is the fact that it is time-dependent. To emphasize this idea, the course is designed to build up to a study of the thermo-mechanical behavior of viscoelastic materials. (Baccalaureate degree in a science or engineering, or permission of instructor) **Class 4, Credit 4 (F-X*)**

1029-704 Polymer Characterization Laboratory
Many students in the Chemistry and Materials Science and Engineering graduate programs are involved in polymer research. This course gives these students an opportunity to acquire proficiency in using the tools of polymer characterization. Techniques for studying 1) molecular weight distributions, 2) spectroscopic analysis of chemical structure, 3) thermal stability, 4) morphology and phase transitions, and 5) mechanical properties will be introduced and mastered. Techniques may concentrate on particular research topics. (Baccalaureate degree in a science or engineering discipline, or permission of instructor) **Lab 6, Credit 2 (S) (offered alternate years)**

1029-705 Preparative Polymer Chemistry Laboratory
Students will carry out about eight experiments. About half of the experiments conducted will be step-growth polymerizations; the other half will be chain-addition polymerizations. The polymers produced will include: Nylon 6-10, Nylon 11, a polyurethane, polystyrene, high density polyethylene, and a copolymer of styrene and methyl methacrylate. More specifically, the types of polymerizations and reactions introduced will be crosslinking of polymers, interfacial and bulk step-growth polymerizations, cyclopolymerization, radical, ionic, and coordinative chain polymerizations. Instructors may add and/or delete polymer related experiments of their choice. The students in this course will also analyze the polymers produced and use literature data to confirm structural features. (1013-437) **Lab 6, Credit 2 (offered alternate years) (F)**

Applied Mathematics

1016-706 Advanced Differential Equations
This course provides a study of first order, linear high order and systems of differential equations and their applications in the physical sciences. Mathematical modeling will be used to illustrate the concepts. Applications and computer projects will be used to involve students in intense problem solving experiences. Topics such as existence, uniqueness, theory and methods of solutions, linear systems, stability, Sturm-Liouville problems and asymptotic methods of solution will be studied. (1016-306 or equivalent, 1016-331 desirable) **Class 4, Credit 4**

1016-711 Numerical Analysis
This course is a rigorous study of floating point arithmetic, numerical techniques for finding roots of nonlinear equations, interpolations and approximation of functions, approximations of definite integrals and numerical solutions to initial boundary value problems for ordinary differential equations with a study of the errors produced. This course requires independent study of certain topics that are not covered in the class lectures. Software packages such as MATLAB will be utilized. (1016-306, 1016-331, and graduate standing) **Class 4, Credit 4 (F)**

1016-712 Numerical Linear Algebra
This course is a rigorous study of theoretical concepts and computational issues in linear algebra. Topics include an analysis of gaussian elimination with pivoting, its error and its stability, iterative methods for solving linear systems, matrix factorizations, eigenvalues, singular value decomposition, Krylov subspace methods and application to least squares, systems of nonlinear equations and partial differential equations. This course requires independent study of certain topics that are not covered in the class lectures. Software packages like MATLAB will be utilized through several computing projects. (1016-331, and graduate standing, 1016-432 recommended) **Class 4, Credit 4 (W)**

1016-715 Statistical Models for Bioinformatics
Organic evolution over thousands of years has provided us with one of the most complicated statistical models imaginable. This course will investigate some of the statistical models that have proved useful in analyzing biological information. Examples include Markov models, such as the Jukes-Cantor and Kimura evolutionary models and hidden Markov models, and multivariate models used for discrimination and classification. (1016-415 or permission of instructor) **Class 4, Credit 4** (F)

1016-720 Complex Variables
This course introduces the student to the basic elements of calculus of complex valued functions of a complex variable. The major emphasis is on integration, with the goal of using these results to evaluate certain types of real integrals. The course includes the concept of analyticity, complex integration, Cauchy's integral theorem and integral formulas, Taylor and Laurent series, residues, real integrals by complex methods, and conformal mappings. (1016-305 or equivalent**) Class 4, Credit 4 (F, W, SU)**

1016-725 Stochastic Processes
This course is an introduction to stochastic processes. Important random processes that appear in various applications are studied. It covers basic properties and applications of Poisson processes and Markov processes as well as applications in renewal theory, queuing models, and optimal stopping. (Advanced Calculus, Probability, Matrix Algebra) **Class 4, Credit 4**

1016-764 Topics in Logic, Set Theory and Computability
This course surveys logic and set theory and their connections to computer science and the foundations of discrete mathematics. Starting with the abstract construction of integers and real numbers, it proceeds to axiomatic set theory and logic stressing questions of completeness, consistency, decidability and recursive enumerability. The course includes a survey of NP (non-deterministic polynomial) and NP complete problems. The student should gain a greater awareness of the paradoxical, the impossible and the slow. (1016-411 and 1016-532 and graduate standing, or permission of instructor) **Class 4, Credit 4 (F)**

1016-766 Optimization Theory
This course provides a study of the theory of optimization of linear and nonlinear functions of several variables with or without constraints. Applications of this theory to solve problems in business, management, engineering, and the sciences are considered. Algorithms for practical applications will be analyzed and implemented. Students taking this course will be expected to complete applied projects and/or case studies. (1016-331 or equivalent, 1016-465 desirable) **Class 4, Credit 4 (S)**

1016-767 Combinatorics
This course introduces the fundamental concepts of combinatorics and graph theory. Topics to be studied include counting techniques, generating functions, recurrence relations, the inclusion-exclusion principle, special graphs. Applications such as design of experiments, traffic routing, tournaments will be considered. (Graduate standing or permission of instructor**) Class 4, Credit 4 (F)**

1016-768 Graph Theory
This course studies advanced concepts in graph theory and their applications. After a review of basic terminology, the topics of coverings, matchings, connectivity, and coloring will be studied. Applications to areas such as optimal routing, transport networks, network design, tournaments, and scheduling will be considered. The interplay between graph theory, counting techniques, and algebra will also be studied. (1016-767) **Class 4, Credit 4 (S)**

1016-785 Number Theory
This course is an introduction to the standard results and techniques of Number Theory. Topics include induction, divisibility, congruences, Mobius inversion, quadratic reciprocity, and primitive roots. Cryptography and other applications will be discussed. Projects may be required. (1016-265 or permission of instructor) **Class 4, Credit 4 (W)**

1016-802 Methods of Applied Mathematics I
This course provides an introduction to some classical topics in mathematical analysis. Models arising in physics and engineering are introduced. Topics include: dimensional analysis and scaling; partial differential equations, classical techniques; Fourier series; integral transforms; orthogonal functions; wave phenomena in continuous systems. (Advanced Calculus, Differential Equations) **Class 4, Credit 4**

1016-803 Methods of Applied Mathematics II
This is a continuation of 1016-802 and deals with further applications of differential equations. Topics include: classification of partial differential equations; Laplace's equation; diffusion equations and their applications in physics and engineering. (1016-802) **Class 4, Credit 4**

1016-804 Numerical Methods for Stochastic Processes
This course covers the algorithmic and numerical aspects of analyzing stochastic processes. Emphasis here is on computing the solutions to the systems represented by stochastic processes and identifying their probabilistic interpretations. Topics include: queuing models; examples from communications networks and manufacturing systems; reliability models; simulation; approximation methods. (1016-725, 1016-801) **Class 4, Credit 4**

1016-807 Boundary Value Problems
This course is an introduction to methods of applied mathematics that are used in the solution of problems in physics and engineering. Models such as heat flow, vibrating strings and membranes will be formulated from physical principles and solution methods such as separation of variables, Fourier series, and integral transforms will be studied. (1016-306 and Graduate standing) **Class 4, Credit 4 (W)**

1016-808 Partial Differential Equations
This is a continuation of 1016-807 Boundary Value Problems and deals with advanced methods for solving partial differential equations arising in physics and engineering problems. Topics to be covered include first order linear and nonlinear equations, second order equations, Green's functions, integral equations, transform methods, and wave phenomena. (1016-802) **Class 4, Credit 4 (S)**

1016-812 Wavelets and Applications
A mathematical introduction to the theory and applications of orthogonal wavelets and their use in analyzing functions and function spaces is provided. Topics include a brief survey of Fourier series representation of functions, Fourier transform and the Fast Fourier Transform (FFT) before proceeding to the Haar wavelet system, multiresolution analysis, decomposition and reconstruction of functions, Daubechies wavelet construction, and other wavelet systems. Applications such as data compression, noise reduction, and image processing will be studied. (1016-432) **Class 4, Credit 4 (S)**

1016-859 Topics in Applied Mathematics
This course covers some topics that are not covered in the regular courses and are not offered in other departments. This course may be used to study other areas of applications in the student's concentration. A wide variety of topics may be offered. Some examples are: reliability models; biological models; calculus of variations; computational probability; and dynamical systems. (Consent of the adviser and the instructor) **Class 4, Credit 4**

1016-879 **Thesis/Project Work**
This is the capstone of the program in which the student works on a problem in applied mathematics under the guidance of the advisory committee. A formal written proposal of the problem to be studied must be presented before embarking on the project. A written report and an oral defense of the project/thesis are required at the completion of the work. This course may be repeated for a maximum of 12 quarter credit hours. (Consent of the adviser)

1016-899 **Independent Study**
A topic of special interest to the student and related to the student's area of concentration may be taken for independent study with the approval of the adviser and the instructor who will offer the course. The student submits a proposal for independent study to the advisory committee for consideration and approval. (Consent of the adviser and the instructor) **Variable credit (maximum of 4 credits/quarter)**

Clinical Chemistry

1023-705 **Mechanisms of Disease**
Mechanisms of cellular injury, the healing process, atherosclerotic heart disease, hypertension, infectious disease, and many other disease states are presented. **Class 4, Credit 4 (S)**

1023-820 **Advanced Clinical Chemistry I**
Electrolytes, acid-base physiology, renal function, trace metals, lipids, carbohydrate metabolism, enzymes, and various standard methods are covered. **Class 4, Credit 4 (offered alternate years)**

1023-821 **Advanced Clinical Chemistry II**
A study of the concepts and applications of therapeutic drug monitoring, pharmacokinetics, toxicology, inherited disorders of metabolism, liver function tests, protein measurement, hepatitis, hemoglobinopathies, vitamins, and gene probes. **Class 4, Credit 4 (offered alternate years)**

1023-822 **Advanced Clinical Chemistry III**
A survey of endocrinology and of the immunoassay methods used in performing endocrine assays. The endocrine systems covered include the thyroid, the adrenals, calcium metabolism, growth hormone, the human reproductive system, and the fetal-placental unit. Basic principles of clinical trials will also be presented. **Class 4, Credit 4 (offered alternate years)**

1023-870 **Clinical Chemistry Seminar**
A seminar offered for 1 credit to graduate students presenting final research outcomes to their graduate committee. **Credit 1**

1023-872 **Special Topics: Clinical Chemistry**
In response to student and/or faculty interest, special courses that are of current interest and/or logical continuations of regular courses are presented. These courses are structured as ordinary courses with specified prerequisites, contact hours and examinations. **Variable class, Variable credit (offered upon sufficient request)**

1023-877 **External Clinical Chemistry Research**
Research carried out in a laboratory outside of the College of Science. Prior to the initiation of external research, a proposal from the student as well as a commitment of support and direction from the laboratory are evaluated. **Variable credit**

1023-879 **Clinical Chemistry Research**
Research carried out in the College of Science laboratories under the direction of RIT faculty members. The amount of credit awarded for such projects is determined after evaluation of a research proposal. **Variable credit**

1023-899 **Clinical Chemistry: Independent Study**
Individual projects or studies carried out under the direction of a faculty member. Study objectives and design are developed through faculty-student interaction with evaluation and credit to be awarded determined after review of a study proposal. **Variable credit**

1023-999 **Clinical Chemistry Graduate Co-op**
Cooperative work experience for MS clinical chemistry students. **Credit 0**

Materials Science and Engineering

1028-701 **Introduction to Materials Science**
The course provides an understanding of the relationship between structure and properties for development of new materials. Topics include atomic and crystal structure, crystalline defects, diffusion theories, strengthening mechanisms, ferrous alloys, cast irons, structure of ceramic and polymeric materials, and corrosion principles. (Graduate standing or permission of instructor) **Class 4, Credit 4 (F)**

1028-702 **Introduction to Polymer Science**
A study of the chemical nature of plastics detailing the relationships between polymerization conditions, structure and properties in both the solid and fluid states. **Class 4, Credit 4 (W)**

1028-703 **Solid State Science**
Survey of topics in the physics of solids. Included are crystal symmetry, structure and binding; mechanical, thermal, and electrical properties of insulators, semiconductors and conductors, including band theory. **Class 4, Credit 4 (W)**

1028-704 **Introduction to Theoretical Methods**
Treatment of waves and fields; selected topics of interest in electrodynamics and fluid mechanics; statistical mechanics; Maxwell Boltzmann, Bose-Einstein and Fermi-Dirac distributions, and their applications. (Graduate standing or permission of instructor) **Class 4, Credit 4 (F)**

1028-705 **Introduction to Experimental Techniques**
Introduction to laboratory equipment for hardness testing, impact testing, tensile testing, x-ray diffraction, and thermal treatment of metallic materials. Experiments illustrating the characterization of high molecular weight organic polymers are conducted. **Variable class, Variable lab, Credit 4 (S)**

1028-706 **Experimental Techniques: Thin Films**
Production of thin films of metals and dielectrics by physical vapor deposition. Lectures cover vacuum systems, evaporation, sputtering, nucleation and growth of thin films, analysis and characterization of thin films, and application of thin films. Laboratories cover use of vacuum systems in evaporation and sputtering and some methods of characterizing the thin films thus produced. (Permission of instructor) **Variable class, Variable lab, Credit 4**

1028-707 **Experimental Techniques: Microscopy and Spectroscopy**
An in-depth look at various techniques used to characterize thin film materials. Lectures will cover resistivity measurements, ellipsometry, reflectance techniques, optical microscopy, electron microscopy, and scanning probe microscopy. The lab provides hands-on training in these techniques and is conducted in the cleanroom housed in the Center for Microelectronic Engineering. Students will be required to perform an in-depth study on a material of their choice using these techniques or to research an associated technique not covered in lecture. (Permission of instructor) **Variable class, Variable lab, Credit 4**

1028-708 **Experimental Techniques**
Provides an in-depth integrated approach to the analysis, investigation and development of materials, concentrating on specific types or classes. (1028-701 or equivalent) **Variable class, Variable lab, Credit 4**

1028-710 **Material Properties and Selection**
Study of the principles of material behavior as applied to design. Application of materials according to these principles is stressed. Ferrous, nonferrous, and nonmetallic materials are considered. (1028-701 or equivalent) **Class 4, Credit 4**

1028-714 **Glass Science**
Topics include the structure and properties of glass, applied areas such as glass melting and processing, and various technological applications of glass. (1028-701 or equivalent; 1028-704) **Class 4, Credit 4**

1028-717 **Material Degradation: Corrosion**
This course introduces the basic electrochemical nature of corrosion and considers the various factors that influence the rate of corrosion in a variety of environments. Various means of controlling corrosion are considered. (1028-701 or equivalent) **Class 4, Credit 4**

1028-720 **Organic Polymers**
Meets the needs of students in the area of organic chemistry related to synthesis, polymerization mechanism, structures, stereochemistry of reactions of organic polymers and their industrial usage. (1028-702 or equivalent) **Class 4, Credit 4**

1028-721 **Physical Chemistry of Polymers**
A study of the theoretical and experimental methods available for designing plastics products and selecting appropriate materials, with special emphasis on the interrelationships between materials, product design, tooling construction, and manufacturing producibility. (1028-702 or equivalent) **Class 4, Credit 4**

1028-722 **Polymer Processing**
A study of the basic principles and methods involved in the technology of processing polymeric materials, including treatments of heat transfer, mass transfer, and mixing and shaping or molding of these materials. (1028-702 or equivalent) **Class 4, Credit 4**

1028-730 **Optical Properties of Materials**
Fundamentals of geometrical and physical optics, interaction of radiation with matter, dielectrics and thin films, introduction to electro-optic and acousto-optic effects. (1028-704 or equivalent) **Class 4, Credit 4**

1028-733 **Magnetic Properties of Materials**
Magnetostatics, creation and measurement of magnetic fields, galvanomagnetic and magneto-optic effects, magnetic materials, applications. (1028-701 and 704 or equivalent) **Class 4, Credit 4**

1028-734 **Advanced Optics**
Lasers: theory, types and construction; optics of metals; multilayer dielectrics; electro- and acousto-optic modulators and deflectors; optical detectors. (1028-730 or equivalent) **Class 4, Credit 4**

1028-736 **Amorphous and Semicrystalline Materials**
Electrical, thermal, and optical properties of amorphous materials; model of conduction. (1028-701, 703, 704 or equivalents) **Class 4, Credit 4**

1028-740 **Nuclear Science and Engineering**
Systemics of the atomic nuclei, radioactivity, nuclear reactions, fission, nuclear reactor principles, designs, materials, and safety. (1028-701 and 704 or permission of instructor) **Class 4, Credit 4**

1028-760 **Plasma Science**
An introduction to plasma science; a study of the basic phenomena and application of plasma to etching, deposition, polymerization, plasma production of materials, analytical emission spectroscopy, and atmospheric science. (1028-701 or equivalent) **Class 4, Credit 4**

1028-770 **Physics and Chemistry of IC Processes**
Study of the various processing steps used in integrated circuit fabrication technology with special emphasis on diffusion, thermal oxidation, ion implantation and plasma-assisted deposition, and etching processes. Process modeling using SUPREM. (1028-703 or permission of instructor) **Class 4, Credit 4**

1028-780 **Theory of Microsensors**
This course gives a broad background to the theory and development of sensors at the molecular and ionic levels. The mechanistic details of operation of the sensors and actuators limited to selected examples will be considered. Fundamental aspects related to chemical, bio chemical, piezo resistive, magnetic, thermal and luminescent sensors will be discussed with an orientation towards development of innovative products. Control systems based on ion selectivity for biomedical applications will be dealt with rigorously. Special topics to be covered will be neuro transmitters, neural network and directional selectivity using conducting polymers. (Permission of instructor) **Class 4, Credit 4 (S)**

1028-800 **Special Topics**
In addition to in-depth study of any of the courses listed under Elective Courses, special topics may be selected from such areas as elastomers, organometallics, radiation damage, processing of materials, superconductivity, sensors, and actuators, etc. (Permission of instructor) **Variable class, Credit 4**

1028-877 **External Research**
Research using equipment and facilities at a site other than RIT. Prior to enrollment in the course, a proposal from the student that includes a letter of support from the host facility is evaluated for determination of credit to be awarded upon successful completion of the project. A total of 8 quarter credit hours, with a maximum of 4 quarter credit hours per quarter, can be applied toward the MS degree. For matriculated MSE students employed full time by local companies. (Permission of program director) **Variable credit**

1028-879 **Research and Thesis Guidance**
A project involving research on a topic in materials science and engineering. An oral examination and written thesis are required. **Variable credit**

1028-890 **Seminar**
Required for completion of the program and involves a one-hour presentation on some topic in materials science in engineering. **Variable class, Credit 1 (F, S)**

1028-899 **Independent Study**
This course number should be used by students wishing to study a topic on an independent study basis. (Permission of instructor) **Variable credit**

1028-999 **Materials Science Graduate Co-op**

Color Science

1050-702 **Applied Colorimetry**
This course covers the principles of color science including theory and application. Topics include CIE colorimetry, the use of linear algebra for color transformations, the Munsell color order system, metamerism, color inconstancy, history and theory of color tolerance equations and spaces, and an overview of color management. (Graduate status in color science or permission of instructor) **Class 4, Credit 4 (W)**

1050-703 **Color Appearance**
This course is for students who have an understanding of the applications of colorimetry. It presents the transition from the measurement of color patches and differences to the description and measurement of color appearance. This seminar course is based mainly on review and discussion of primary references. Topics include appearance terminology, appearance phenomena, viewing conditions, chromatic adaptation and color appearance modeling. (1050-702) **Class 3, Credit 3 (S)**

1050-721 **Color Measurement Laboratory I**
This course is the first part of a two-course sequence in which students develop the background and skills required for successful laboratory practice for color science research including data management and analysis, technical writing, and basic programming. Topics include the instrumentation and standardization required for high quality optical radiation measurements, analysis techniques for determining the accuracy and precision of those measurements, the optical properties of objects and radiation, optical and electronic design of spectroradiometric and spectrophotometric instrumentation, the use of standard reference materials for calibration, and evaluation of instrumentation and psychophysical experimentation. (Graduate status in color science or permission of instructor) **Class 1, Lab 3, Credit 3 (F)**

1050-722 **Color Measurement Laboratory II**
This course is the second part of a two-quarter sequence in which students develop the background and skills required for successful laboratory practice for color science research including data management and analysis, technical writing, and basic programming. Topics include the precision and accuracy analysis of color measuring instrumentation, color tolerance psychophysics, and building an imaging colorimeter. (1050-721) **Class 1, Lab 3, Credit 3 (W)**

1050-751 **Special Topics**
Advanced topics of current interest, varying from quarter to quarter, selected from the field of color science. Specific topics announced in advance. (Not offered every quarter. Consult the color science graduate program coordinator.) **Variable credit**

1050-752 **Special Topics**
Advanced topics of current interest, varying from quarter to quarter, selected from the field of color science. Specific topics announced in advance. (Not offered every quarter. Consult the color science graduate program coordinator.) **Variable credit**

1050-753 **Special Topics**
Advanced topics of current interest, varying from quarter to quarter, selected from the field of color science. Specific topics announced in advance. (Not offered every quarter. Consult the color science graduate program coordinator.) **Variable credit**

1050-799 **Independent Study**
An independent project in an area of color science not covered in the available courses. This project can be experimental research, literature review, or other appropriate work. This course requires a formal proposal and a faculty sponsor. **Variable credit**

1050-801 **Color Science Seminar**
A seminar course in which students will study the literature in particular areas of color science and present that material to the class. Topics will be based on student interest and current issues in the field. Available to color science MS students or by permission of the instructor. May be taken more than once for credit with permission of coordinator. (Graduate status in color science or permission of instructor) **Class 1, Credit 1 (F, W, S)**

1050-813 **Color Modeling**
This course explores mathematical techniques for predicting the spectral and colorimetric properties of colored materials and images from user-controlled drive signals. Color systems that are modeled include paint, computer-controlled LCD and projector, continuous and halftone printing, and spectral cameras. Accompanying laboratory stresses the use of multivariate statistics, nonlinear optimization, and technical writing. Final laboratory consists of spectral-based color reproduction system including input, display, and printed output. (1050-702, 721, 722) **Class 4, Credit 4 (S)**

1050-840 **Color Science MS Project**
An independent project in an area of color science that serves as the major culminating experience for students in the Graduate Project Option of the color science MS program. This project can be an experiment, critical literature review, demonstration or other appropriate work. This course requires a formal proposal and faculty sponsor; a written technical report and oral presentation of the results. **Credit 4**

1050-890 **Research and Thesis**
Thesis based on experimental evidence obtained by the candidate in an appropriate topic as arranged between the candidate and the coordinator of the program. **Variable credit (minimum of 9 credits for MS)**

1050-999 **Color Science Co-op**
Cooperative work experience for graduate color science students. **Credit 0**

Imaging Science

1051-706 **Introduction to Imaging Science Research**
This course is focused on familiarizing students with research activities in the Carlson Center, research practices in the university, research environment and policies and procedures impacting graduate students. The course is coupled with the research seminar sponsored by the Center for Imaging Science (usually weekly presentations). The students are expected to attend and participate in the seminar as part of the course. The course will also address issues and practices associated with technical presentation and technical writing. Credits earned in this course apply to research requirements. **Class 1, Credit 1 (F)**

1051-707 **Introduction to Imaging Science Research**
This course is focused on familiarizing students with research activities in the Carlson Center, research practices in the university, research environment and policies and procedures impacting graduate students. This course is coupled with the research seminar sponsored by the Center for Imaging Science (usually weekly presentations). Students are expected to attend and participate in the seminar as part of the course. The course will also address issues and practices associated with technical presentation and technical writing. Credits earned in this course apply to research requirements. **Class 1, Credit 1 (W)**

1051-708 **Introduction to Imaging Science Research**
This course is focused on familiarizing students with research activities in the Carlson Center, research practices in the university, research environment and policies and procedures impacting graduate students. The course is coupled with the research seminar sponsored by the Center for Imaging Science (usually weekly presentations). Students are expected to attend and participate in the seminar as part of the course. The course also addresses issues and practices associated with technical presentation and technical writing. Credits earned in this course apply to research requirements. **Class 1, Credit 1 (S)**

1051-713 **Noise and Random Processes**
The purpose of this course is to develop an understanding and ability in modeling noise and random processes within the context of imaging systems. The focus will be on stationary random processes in both one dimension (time) and two dimensions (spatial). Power spectrum estimation will be developed and applied to signal characterization in the frequency domain. The effect of linear filtering will be modeled and applied to signal detection and maximization of SNR. The matched filter and the Wiener filter will be developed. Signal detection and amplification will be modeled, using noise figure and SNR as measures of system quality. At completion of the course, the student should have the ability to model signals and noise within imaging systems. Also offered online. (1051-716, 718, 719 or permission of instructor) **Class 4, Credit 4 (S)**

1051-714 **Information Theory for Imaging Systems**
This course develops a basic understanding of the efficient representation of information for storage and transmission. Classical concepts of information theory are developed and applied to image compression, storage and transmission. The intent is to develop a foundation for the efficient handling of image-based information in imaging systems. Also offered online. (1051-713 or consent of instructor) (offered alternate years) **Class 4, Credit 4 (F)**

1051-716 **Fourier Methods for Imaging**
This course develops the mathematical methods required to describe continuous linear systems, with special emphasis on tasks required in the analysis or synthesis of imaging systems. The classification of systems as linear/nonlinear and shift variant/invariant is discussed first, followed by development and use of the convolution integral, and by a discussion of Fourier methods as applied to the analysis of linear systems, including the Fourier series and Fourier transform. Emphasis is placed on the physical meaning and interpretation of these transform methods. Within the context of image analysis, imaging systems as a linear filter, image enhancement and information extraction, and several basic image processing techniques are also introduced. Also offered online. (Graduate standing in a science or engineering program or permission of instructor) **Class 4, Credit 4 (F)**

1051-718 **Digital Imaging Mathematics**
This course provides a basic understanding of imaging systems, image transformations and associated mathematics and computational processes needed for upper-level classes in the imaging science graduate program. Topics covered include: camera models; image projections and rectification; image statistics and point processing; linear and nonlinear image filters; image transforms; image mathematics; and computer algorithms. Some laboratory experiments are included. Also offered online. (1051-716) **Class 4, Credit 4 (W)**

1051-719 **Radiometry**
This course is focused on the fundamentals of radiation propagation as it relates to making quantitative measurements with imaging systems. It includes an introduction to common radiometric terms and derivation of governing equations with an emphasis on radiation propagation in both non-intervening and turbid media; and an introduction to detector figures of merit and noise concepts. Includes some laboratory experiments. Also offered online. (Graduate standing in a science or engineering program, or permission of instructor) **Class 4, Credit 4 (F)**

1051-720 **Vision**
This course describes the underlying structure of the human visual system and the design of visual displays. The optical and neural systems responsible for collecting and detecting spatial, temporal, and spectral signals from the environment are described and discussed in terms of the "enabling limitations" of the human visual system that allow practical visual displays. Softcopy and hardcopy display systems are described in terms of their spatial, spectral, and temporal characteristics. Some laboratory experiments are included. Also offered online. (Graduate standing in a science or engineering program, or permission of instructor) **Class 4, Credit 4 (F)**

1051-724 **Introduction to Microscopy Using Light, Electrons and Scanning Probes**
This is the first course in a three-quarter microscopy sequence. The purpose of this course is to give the student an overview of the various modes of microscopy for the study of materials. The first part of the course will focus on various modes of light microscopy. The bulk of the course will be devoted to electron microscopy, with the final part of the course devoted to scanning tunneling and atomic force microscopy. Demonstrations will be held in the NanoImaging Lab to reinforce the lecture material. (Graduate student standing in science or engineering, or permission of instructor) **Class 4, Credit 4 (W)**

1051-726 **Computing for Imaging Science**
A course to prepare graduate students in science and engineering to use computers as required by their disciplines. Covers: the organization and programming of computers at various levels of abstraction (e.g. assembly, macros, high-level languages, libraries), advanced programming techniques, the design, implementation, and validation of large computer programs, modern programming practices, introduction to a programming environment and to a variety of programming languages. Programming projects will be required. Also offered online. **Class 4, Credit 4 (W)**

1051-728 **Design and Fabrication of a Solid State Camera**
The purpose of this course is to provide the student with hands-on experience in building a CCD camera. The course provides the basics of CCD operation including an overview, CCD clocking, analog output circuitry, cooling, and evaluation criteria. **Class 1.5, Lab 7.5, Credit 4 (W)**

1051-733 Optics
This course will provide the requisite introductory knowledge in optics needed by a student in the graduate program in imaging science. The course will cover geometrical optics; wave nature of light, the Fresnel equations, interference and diffraction, and resolution of imaging systems. Some laboratory experiments are included. Also offered online. (1051-716, 719) **Class 4, Credit 4 (W)**

1051-736 Geometrical Optics
This course leads to a thorough understanding of the geometrical properties of optical imaging systems. A method is developed of performing a first-order design of an optical system, applicable to uniform and Gaussian beams. The following topics are included: paraxial optics of axisymmetric systems, Gaussian optics (cardinal points, pupils and stops, optical invariant), propagation of energy through lens systems, basic optical instruments and components, gradient index optics, finite raytracing, introduction to aberrations, geometrical optics of Gaussian beams. Also offered online. **Class 3, Lab 3, Credit 4 (F in class, S online)**

1051-737 Physical Optics
The wave properties of light and their application to imaging systems and metrology. Polarization, birefringence, interference and interferometers, spatial and temporal coherence, scalar diffraction theory are covered. (1051-733) **Class 4, Credit 4 (W)**

1051-738 Optical Image Formation
This course presents a unified view of the formation of images and image quality of an optical system from an applications viewpoint, but with a strict mathematical development. Topics covered are: geometrical and diffraction theory of aberrations, image quality criteria and MTF, MTF tolerance theory, image formation with coherent light. Throughout the course, the problem of image formation is treated also in its inverse form of designing an optical imaging system that satisfies a given set of specifications. (1051-716, 718) **Class 3, Lab 3, Credit 4 (offered alternate years, offered 2006–07) (S)**

1051-739 Principles of Solid State Imaging
This course covers the basics of solid state physics, electrical engineering, linear systems and imaging needed to understand modern focal plane array design and use. The course emphasizes knowledge of the working of infrared arrays. (Optics, Linear Systems) **Class 4, Credit 4 (F)**

1051-742 Testing of Focal Plane Arrays
An introduction to the techniques used for the testing of solid state imaging detectors such as CCDs, CMOS and Infrared Arrays is provided. Focal plane array users in industry, government and university need to ensure that key operating parameters for such devices either fall within an operating range or that the limitation to the performance is understood. This is a hands-on course where the students will measure the performance parameters of a particular camera in detail. While this course can be taken individually, students will obtain maximum educational value by taking it as the third part of a sequence of imaging science courses preceded by 1051-739 Principles of Solid State Imaging Arrays and then 1051-728 Design and Fabrication of a Solid State Camera. (Graduate status in imaging science or permission of instructor) **Class 2, Lab 6, Credit 4 (S)**

1051-749 Color Reproduction
This course presents the concepts required for an understanding of the relationships between mean-level input and output in various color imaging systems. Analog, digital, and hybrid color imaging systems will be covered. Special emphasis will be given to mean-level reproduction in photography, printing, and television. Offered online only. **(W)**

1051-751 Special Topics: Imaging Science
Advanced topics of current interest, varying from quarter to quarter, selected from the field of imaging science. Specific topics announced in advance. (Not offered every quarter. Consult the imaging science graduate program coordinator.) **Variable credit**

1051-752 Special Topics: Imaging Science
Advanced topics of current interest, varying from quarter to quarter, selected from the field of imaging science. Specific topics announced in advanced. (Not offered every quarter. Consult the imaging science graduate program coordinator.) **Variable credit**

1051-753 Special Topics: Imaging Science
Advanced topics of current interest, varying from quarter to quarter, selected from the field of imaging science. Specific topics announced in advanced. (Not offered every quarter. Consult the imaging science graduate program coordinator.) **Variable credit**

1051-762 Remote Sensing and Image Analysis
The problem of inverting recorded image data to surface reflectance on temperature values is treated using a variety of techniques, including the use of ground truth, "in scene" methods, and radiation propagation models. Multispectral digital image processing methods are introduced and their utility in various remote sensing applications considered. The potential for including multiple sources of data in image analysis is treated through consideration of multispectral image data fusion and the use of geographic information systems. (1051-719) Also offered online. **Class 4, Credit 4 (W)**

1051-763 Remote Sensing and Image Analysis II
Analysis of digital remotely sensed images is treated with emphasis on multispectral analysis techniques. This includes consideration of multivariate discriminate analysis and principal components for material identification and analysis. Special topics such as radar, Fraunhofer line discriminator, hierarchical classifiers will also be treated. (1051-762) Also offered online. **Class 4, Credit 4 (S)**

1051-765 Remote Sensing Systems
This course is designed to draw on the student's knowledge of linear system theory, digital image processing, and noise concepts and apply it to an end-to-end system in an area associated with remote sensing. Generalized concepts from these fields will be focused to show how they can be applied to solve remote sensing image analysis and systems design and evaluation problems. An overriding objective is on the application of theory to practice. (Permission of instructor) **Credit 4**

1051-769 Spectral Sensing Methods and Instrumentation
This course examines methods and instrumentation for spectral sensing as applied to earth observation. Spectral dispersion and selection methods, with an emphasis on gratings, will be studied. The data collection and analysis procedures for spectral and radiometric calibration of a field spectroradiometer and an airborne spectral imager will be performed by the students in a research laboratory setting. Other methods and practices in spectral instrumentation for both passive and active sensing across the electromagnetic spectrum will be described. (1051-719 or permission of instructor) **Class 4, Credit 4 (offered alternate years) (F)**

1051-775 Applied Colorimetry
This course covers the principles of color science including theory and application. Topics include CIE colorimetry, the use of linear algebra for color transformations, the Munsell color order system, metamerism, color inconstancy, history and theory of color tolerance equations and spaces, and an overview of color management. Also offered online. **Class 4, Credit 4 (W)**

1051-776 Color Modeling
This course explores mathematical techniques for predicting the spectral and colorimetric properties of colored materials and images from user-controlled drive signals. Color systems that are modeled include paint, computer-controlled LCD, continuous and halftone printing, and spectral cameras. Accompanying laboratory stresses the use of multivariate statistics, nonlinear optimization, and technical writing. Final laboratory consists of a spectral-based color reproduction system including input, display, and printed output. (1051-775) **Class 4, Credit 4 (S)**

1051-779 Astronomical Instrumentation and Techniques
This course provides an in-depth look at various pieces of instrumentation used in many low light imaging applications with emphasis on astronomical requirements. Aspects of hardware, systems analysis, and performance calculation will be covered. **Class 4, Credit 4 (offered occasionally) (S)**

1051-782 Digital Image Processing
This course follows up on concepts introduced in 1051-718 Digital Imaging Mathematics. Topics covered include linear vector spaces, image mathematics, image statistics and point processing, linear and nonlinear image filters, image transforms and computer algorithms. Computational methods and techniques for essential processes for imaging systems are used as the course framework. Also offered online. (1051-718 or permission of instructor) **Class 4, Credit 4 (S)**

1051-784 **Spatial Pattern Recognition**
This course develops a fundamental understanding of adaptive pattern recognition and a basic working knowledge of techniques for use in a broad range of applications. Inherent in adaptive pattern recognition is the ability of the system to learn by supervised or unsupervised training, or by competition within a changing environment. The effectiveness of the system depends upon it structure, adaptive properties and specifics of the application. Particular structures developed and analyzed include statistical PR, clustering systems, fuzzy clustering systems, multi-layered perceptrons (with a variety of weight training algorithms), and associative memory systems. The goal is to gain both a fundamental and working knowledge of each kind of system and the ability to make a good system selection when faced with a real application design. Also offered online. (1051-716, 718, 726, and 0304-834 or equivalent) **Class 4, Credit 4 (W)**

1051-786 **Advanced Digital Image Processing**
This course investigates algorithms and techniques for a variety of imaging applications. The techniques build on the background that is established in the course 1051-782 Introduction to Digital Image Processing, which focuses on basic image processing methods. The course is taught using a lecture and group project format, in which the lectures focus on advanced techniques and provide applications of their use in selected applications. The group projects enable students to work on substantial designs that require the understanding of the task domain, exploration of solution methods by analysis and prototyping, and implementation of a selected approach. Each team presents a preliminary plan, an approach with feasibility analysis, and a final demonstration. (1051-726, 1051-782 or permission of instructor) **Class 4, Credit 4 (offered alternate years, offered 2005–06) (S)**

1051-790 **Image Rendering**
This course covers the fundamental principles of computer image synthesis with a focus on rendering techniques. Topics include geometric scene specification, shading (e.g., flat, Gouraud, Phong), and global illumination rendering (e.g., ray tracing, radiosity). Commercial software such as OpenGL and Radiance will be briefly described. Lastly, the design, advantages and limitations of modern computer graphics hardware are discussed. Students implement fundamental computer graphics techniques and produce images using IDL (or similar) environment. (Graduate status CIS or permission of instructor, 1051-726 or equivalent, Matrix Algebra) **Class 4, Credit 4 (offered alternate years, offered 2005–06) (W)**

1051-797 **Principles of Computed Tomographic Imaging**
Image reconstruction from projections is introduced as a mathematical problem. Technique for reconstruction via Fourier domain is explained using Fourier slice theorem. Simple and Filtered Backprojection and iterative methods are analyzed. Algorithms for various techniques are developed and artifacts and noise in discrete case are considered. Applications to several medical imaging modalities are outlined, with brief consideration of the physics of imaging involved in each case. **Class 4, Credit 4 (S)**

1051-799 **Independent Study**
An independent project in an area of imaging science not covered in the available courses. This project can be experimental research, literature review, or other appropriate work. This course requires a formal proposal and a faculty sponsor. **Variable credit**

1051-807 **Hard Copy Systems**
The focus is on concepts of "Imaging Systems" and system's Image Quality (IQ) metrics of concern in systems which are not discussed elsewhere in the curriculum. These will include concepts such as costs, reliability, and permanence. Two particular types of imaging systems will be covered in detail. The first, designated the "Internal Imaging System", focuses on strategies for the design and quality optimization of components internal to individual technologies. The second type of imaging system, designated the "External Imaging System", focuses on strategies for the design and quality optimization of components of an imaging chain. **Class 4, Credit 4 (S)**

1051-812 **Medical Imaging Systems**
This is an advanced graduate level course that describes existing medical imaging systems in terms familiar to imaging scientists and electrical engineers. These include impulse response, the transfer functions, and the signal to noise ratio. The course considers in detail, four different imaging modalities: conventional projection X-ray, CT, ultrasonic imaging, and magnetic resonance imaging. A complete system is examined piece by piece in terms of subsystems. **Class 4, Credit 4 (S)**

1051-816 **Color Systems**
This course builds on the theory and concepts presented in the Color Reproduction and Color Modeling courses to cover the key techniques utilized in device-independent color imaging systems. Topics covered include: device calibration and characterization (input, output, display), device profiles, multidimensional look-up table construction, inversion, and interpolation, gamut mapping, appearance matching, and color-management systems. Also offered online. (1051-775, 726 or permission of instructor) **Class 4, Credit 4**

1051-840 **MS Project Paper**
The analysis and solution of Imaging Science Systems problems for students enrolled in Systems Capstone option. **Credit 1**

1051-890 **Research and Thesis**
Thesis (MS) or dissertation (Ph.D.) based on experimental data obtained by the candidate for an appropriate topic as arranged between the candidate and the research adviser. **Variable credit**

1051-999 **Imaging Science Graduate Co-op**
Cooperative work experience for graduate imaging science students. **Credit 0**

National Technical Institute for the Deaf

www.ntid.rit.edu

T. Alan Hurwitz,
Vice President
and Dean

The National Technical Institute for the Deaf (NTID) is the world's largest technological college for deaf students. Among RIT's more than 15,000 full- and part-time students are more than 1,100 deaf students from the United States and other countries.

NTID offers a master of science degree in secondary education of students who are deaf or hard-of-hearing, as well as a fellowship program. Students also can pursue master's degrees through RIT's other seven colleges.

Master of Science in Secondary Education of Students Who Are Deaf or Hard-of-Hearing

Gerald C. Bateman, Director
(585) 475-6480 (voice/TTY), gcbnmp@rit.edu
www.rit.edu/~437www/

NTID offers a graduate program leading to the master of science degree in secondary education of students who are deaf or hard-of-hearing. This unique program prepares students to meet the national need for teachers of secondary students who are deaf or hard-of-hearing. The program's purpose includes the preparation of teachers not only as effective practitioners but also as leaders in the profession.

Faculty members in this program are international leaders in research and are highly skilled in the education of deaf people. A carefully designed system of faculty advisement is a prominent feature of this program. On-campus facilities, state-of-the-art technology and a well-established system of educational access services combine to make this a vital program for both deaf and hearing students who desire careers as professional educators of deaf students. Graduates of this program have a 96 percent pass rate on the New York State Teacher Certification examinations.

Admission guidelines

Admission to the program is based on the following criteria:

- Successful completion of the baccalaureate degree at an accredited college or university
- Cumulative grade point average of 3.0 or above
- Submission of Test of English as a Foreign Language scores (minimum score of 550 paper-based or 213 computer-based) for international students
- A basic knowledge of sign language as measured by a departmental skill assessment, or willingness to take American Sign Language I, or its equivalent, at NTID or another college prior to beginning the program
- Evidence of professional commitment and potential for

Programs

Master of Science degree in:

Secondary Education of Students Who are Deaf or Hard of Hearing p. x

success in the program, i.e., letters of reference and an expository essay
- An individual interview

Additionally, 30 semester credit hours in a content area required by the New York State Department of Education for initial certification to teach a secondary (grades 7–12) content area. Students who do not have the required number of hours must complete the additional credits before applying for New York State certification. Secondary academic subjects include American Sign Language, English, mathematics, social studies or science. **Note:** A major in social studies includes economics and government, and at least 21 semester hours in the history and geography of the United States and the world.

Costs

At the time of this printing, the 2007–08 tuition for students pursuing a master of science degree in secondary education of students who are deaf or hard-of-hearing is as follows:

Domestic
- Full time (12–18 credit hours)—$3,357 per quarter
- Part time (11 credit hours or less)—$373 per credit hour

International
- Full time (12–18 credit hours)—$6,714 per quarter
- Part time (11 credit hours or less)—$746 per credit hour

		Qtr. Cr. Hrs.
0835-701	Psychology and Sociology of Deaf Students	4
0835-702	Deaf Students: Educational and Cultural Diversity	4
0835-703	Special Education in the Social Context	4
0835-704	Teaching Deaf Learners with Secondary Disabilities	4
0835-705	Political/Legal Environment	4
0835-706	Educational Technology and Teaching	2
0835-712	Curriculum Content and Methods of Instruction	4
0835-713	Assessment	4
0835-721	Structure of American Sign Language	4
0835-722	Audition and Spoken Language: Application in Education	4
0835-723	Language Acquisition and Variation	4
0835-724	English Language Development	4
0835-790	Foundations of Educational Research	4
0835-820	Perspectives in Teaching Deaf and Hard-of-Hearing Students	2
0835-860	Student Teaching I	10
0835-861	Student Teaching II	10
0835-880	Master's Project Seminar	2
0835-890	Master's Project	8
0835-898	Special Topics	variable
	Professional Development Seminars	0
0886-xxx	American Sign Language*	8
0507-701	History of American Educational Thoughts and Practice	4
	Total Credits	**94**

**Course placements and credit by exam for American Sign Language courses are determined by the department of American sign language and interpreting education.*

Note: At graduation, students are expected to have at least intermediate-level signing skills as determined during a Sign Language Proficiency Interview.

Proposed plan of study

First Year	Fall Quarter	0835-703	Special Education in the Social Context
		0835-701	Psychology and Sociology of Deaf Students
		0835-706	Educational Technology and Teaching
		0835-721	Structure of American Sign Language
		0886-xxx	ASL course
	Winter Quarter	0835-722	Audition and Spoken Language: Application in Education
		0835-712	Curriculum Content and Methods of Instruction
		0835-723	Language Acquisition and Variation
		0507-701	History of American Educational Thoughts and Practice
		0886-xxx	ASL course
	Spring Quarter	0835-860	Student Teaching I*
		0835-820	Perspectives in Teaching Deaf and Hard-of-Hearing Students
Second Year	Fall Quarter	0835-713	Assessment
		0835-790	Foundations of Educational Research
		0835-724	English Language Development
		0835-702	Deaf Students: Educational and Cultural Diversity
	Winter Quarter	0835-880	Master's Project Seminar
		0835-861	Student Teaching II*
	Spring Quarter	0835-890	Master's Project
		0835-704	Teaching Deaf Learners with Secondary Disabilities
		0835-705	Political/Legal Environment

** Students are required to complete a minimum of 250 hours of supervised student teaching, working with deaf and hard-of-hearing students at the 7–12 grade level. In addition to the above requirement, 100 hours of field experience are required before the first student teaching placement.*

Degree requirements

Course work will require a minimum of six quarters. A cumulative GPA of at least 3.0 must be maintained. Before graduation, students are expected to have at least intermediate-level signing skills as determined by a Sign Language Proficiency Interview.

Professional Fellowship Program

Dianne Brooks, Associate Dean
(585) 475-6433 (voice/TTY), dkbnca@rit.edu

The professional fellowship program at NTID is a full-tuition fellowship for deaf or hard-of-hearing students who choose to pursue selected technical programs of study. The purpose of this fellowship is to expand options for deaf and hard-of-hearing students in areas of professional and technical employment by providing the opportunity to earn a master's degree.

Two fellowship appointments are made each year to qualified deaf and hard-of-hearing graduate students who are pursuing a two- or three-year master's degree program at RIT.* To qualify for the fellowship, students must first apply for graduate study in one the following program areas:
- Photography, fine arts, graphic arts, communication
- Business, management
- Engineering, engineering-related programs
- Science, mathematics, imaging science
- Computer science, information technology

Students who are accepted into one of these programs and chosen for the fellowship will receive:

- Full tuition waiver for the master's degree
- A guaranteed part-time, career-related, paid internship at NTID for which the recipient will receive a $15,000 annual stipend
- Free housing on campus in a single room in a residence hall†

The only educational expenses remaining for the recipient are health insurance, books and supplies.

Depending on his or her program of study, the recipient must complete course work within two or three years, maintain a 3.0 GPA and meet the same university requirements as other matriculated graduate students.

Fellowship selection guidelines

The NTID Selection Committee evaluates applicants on academic achievement, clarity of career goals, prior work experience, community involvement and leadership ability or potential. The fellowship recipient must first apply and be accepted to a two- to three-year master's degree program, and therefore must meet the requirements of the individual program to which he or she applies. In addition, fellowship selection is based on the following criteria:

- Successful completion of the baccalaureate degree from an accredited college or university
- United States citizenship
- A 70-decibel or greater hearing loss in the better ear, unaided
- A minimum GPA of 3.0
- Acceptance into a program of graduate study at RIT

Application materials should be submitted by March 30 for admission the following fall. Applicants will be notified after May 1. For application materials and more information, contact:

Rochester Institute of Technology
National Technical Institute for the Deaf
Outreach and Technical Assistance
One Lomb Memorial Drive
Rochester, NY 14623-9650
(585) 475-6433 (voice/TTY)
dkbnca@rit.edu

* *Students pursuing a master's certificate program do not qualify for this fellowship.*
† Fellows are required to live in an on-campus residence hall.

Graduate Faculty

John A. Albertini, BA, Drew University; MS, Ph.D., Georgetown University—Professor, Linguistics

Gerald C. Bateman, BS, MS, State University of New York at Geneseo; Ed.D., University of Rochester—Professor; Director, MSSE, Curriculum and Teaching

Gerald P. Berent, BA, University of Virginia; Ph.D., University of North Carolina at Chapel Hill—Professor, Linguistics

Joseph Bochner, BA, City University of New York, Queens College; MA, Ph.D., University of Wisconsin—Professor, Language and Audition

Gerard J. Buckley, BS, Rochester Institute of Technology; MSW, University of Missouri; Ed.D., University of Kansas—Associate Professor; Assistant Vice President for College Advancement, Educational Policy, Politics and Legal Issues

Karen Christie, BS, M.Ed., Lewis and Clark College; Ph.D., University of Pittsburgh—Associate Professor, Education

Amanda Davis, BS, State University of New York at Geneseo; MES, Smith College; MS, Syracuse University; AuD., University of Florida—Audiologist, Audiology

Carol Lee De Filippo, BA, Newark State College; MS, Purdue University; MS, Ph.D., Washington University—Associate Professor, Communication Sciences: Audiology

Susan Foster, BA, Northwestern University; BS, University of Maine; M.Ed., Bridgewater State College; Ph.D., Syracuse University—Professor, Special Education and Rehabilitation

Ronald Kelly, BS, M.Ed., Ph.D., University of Nebraska at Lincoln—Professor, Educational Psychology and Measurements

Baldev Kaur Khalsa, BA, M.Ed., Western Maryland College—Associate Professor, Deaf Education

Christopher Kurz, BA, Rochester Institute of Technology; MS, Ph.D., University of Kansas—Assistant Professor, MSSE, Special Education: Education of Deaf Students

Harry G. Lang, BS, Bethany College; MS, Rochester Institute of Technology; Ed.D., University of Rochester—Professor, MSSE, Science Curriculum and Teaching

Gary Long, BA, University of Akron; MA, Ph.D., Texas Christian University—Associate Professor, Cognitive Psychology/Mathematical Psychology

Ila Parasnis, BA, MS, Nagpur University; MA, Ph.D., University of Rochester—Professor, Psychology

Jeffrey E. Porter, B.Ed., M.Ed., University of Virginia; Ph.D., Washington University—Associate Professor, Educational Psychology

Vincent Samar, BA, MA, Ph.D., University of Rochester—Associate Professor, Psychology/Cognitive Neuroscience

Cynthia Sanders, BS, MA, Syracuse University; DA, State University of New York at Albany—Assistant Professor, Communication

J. Matt Searls, BA, MA, Gallaudet University; Ph.D., American University—Associate Professor, Counseling and Development

Nora Shannon, BS, Nazareth College of Rochester; MS, Canisius College—Associate Professor; Coordinator of Student Teaching, MSSE, Education of the Deaf

Donald G. Sims, BA, University of Colorado; MS, Ph.D., University of Pittsburgh—Associate Professor, Audiology

Michael S. Stinson, BA, University of California at Berkeley; MA, Ph.D., University of Michigan—Professor, Educational Psychology

Secondary Education of Students Who Are Deaf or Hard of Hearing

0835-701 Psychology and Sociology of Deaf Students
The purpose of this course is to examine the psychological and social development of deaf and hard-of-hearing students in childhood and adolescence. The ways that family, school, and community affect the student's development, including effects on cognitive processes, identity formation, and peer relationships, are considered. Psychological and sociological perspectives on the students' experience in general are used to provide a framework for understanding the development of deaf and hard-of-hearing students. Educational implications of the theories and research presented are discussed. **Class 4, Credit 4 (W)**

0835-702 Deaf Students: Educational and Cultural Diversity
This course introduces the concepts underlying cultural anthropology and uses a cross-cultural approach to examine issues that include transmission and preservation of culture, cultural change and transformation, concepts of marginality, and majority and minority cultures. Deaf culture is examined and compared with other cultures, using comparative studies and cultural constructs such as norms, values, and beliefs. The relationship between education and culture is discussed, and the nature of this relationship with respect to Deaf culture is studied. **Class 4, Credit 4, (F, S)**

0835-703 Special Education in the Social Context
This course takes a sociological approach to disability and special education. Three models of disability are introduced: clinical, social interactionist, and political. The models provide a foundation for the course and guide study of three major aspects of disability and special education. First, students explore how each of the models has guided and continues to guide service and social institutions for persons with disabilities including educational and rehabilitation services. Second, students examine the process through which people with disabilities are so labeled and the interaction between these individuals and others (family, school, community). Third, students analyze the role of the human service professional (including teachers) and the ways in which training programs reflect the various models of disability. The course draws heavily on a variety of philosophical, theoretical, conceptual and methodological perspectives, including phenomenology, symbolic interactions, and human ecology. **Class 4, Credit 4 (F)**

0835-704 Teaching Deaf Learners with Secondary Disabilities
This course focuses on providing students with basic information regarding the needs of deaf learners with disabilities, including (1) developmental disability, (2) emotional or behavioral disorder, (3) learning disability, attention deficit disorder or attentional deficit hyperactivity disorder, or (4) visual impairment. Topics include incidence, identification, assessment, and teaching strategies. The goal is to enable students to see students in a holistic fashion, and incorporates the perspectives of parents, teachers, and students themselves through site visits, interviews, and panel discussion. The course regularly incorporates guest lecturers who have specialized expertise in teaching or research in one or more topic areas. (0835-703) **Class 4, Credit 4 (S)**

0835-705 Political/Legal Environment
The relationship of the goals and processes of deaf education to those of special education and education in general is explored. The course provides a detailed examination of historical and current demographic, economic, political, legal, and social trends that affect the education of deaf and hard-of-hearing students. Current federal and state legislation affecting students with disabilities is analyzed and critiqued. **Class 4, Credit 4 (S)**

0835-706 Educational Technology and Teaching
This introductory course provides an overview of the use of educational technologies to enhance the learning experiences of deaf students. The use of productivity software and educational software including Web-based instruction and resources are explored. The selection, development, implementation, and evaluation of technology-based solutions are addressed. Instructional materials are created following a simplified model of instructional development. **Class 2, Credit 2 (F)**

0835-712 Curriculum Content and Methods of Instruction
Note: There are five discipline-specific courses here, designated by section: 01 (English), 02 (Mathematics), 03 (Science), 04 (Social Studies) and 05 (American Sign Language). Students will take only the section focusing on the content area in which they will be certified.

0835-712 Section 01 English
This course examines issues and methods related to teaching English in the secondary level to students who are deaf or hard-of-hearing. Students investigate and analyze current approaches to curriculum, instruction and materials in the area of English instruction through readings, observations, and seminars. Students design content area projects to demonstrate a variety of methodological philosophies. **Class 4, Credit 4 (W)**

0835-712 Section 02 Mathematics
This course examines issues and methods related to teaching Mathematics at the secondary level to students who are deaf or hard-of-hearing. Current instructional methods, curriculum and professional resources in mathematics are studied through seminars, readings, special projects, observations and work with content-area specialists and teachers in secondary-level mathematics courses. **Class 4, Credit 4 (W)**

0835-712 Section 03 Science
This course examines issues and methods in teaching secondary-level Science to deaf or hard-of-hearing students, including the selection, modifications, and use of curriculum materials in science. Discussions will be concerned with instructional strategies, classroom managements, cognitive development, testing and evaluation, lab report writing and theories of science teaching. Students will be required to observe teachers in secondary level science courses. **Class 4, Credit 4 (W)**

0835-712 Section 04 Social Studies
This course examines issues and methods related to teaching social studies at the secondary level to students who are deaf or hard-of-hearing. Through seminars, readings, special projects, and work with content area specialists/teachers, current instructional methods, curriculum and professional resources in social studies are examined. Students will be required to observe teachers of secondary level social studies courses at public schools, residential schools for deaf students or in mainstream programs. **Class 4, Credit 4 (W)**

0835-712 Section 05 American Sign Language
This course examines issues and methods related to teaching American Sign Language at the secondary level. Students investigate and analyze current approaches to ASL curriculum, instruction, and materials through readings, observations, and seminars. Students design content area projects to demonstrate their understanding of teaching theories and methods, curriculum design and evaluation techniques. **Class 4, Credit 4 (W)**

0835-713 Assessment
This course addresses assessment as a process involving the choice and interpretation of assessment measures to diagnose the need for and aid in planning for services, referrals, and placement of secondary students who are deaf and hard of hearing, including students with other secondary disabilities. The respective roles of the classroom teacher, school psychologist, parents, and support service providers are addressed. Assessment and educational planning for a student are viewed from an ecological perspective, including the family, the school, the community, the support services, and the legal systems. This course also addresses the development and interpretation of assessment measures of learning through teacher-made, criterion referenced, curriculum-based, and norm-referenced methods. (0835-802, 0835-860) **Class 4, Credit 4, (F)**

0835-721 Structure of American Sign Language
This course concentrates on the linguistic structures of American Sign Language (ASL). Students examine all levels of structure from phonology (sublexical) through morphology and syntax to semantics and discourse. ASL structures will be elucidated through comparison and contrast with English and other spoken languages or dialects, as well as with other sign languages. ASL literacy, language variation, and code switching in the deaf population are also examined. **Class 4, Credit 4 (F)**

0835-722 Audition and Spoken Language: Applications in Education
This course focuses on the ways individuals comprehend and produce spoken English. It provides a functional understanding of auditory physiology, speech perception and deafness, hearing aids and other assistive listening devices. Procedures for audiological and speech/language assessment are examined with their implications for auditory training, speechreading, and speech/language instruction. Models of collaboration among teachers, speech/language pathologists, and audiologists to enhance students' communication using spoken English are discussed and observed. **Class 4, Credit 4 (W)**

0835-723 Language Acquisition and Variation
This course is designed to familiarize students with the processes involved in learning English with a focus on reading and writing. The course concentrates on those aspects of English language development that pertain to teaching deaf and hard-of-hearing students in grades 7 to 12. Students investigate deaf learners' attainments in reading and writing, patterns of English language performance observed in deaf learners, relationships between spoken and written English performance, bilingual/bicultural issues related to English learning and use, second language teaching strategies, and reading and literacy questions. (0835-721 or permission of instructor) **Class 4, Credit 4 (W)**

0835-724 English Language Development
This course is designed to familiarize students with the processes involved in learning English with a focus on reading and writing. The course concentrates on those aspects of English language development that pertain to teaching deaf and hard-of-hearing students in grades 7 to 12. Students investigate deaf learners' attainments in reading and writing, patterns of English language performance observed in deaf learners, relationships between spoken and written English performance, bilingual/bicultural issues related to English learning and use, second language teaching strategies, and reading and literacy questions. **Class 4, Credit 4 (F)**

0835-790 Foundations of Educational Research
This course is an introduction to research and inquiry in education. Perspectives on and issues related to research in the education of people who are deaf and hard of hearing are examined. Students are introduced to the research process, including design, theoretical perspectives, methods of data collection, validity/reliability, data analysis, and interpretation. Students leave this course with a preliminary proposal for the master's thesis or project. **Class 4, Credit 4 (F)**

0835-820 Perspectives on Teaching Deaf and Hard-of-Hearing Students
This course reviews fundamental principles of teaching and learning in light of the recently completed student teaching assignment. Students analyze examples of theoretical applications in teaching this class and from viewing videotapes of their actual lessons used during the student teaching experience. Students propose a plan for change and skill development. (Student Teaching I, 0835-860) **Class 2, Credit 2 (S)**

0835-860 Student Teaching I
This first practicum consists of 10 weeks (250 hours) of teaching and observation. Student teachers are placed with cooperating teachers in residential schools for the deaf. Students develop lesson and unit plans and teach in the content area in which they plan to receive New York State certification. (Curriculum Content and Methods of Instruction, 0835-712) **Credit 10 (S)**

0835-861 Student Teaching II
This is an eight-week practicum done in conjunction with an itinerant or resource room cooperating teacher at the middle or secondary level in a mainstream setting with students who are deaf or hard of hearing. Students develop and deliver support for instruction, participate in student assessment, and, where appropriate, prepare lesson plans and teach to specific IEP objectives. (Student Teaching I, 0835-860; Perspectives on Teaching Deaf and Hard-of-Hearing Students, 0835-820) **Credit 10 (W)**

0835-880 Master's Project Seminar
Students finalize their project proposal and begin research and development. Students also finalize the selection of their project adviser. Format for the seminar is full group meetings in the early part of December followed by individual or small group consultation with project advisers. (Foundations of Educational Research, 0835-790) **Class 2, Credit 2 (W)**

0835-890 Master's Project
This is the capstone experience of the master's degree program. Students must have already submitted an acceptable proposal in order to enroll. Project development, presentation, and/or reporting or research and the preparation of the written thesis are completed in this course. The coursework and project must be completed within a seven-year period; register for one credit of continuation of master's project each school term (except summer quarter) after all required coursework/student teaching assignments have been met and until the final project is completed. **Variable credit 0-8 (S)**

0835-898 Special Topics
Special topics courses will be developed based on student interest and demand as well as faculty interest and availability. They may include electives in speech, audiology, and comparative linguistics, among others. **Variable credit**

0886-199 American Sign Language I
Designed for students who have no previous knowledge of American Sign Language. ASL I includes the linguistic features, cultural protocols and core vocabulary for students to function in basic ASL conversations that include ASL grammar for asking and answering questions while introducing oneself; exchanging personal information; talking about family, friends and surroundings; and discussing activities. Classroom and lab activities include practicing conversations and videotaping. **Class 4, Credit 4 (F, W)**

0886-200 American Sign Language II
Expands the basic principles presented in ASL I. The course teaches students to use linguistic features, cultural protocols, and core vocabulary to function in additional basic ASL conversations including ASL grammar for giving directions; describing others; making requests; talking about family, occupations and routines; and attributing qualities to others. Classroom and lab activities include practicing conversations and videotaping. (0886-199) **Class 4, Credit 4 (F, W, S)**

0886-201 American Sign Language III
This course is a continuation of ASL II expanding the emphasis on ASL grammar, syntax, spatial referencing and vocabulary development. ASL III teaches further communicative competencies in ASL conversations beyond the basic level that include telling life events, describing events in time, asking for clarification, correcting, conforming, elaborating on information, agreeing and disagreeing, resolving conflicts, and giving directions. Classroom and lab activities include practicing dialogues, short stories, narratives and short conversations. (0886-200) **Class 4, Credit 4 (F, W, S)**

0507-701 History of American Educational Thought and Practice
A historical analysis of change and continuity in American educational history from colonial through contemporary America. Special emphasis on the leading historiological aspects of American educational history and on enabling the student to acquire mastery of the relevant bibliography. Lectures, seminars, and readings offer comprehensive coverage of the salient intellectual themes and a chronological structure to mark the significant educational developments in particular periods-e.g., the Progressive Era, the 1920's and '30's and post-World War changes. Course structure: lectures, seminars, readings from multiple paperbacks and class handouts, essay exams and critique. **Class 4, Credit 4 (W)**

Professional Development Seminars
Variety of topics: second-year students present research topics and ideas to all program faculty and students; child abuse and substance abuse; the code of ethics for interpreters; using educational support personnel effectively; identifying and using community resources. **Credit 0**

Online Learning and Executive Education

Rochester Institute of Technology is a recognized leader in the delivery of online asynchronous education. Since the late 1980s, RIT has offered distance learning courses, and was among the first universities nationwide to utilize the Internet as a mode of delivery. In 1991, RIT began offering full degrees through distance deliverylearning.

Online Learning is responsible for supporting distance learning, the RIT online course management software (myCourses), training for faculty and assisting the ITS Help Desk with student questions about myCourses. Online Learning also reviews emerging technologies that support the critical mission of constantly improving teaching and learning.

RIT offers 472 degree and certificate programs in an online format; 131 master's degrees, five undergraduate degrees, nine 12 graduate certificates and 17 undergraduate certificates—most of which can be earned without ever coming to campus. Including graduate and undergraduate courses, RIT offers more than 500 courses online annually. In 2006, more than 4,600 students enrolled in an online learning course. Students are encouraged to select and apply to their chosen academic program, but may enroll in courses prior to matriculation into a program.

Online learning offers students the flexibility to learn on their own time, when and where it best meets their needs. All online courses are taught using Internet and Web-based technologies. Students must have full Internet access, a computer, VCR and monitor, and a telephone to participate in courses. Not all courses use the same technologies. Some take advantage of toll-free phone conferences while others use text-based chat or CD-ROMs. Some have Web-based simulations and some require additional software to complete course requirements. All courses use asynchronous Internet/Web-based tools for the fundamental class structure.

Online students have full access to customer and technical support through a toll-free phone number and e-mail. Online learners also have full access to the library and library services. Other online services include registration, orientation, access to student records and course material ordering. Registration also can be accomplished through touchtone phone and fax. Annual offerings can be found at http://online.rit.edu. Officially registered students receive orientation information about three weeks before the quarter begins. This directs them to the registered students website at http://online.rit.edu/students, where they follow the process to prepare for their upcoming courses.

All courses offered online meet the same rigorous objectives set for traditional classroom experiences. Faculty members who teach online courses often teach the same class in a traditional format.

However, just as each professor establishes the learning outcomes for a traditional course, their individual choices will be present in the online classroom. Most classes establish either a weekly schedule for learning activities or a project-based learning approach, where deliverables are due after certain learning outcomes are accomplished. These may include team-based projects, required asynchronous discussion or computer programs. Most classes also include various readings either from textbooks or electronic reserves. Students interact online with other students to exchange ideas and collaborate much as they would face-to-face.

Online Learning serves students throughout the United States and in more than 40 countries. Students living near Rochester can choose to take both online and traditional courses as a way of increasing flexibility and remaining on target to complete a degree. For more information on Online Learning at RIT go to http://online.rit.edu or call us at 1-800-CALL-RIT (V/TTY) or (585) 475-5089/5896 (V/TTY).

Online Graduate Programs:

Master's Degrees

- Applied Statistics
- Cross-Disciplinary Professional Studies
- Environmental, Health and Safety Management
- Facility Management
- Health Systems Administration
- Imaging Science
- Information Technology
- Learning and Knowledge Management Systems
- Microelectronics Manufacturing Engineering
- Networking and Systems Administration
- Print Media
- Software Development and Management
- Telecommunications Engineering Technology

Online Advanced Certificates

- Digital Print and Publishing
- Health Information Systems Administration (Elements of Healthcare Leadership, Health Information Resources, Health Systems Finance, Senior Living)
- Human Resource Development
- Information Assurance
- Learning and Knowledge Management Systems
- Project Management
- Statistical Methods for Product and Process Improvement
- Statistical Quality
- Technical Information Design

Admission

Decisions on graduate selection are made by the college offering the program. Correspondence between the student and the university is conducted through the Office of Graduate Enrollment Services, according to the following policies and procedures:

1. Inquiries about, and applications for, graduate study are directed to the Office of Graduate Enrollment Services, Rochester Institute of Technology, Bausch & Lomb Center, Building 77, Room 1241, 58 Lomb Memorial Drive, Rochester, NY 14623-5604.
2. The Office of Graduate Enrollment Services will acknowledge the inquiry or application, instructing the student as to the information required for admission by the school or department to which he or she is applying.
3. Once a student has made formal application, the Office of Graduate Enrollment Services will prepare an applicant file for him or her. All correspondence and admission data will be collected by the Office of Graduate Enrollment Services and placed in the applicant's file. The file will include an RIT application, previous college records, applicable test scores, letters of recommendation and other documents that may support admission of the candidate.
4. When all relevant admission data has been received, the applicant's file will be sent to the appropriate school or department for action.
5. When the school or department has made a decision on the application, this decision and the applicant's file will be returned to the Office of Graduate Enrollment Services.
6. The Office of Graduate Enrollment Services will notify the student of the admission decision.
7. Academic departments may informally advise nonmatriculated students, but no formal program of study can be approved prior to matriculation.
8. The formal program of study will be approved by the dean's designee (department head, coordinator, program director, etc.). This program must be followed by all students applying for admission or readmission.
9. The basic entry requirements for master's degree candidates include the completion of a baccalaureate degree and whatever other evidence of the applicant's potential to successfully complete graduate studies may be required by the particular college. Rare exceptions to the baccalaureate requirement can be made in the case of candidates who have demonstrated unusual competence in their field of specialization. For these exceptions, the recommendation of the department chairperson or director and the approval of the appropriate dean and the Graduate Council are required.

International applicants must demonstrate English language proficiency as part of the admission process. This is normally accomplished through submission of scores from the Test of English as a Foreign Language (TOEFL). Minimum TOEFL scores vary by program. Most programs require a TOEFL score of 213 (550 paper-based, or 79-80 Internet based) or higher. Upon arrival at RIT, students for whom English is a second language may be required to take a battery of English language exams. Depending on the results, a student may have to enroll in English instruction, which will result in additional study time and tuition cost.

In certain cases graduate students may be admitted prior to, but conditional upon, completion of the baccalaureate degree. Applicants will not be considered for admission prior to the start of the final year of undergraduate study. The student must present a final transcript covering all undergraduate study within one quarter after first registering for a graduate program.

Graduate applicants who do not fully satisfy all admission criteria as to grades, test scores or their credentials but show sufficient promise to qualify for a trial period of graduate study may be admitted to the university on probation. Such students must achieve a 3.0 (B) program cumulative grade point average by the end of their first 12 quarter credit hours of graduate study. Those students who do not meet this criterion will be suspended. Responsibility for specific requirements and maintenance of the student's appropriate status rests with the student's academic department in consultation with the Office of Graduate Enrollment Services and the Registrar. Evaluation of transfer credit (see p. 210) is made by the academic school or department in question. RIT will admit and hire men and women, veterans, people with disabilities and individuals of any race, creed, religion, color, national or ethnic origin, sexual orientation, age or marital status in compliance with all appropriate legislation.

New York State immunization requirement

New York State Public Law 2165 requires that all matriculated students enrolled for six or more quarter credit hours in a term and born after January 1, 1957, must provide the RIT Student Health Center with proof that they have received the appropriate immunizations against measles, rubella and mumps. Immunization requirements include: two measles vaccinations at least one month apart, with a live virus after January 1, 1968, and after the first birthday; and one vaccination each against mumps and rubella after January 1, 1969, and after the first birthday. Additional information concerning the necessary documentation and where it must be sent is included with the student's acceptance packet or available from the Student Health Center.

Readmission

If a student has become inactive (has not completed a course in four quarters) or has withdrawn from RIT, university policy requires that he or she reapply for admission as follows:

1. Students who left a graduate program with a GPA of 3.0 or better (in good standing) and will return to the program within two years of the time their last course was completed will be readmitted to the program upon reapplication.
2. Students who left the program with a GPA of 3.0 or better and return to the program more than two years after the last course was completed must meet current admission standards upon reapplication. The program of study shall be subject to review and will be rewritten. Previous waiver/transfer credit may be lost, and the student may need to make up program deficiencies.
3. Students who leave a program with a GPA below 3.0 must meet current admission standards upon reapplication. Readmission will be based on all information, including previous graduate-level work. Program requirements in effect at the time of reapplication will apply. Previous waiver/transfer credit may be lost, and the student may need to make up program deficiencies.

Expenses and Financial Aid

Electronic Billing

The university has an electronic billing (E-Bill) program for students. Each quarter, all RIT students receive an e-mail notification to their official university e-mail account stating that their E-Bill is available. Students have the option of selecting three additional e-mail addresses to allow for a parent, guardian, sponsor or other authorized user to receive E-Bill notifications.

Costs and Payment Procedures

The university reserves the right to change its tuition and fees without prior notice. Nonmatriculated students are charged graduate rates for graduate courses.

Graduate costs are listed in the table on this page. In addition, any graduate student carrying more than 18 credit hours of study will be charged the full-time tuition rate plus $800/credit hour for each hour of study exceeding 18.

Room and board for full-time students for 2007–08 will be $1,281 per quarter for a standard meal plan and $1,737 for a double occupancy room. A variety of housing options and meal plans are available, and costs may vary according to options selected.

The cost of books and supplies will vary depending on the area of study and the number of courses taken by a student. The estimated cost for books and supplies ranges from $500 to $2,500 a year for full-time students and $300 to $700 a year for part-time students.

Charges for tuition, fees, and room and board are computed on a quarterly basis. University billing statements may be paid by cash, check or electronic check (e-check). The university does not accept credit card payments for tuition, fees, and room and board that appear on the student billing statement. However, we have an arrangement for a third-party vendor to accept MasterCard and Discover Card when payment is made online. The vendor does charge a percentage fee for each credit card transaction. Billing-related payments (check) may be mailed to: Rochester Institute of Technology, Student Financial Services, P. O. Box 92878-200, Rochester, NY 14692-8978. Payment also may be made in person at the Office of Student Financial Services on the first floor of the George Eastman Building. Credit card and e-check payments can be made at http://ipay.rit.edu.

Due dates are clearly designated on the billing statement and our website. Failure to pay the amount due or arrange an optional payment by the due date will result in a late payment fee.

Fall Quarter—August 15, 2007
Winter Quarter—November 16, 2007
Spring Quarter—March 5, 2008
Summer Quarter—May 21, 2008

Students who have not participated in the early registration process for the quarter will be expected to pay the quarterly charges (tuition, fees, room and board) at the time of registration. They may pay these charges in a single payment or by the partial payment plan. Partial payments are due twice a quarter: 50 percent (plus a $25 partial payment processing fee) at the time of registration and the remaining 50 percent by the mid-quarter bill due date. A late payment fee will be assessed if the balance is not paid by the due date.

Graduate Costs

Tuition	Per Quarter	3 Quarters
Full-time (12–18 credit hours)	$9,497	$28,491
Part-time (11 credit hours or less)	$ 800/credit hour	$ 800/credit hour
Student activities fee	$ 67	$ 201

If you have questions concerning payment options, please contact the RIT Student Financial Services Office, (585) 475-6186.

Student Accident and Sickness Insurance

All registered students are required to maintain medical insurance while attending RIT. Insurance coverage can be through RIT, a family member's policy or a personal policy.

A student accident and sickness insurance plan is available through RIT. There is a separate charge for this insurance. The plan provides coverage, within limits specified in the policy, for sickness and injury, outpatient services, emergency care and prescriptions.

Enrollment in this plan is voluntary for all students except registered international undergraduate students (full- and part-time) on A, B, E, F, G, I, J, K, O, Q, R, and V visas. These students will be enrolled automatically in the basic accident and sickness policy on a semiannual basis.

There is no need to waive coverage if it is not desired. Students who want to enroll in this plan may enroll online or by mail. An open enrollment period is available at the beginning of each academic quarter. Payment can be made by check, money order or credit card, or the premium can be added to the student's account.

The open enrollment period ends 30 days after the start of the academic quarter the student first registers at RIT.

For plan and enrollment information, visit the Web at www.universityhealthplans.com or call (800) 437-6448. Students are not required to obtain the RIT student accident and sickness insurance plan to receive services at the RIT Student Health Center.

Financial Aid

Rochester Institute of Technology is interested in seeing that all students qualified for graduate study at RIT find the financial resources needed to assist with their educational expenses. The information provided in this section is an overview of the sources of assistance available. Please contact the offices listed for additional information.

Scholarships and assistantships are available in most graduate departments. In addition, some departments offer externally funded stipends from corporate or governmental sources. Please contact the appropriate department chairperson or the Office of Graduate Enrollment Services at (585) 475-2229 for additional information.

While students may apply before matriculation, these awards are granted only to matriculated students. Awards are generally given to full-time students, but exceptions are made for qualified part-time students.

Standard of Satisfactory Progress for the Purpose of Determining Eligibility for State Student Aid
Graduate Degree—Quarter System

Before being certified for this payment,	1st	2nd	3rd	4th	5th	6th
a student must have accrued at least this many credits	0	12	24	36	48	60
with at least this cumulative grade point average	0	2.00	2.50	2.70	2.80	2.90

Additional sources of financial assistance include the New York State Tuition Assistance Program, work-study and various student loan programs. Please refer to the Graduate Financial Aid Programs for details.

It should be noted that international students (F-1 or J-1 visa holders) may generally work on campus up to 20 hours a week. Special authorization from International Student Services and/or the INS is needed for all other employment, including co-ops and internships. Please consult International Student Services at (585) 475-6943 or www.rit.edu/internationalservices for employment or visa questions.

All federal assistance programs require submission of the Free Application for Federal Student Aid (FAFSA). The FAFSA is available from the Office of Financial Aid and Scholarships, (585) 475-2186. You can also complete the FAFSA online at www.fafsa.ed.gov. Satisfactory academic progress for federal aid recipients is evaluated at the end of spring quarter each year. Students must maintain a 2.0 grade point average and complete two-thirds of credit hours attempted each year. Federal aid eligibility is exhausted after attempting 150 percent of the number of credit hours required for the degree or certificate. In addition, loan eligibility for students with full-time-equivalent status is limited to a maximum of four quarters.

Students receiving New York Tuition Assistance Program benefits must meet credit hour and grade point average requirements based on the number of TAP payments received at the graduate level at RIT. Course completion is defined as meeting course requirements and receiving a letter grade of A, B, C, D, or F.

Refund Policies

The acceptable reasons for withdrawal with full refund during the quarter are:

1. Active military service: A student called to active military service during the first eight weeks of the term may receive a full tuition refund. If called after the eighth week, he or she may elect to complete the course by making special arrangements with both the instructor and department, or may withdraw and receive a full tuition refund. If he or she withdraws, the course must be repeated at a later date.
2. Academic reasons: Students sometimes register before grades for the previous quarter are available. If such a student later finds that he or she is subject to academic suspension or has failed to meet prerequisites, the student will be given a full refund upon withdrawal.
3. Part-time students: If part-time students drop a course during the official drop/add period (first six days of classes in any quarter), they may contact the Student Financial Services Office for a full refund for the course dropped.

Full-time students must officially withdraw from all courses or take a leave of absence in order to be eligible for a partial tuition refund. Students must complete a leave of absence or withdrawal form, which can be initiated with their academic department. A partial refund will be made during a quarter if withdrawal/leave of absence is necessitated for one of the following reasons:

1. Illness, certified by the attending physician, causing excessive absence from classes
2. Withdrawal for academic or disciplinary reasons at the request of RIT during a quarter
3. Transfer by employer, making class attendance impossible
4. Withdrawal for academic, disciplinary or personal reasons at the request of the student, approved by the student's adviser or department representative and the Student Financial Services Office.

Partial refund schedule for tuition

Partial refunds will be made according to the following withdrawal schedule and percentage of tuition reduction:

1. During official drop/add period (first six days of classes)—100 percent tuition reduction
2. From the end of the official drop/add period through the end of the second week of classes—70 percent tuition reduction

3. During the third week of classes—60 percent tuition reduction
4. During the fourth week of classes—50 percent tuition reduction
5. During the fifth week of classes—25 percent tuition reduction
6. Sixth and subsequent weeks—no tuition reduction

Note: *Nonattendance does not constitute an official withdrawal.*

A student is not "officially withdrawn" until he or she receives a copy of the withdrawal form. The date on which a withdrawal form is properly completed will be the date of official withdrawal, used to determine the refundable amount.

If the student drops his or her course load from full-time (12 or more credits) to part-time (less than 12 credits) status during the official drop/add period, he or she may contact the Student Financial Services Office for a refund based on the difference between the full-time tuition charge and the total per-credit charge for the part-time course load.

No refund will be made for classes dropped after the official drop/add period unless the student is officially withdrawing from the university. Advance deposits are not refundable.

If institutional charges are reduced due to withdrawals, financial aid programs are reimbursed before a cash refund is issued to the student. The student also is responsible for any unpaid balance at the time of withdrawal. Aid programs are reimbursed in the following sequence: Federal Direct Unsubsidized Loan, Federal Direct Subsidized Loan, Graduate PLUS Loan, Parent PLUS Loan, Federal Pell Grants, Federal SEOG, other federal grants, state aid, institutional aid. If a credit balance still remains, the student is then issued a refund.

For further information or comments regarding refund policies and specific withdrawal dates, contact the Student Financial Services Office.

Appeals process

An official appeals process exists for those who feel that individual circumstances warrant exceptions from published policy. The inquiry in this process should be made to Mary Beth Nally, director of Student Financial Services.

Partial refund schedule for room and board

To complete a withdrawal from RIT, a resident student must check out with Housing Operations. All students on a meal plan should check out with the Food Service administrative office, located in the Student Alumni Union, room A520 (lower level). Refunds, when granted, are from the date of official check out. Room and board refund policies are established by the Center for Residential Life and RIT Food Service.

Room

1. During the first week of classes—90 percent of unused room charge
2. During the second week of classes—75 percent of unused room charge
3. During the third week of classes—60 percent of unused room charge
4. During the fourth week of classes—50 percent of unused room charge
5. Fifth and subsequent weeks—no refund

Board

1. Within the first four weeks—75 percent of the unused meal/debit charges
2. After the fourth week (during week five through the end of week eight)—50 percent of the unused meal/debit charges
3. During the last two weeks of classes—no refund

Any student who intentionally defrauds or attempts to defraud the university of tuition, fees or other charges, or who gives false information in order to obtain financial aid, is subject to legal liability, prosecution and university disciplinary action.

Financial Aid Refund Policy

Return of federal funds

In accordance with federal regulations, the Office of Financial Aid and Scholarships recalculates quarterly federal aid eligibility for students who withdraw, drop out, are suspended or take a leave of absence prior to completing 60 percent of a quarter. "Withdrawal date" is defined as the actual date the student initiated the withdrawal process, the student's last date of recorded attendance or the midpoint of the quarter for a student who leaves without notifying the university. Recalculation is based on the percent of earned aid using the following formula: number of days completed up to the withdrawal date/total days in the quarter. Aid returned to federal programs is then equal to 100 percent minus the percentage earned multiplied by the amount of federal aid disbursed.

Funds are returned to the federal government in the following sequence: Federal Direct Unsubsidized Loans, Federal Direct Subsidized Loans, Federal Parent Loans, Federal Perkins Loans, Federal Pell Grants, Federal SEOG, other federal aid.

Late disbursement

If the student is otherwise eligible, the first disbursement of Federal Direct Subsidized Loan or Federal Direct Unsubsidized Loan proceeds is allowed up to 120 days after the student has ceased to be enrolled. Subsequent disbursements are not allowed.

State scholarships

Regulations vary. Any adjustments are done in accordance with the specific requirements of the sponsoring state.

Privately funded grants and scholarships

In the absence of specific instructions from the sponsor, 100 percent of the quarterly award will be credited to the student's account.

RIT grants and scholarships

If a credit balance remains after all federal, state and private adjustments, a percentage of the remaining credit balance is returned to the RIT scholarship account according to the following formula, where A = scholarship amount; B = scholarship plus student payments; C = percent returned to scholarship program and D = remaining credit balance:

$$\frac{A}{B} = C \times D$$

Financial Aid Programs

Grants/Scholarships	Eligibility	Amount	Where to Apply
Graduate Assistantships	Graduate student matriculated into an RIT graduate degree program.	Amounts vary	Contact academic department
Institute Graduate Scholarships	Graduate student matriculated into an RIT graduate degree program.	Amounts vary	Complete Graduate Admissions Application and check appropriate box to be considered for graduate scholarship.
AALANA Graduate Scholarship	Awarded to a full-time, matriculated African-American, Latino American, or Native American who demonstrates financial need and academic achievement.	Awarded to a full-time, matriculated African-American, Latino American, or Native American who demonstrates financial need and academic achievement.	File the Free Application for Federal Student Aid (FAFSA).
Tuition Assistance Program (TAP)	New York state resident matriculated and enrolled full-time (minimum of 12 credit hours per quarter).	Amounts vary	File the Free Application for Federal Student Aid (FAFSA) and Express TAP Application (ETA) if sent after filing FAFSA.
Vietnam Veterans Tuition Award Program/Persian Gulf Veterans Tuition Award Program	Recipients must meet NYS residency requirements and have served in the armed forces in Indochina or the Persian Gulf during specified periods of hostility.	Awards are $1,000 per year for full-time study, $500 per year for part-time study.	Same as TAP. In addition, file the appropriate award supplement to establish eligibility. Contact NYSHESC at 1 (888) 697-4372 for more information.
Regents Professional Opportunity Scholarship	U.S. citizen and permanent NYS resident as defined by legislation. For certain approved professional programs (e.g. accounting, engineering, physician's assistant), recipient must agree to practice for 12 months in chosen profession in NYS for each annual payment received.	Awards are $1,000 to $5,000 per year. TAP and certain other benefits may supplement this award.	Contact: HEOP/VATEA Scholarships. NYS Education Dept., Education Bldg Annex, Rm. 1071, Albany, NY 12234, (518) 486-1319.
Veterans Benefits	Eligible veterans and children of deceased veterans, or service-connected disabled veterans.	Amounts vary	Contact: Office of Veterans Affairs at 1 (888) 442-4551, or visit their website at www.va.gov.
Bureau of Indian Affairs Graduate Fellowship Grants	Enrolled full-time and recognized by Secretary of the Interior as a member of an Indian tribe and demonstrating financial need and academic achievement.	Amounts vary	Contact American Indian Graduate Center (AIGC) at (505) 881-4584, or on the Web at www.aigc.com.
NTID Professional Fellowship Program	Matriculated students in selected programs of study.	Full tuition and stipend	Contact NTID Office of Outreach and Transition Services.
Loans	**Eligibility**	**Amount**	**Where to Apply**
Federal Direct Loans	All students enrolled at least half-time in a degree program	Maximum amount: $20,500 ($8,500 of which may be subsidized, depending on financial need). The maximum amount cannot exceed the cost of education less other financial aid.	File the Free Application for Federal Student Aid (FAFSA).
Federal Perkins Loan	Students who meet requirements established by the federal government	Up to $6,000 per year ($40,000 limit for undergraduate and graduate study)	File the Free Application for Federal Student Aid (FAFSA).
Private Alternative Loans	Enrolled student who is credit-approved by lender	Up to the cost of education less other financial aid	Contact the Office of Financial Aid and Scholarships at (585) 475-2186, or www.rit.edu/financial aid.
Employment	**Eligibility**	**Amount**	**Where to Apply**
Federal Work Study Program	Students with financial need. Most jobs provided on campus. Some community service positions are available.	Varied, depending on hours and wage rate. RIT wage rates start at $7.15 per hour.	File the Free Application for Federal Student Aid (FAFSA).
RIT Employment Program	No financial need requirement; may be on campus or off	Varied, depending on hours and wage rate. RIT wage rates start at $7.15 per hour.	Contact the RIT Student Employment Office at (585) 475-2631, or www.rit.edu/seojobs.

This chart covers the most commonly awarded financial aid programs available to full-time graduate students at RIT. Information is correct as of May 2007. Most graduate programs require satisfactory progress toward degree completion to maintain eligibility. Filing the FAFSA by April 1 will ensure priority consideration for all programs. Applications filed after this date will receive consideration as long as funds remain available. Scholarships provided by RIT will be prorated for NTID-sponsored students to reflect lower NTID tuition rates.

RIT Payment Options

Quarterly Payment Option	Who is Eligible	Terms
Quarterly payment	All students	Payment in full by billing due date. Payments received after each billing due date are subject to a late payment fee.
Deferred payment plan	All students	Participation fee of $25. Bill must be paid in full from prior quarter. 50 percent of net "out of pocket" quarterly balance due with registration. A deferred payment agreement form must be completed and submitted to the Office of Student Financial Services on or before the start of classes. Remaining 50 percent due by mid-quarter bill due date. Payments received after billing due date will be assessed a late payment fee.
Company deferred payment plan	All students who have official verification of employer's tuition reimbursement practice	Account must be paid in full from prior quarter. Official verification form must be submitted quarterly in lieu of payment. Full payment for the quarter is due by mid-quarter bill due date regardless of whether the employer has reimbursed the student. Payment received after the billing due date will be assessed a late payment fee.
Veteran payment option	All veterans who are certified for VA educational benefits by the RIT Veteran Enrollment Services Office	Account must be paid in full from prior quarter. An authorized veteran deferment form must be submitted in lieu of payment. The student pays monthly in accordance with his or her scheduled VA benefit checks.

Annual Payment Option	Who is Eligible	Terms
Monthly Payment Plan	Matriculated day undergraduate and graduate students (full- and part-time)	The plan, which offers flexibility in both timing and method of payment, carries no interest or finance charge, but does require a $50 administration fee. Account must be paid in full from prior school year. Student must submit enrollment and housing plans for upcoming academic year by July 15. Projected net annual amount due is divided into 10 monthly installments. First monthly payment due August 1 prior to school year. The minimum annual amount must be $1,000 ($100 per month). Students must be registered for a minimum of two quarters during the academic year. Applications cannot be accepted after August 22, 2007.

Payment Procedures		
Past Due Amount	**Late Payment Fee**	Payment made by check should be payable to Rochester Institute of Technology. Late payment fees will be assessed as follows on accounts that are past due as of each billing due date. Since there are two billings per quarter, there is a potential that two late fees (total maximum of $150) may be assessed as well.
$100 through $500	$25	
$500.01 through $1,000	$50	
Over $1,000	$75	

Registration and Degree Requirements

A graduate degree at RIT may be obtained in more than 70 programs ranging from business administration to imaging science. (Please refer to page 4 for a complete listing of graduate programs of study.)

Upon completion of the stipulated requirements, students are certified by their academic departments for their degree. After commencement, a statement verifying that a degree has been awarded will be posted to the transcript. Diplomas for fall graduates are mailed in winter quarter; for winter graduates, in spring; for spring graduates, in the summer; and for summer graduates, in the fall.

Registration

1. Student should complete the registration and payment process in accordance with university registration/billing procedures, as indicated in the quarterly schedule of courses.
2. It is the responsibility of the student to update his or her address online through the Student Information System (SIS), or to advise the registrar of any change of address.
3. University ID cards are required for students to use many campus facilities and services (e.g., the library, Student Life Center, meal plans, check cashing). Identification cards are available at the Registrar's Office.
4. Students are expected to pursue their degree without a substantial break. Failure to enroll (register) for four successive academic terms can result in the loss of matriculated status.
5. RIT considers graduate-level students to be "full time" in every academic quarter in which they are enrolled for at least 12 credit hours. With approval of the department chair and associate provost for academic programs, additional "equivalent" credit can be granted for such activities as thesis work, teaching assistantships and internships.

Matriculation

Matriculated graduate students are those who have applied to and been formally accepted into a graduate program through the Office of Graduate Enrollment Services. Such students may register for graduate-level courses (700 and above) that fit their home department-approved programs. When registering for graduate courses outside the home department, students may need to secure the approval of the department offering the course.

Nonmatriculated students will be allowed to take graduate courses on a space-available basis with the department's approval, and with the knowledge that course work completed while a nonmatriculated student will not necessarily apply to any given academic program.

Matriculated and nonmatriculated graduate students may register for undergraduate-level courses with the understanding that these courses may not apply to any RIT graduate program. In certain cases, where educationally sound programs will result, appropriate undergraduate courses, as approved by the faculty adviser and the department, may be included in a master's program. However, not more than nine undergraduate quarter credit hours (600-level or below) may be applied toward the 45-quarter-credit minimum (12 undergraduate hours for those programs requiring 48 or more quarter credit hours). Where undergraduate work is allowed, it must be well-planned and closely controlled. In the vast majority of cases, most, if not all, course work will be at the graduate level.

Degree Requirements

Credit requirements

The minimum credit requirement for a master's degree is 45 quarter credit hours. At least 36 of these quarter credit hours must be earned at the graduate level and in residence at the university.

Transfer credit

A maximum of nine quarter credit hours in a 45-credit-hour program or 12 quarter credit hours in a 48 or more credit-hour program may be awarded as transfer credit from other institutions. A request for transfer credit must be made at the time of application for graduate student status. Only a course with a grade of B (3.0) or better may be transferred.

Transfer credits are not calculated in the student's grade point average but will count toward overall credit requirements for the degree. Transfer credits do not count toward the satisfaction of residency requirements.

A graduate student who wishes to take courses at another institution and transfer them to his or her degree work at RIT must obtain prior permission from the appropriate departmental officer or dean.

Candidacy for an advanced degree

A graduate student must be a candidate for an advanced degree for at least one quarter prior to receipt of the degree. The position of the Graduate Council is that a student is a candidate for the master's degree when he or she has been formally admitted to RIT as a graduate student.

Thesis requirements

Included as part of the total credit-hour requirement may be a research, dissertation, thesis or project requirement, as specified by each department. The amount of credit the student is to receive must be determined by the time of registration for that quarter.

For the purpose of verifying credit, an end-of-quarter grade of R should be submitted for each registration of research and thesis/dissertation guidance by the student's faculty adviser. Before the degree can be awarded, the acceptance of the thesis/dissertation must be recorded on the student's permanent record. Students also should note the following continuation of thesis/dissertation policy.

Continuation of thesis/project/dissertation

Once work has begun on a thesis, project or dissertation, it is seen as a continuous process until all requirements are com-

pleted. If a thesis, project or dissertation is required, or such an option is elected, and if the student has completed all other requirements for the degree, the student must register for the Continuation of Thesis/Project/Dissertation course each quarter (including summer quarter). This course costs the equivalent of one-quarter credit hour, although it earns no credit.

1. Registration for the Continuation of Thesis/Project/Dissertation course preserves student access to RIT services; e.g., Wallace Library, academic computing, and faculty and administrative support. With payment of appropriate user fees, access to the Student Life Center and Student Health Center also is preserved.
2. If circumstances beyond students' control preclude them from making satisfactory progress on their thesis/project/dissertation, they should consider taking a leave of absence and discuss such a leave in advance with their adviser/department head. The dean's signature of approval is required on the Leave of Absence or Institute Withdrawal form, a copy of which also must be sent to the associate provost for academic programs. If students do not register for the Continuation of Thesis/Project/Dissertation course or take an approved leave of absence, their departments may elect to remove them from the program.
3. The length of time to complete a thesis/project/dissertation is at the discretion of the department. Be sure to read, however, the first point under "Summary of requirements for master's degree" on this page.

Note: The dissertation is required only of Ph.D. students.

Summary experience

The Graduate Council regards some form of integrative experience as necessary for graduate students. Such requirements as the comprehensive examination, a project, the oral examination of the thesis and a summary conference are appropriate examples, provided they are designed to help the student integrate the separate parts of his or her total educational experience. The nature of the experience will be determined by the individual college or department.

Overlapping credit for second degree

At the discretion of the Graduate Committee in the specific degree area, nine to 12 previous master's quarter credit hours normally can be applied toward satisfying requirements for a second master's degree. The use of a given course in two different programs can be allowed only if the course that was used for credit toward the first degree is a required course for the second degree. The course must be used in both programs within five years; i.e., no more than five years between the time used for the first degree and when applied again toward the second degree.

In no case shall fewer than the minimum 36 quarter credit hours of residency be accepted for the second degree. If duplication of courses causes a student to go below the 36-hour limit in the second degree program, he or she would be exempted from these courses but required to replace the credit hours with departmentally approved courses. An RIT student will not be admitted through the Graduate Enrollment Services Office to the second degree program until the first program has been completed.

Financial standing

Tuition and fees paid to the university cover approximately 60 to 70 percent of the actual expense of a student's education. The rest of the cost is borne by the university through income on its endowment, gifts from alumni and friends, and grants from business and industry. Students, former students and graduates are in good financial standing when their account is paid in full in the Student Financial Services Office. Any student whose account is not paid in full will not receive transcripts, degrees or recommendations from RIT.

The university reserves the right to change its tuition and fees without prior notice.

Summary of requirements for master's degree

1. Successfully complete all required courses of the university and the college. These requirements should be met within seven years of the date of the oldest course counted toward the student's program. Extension of this rule may be granted through petition to the Graduate Council.
2. Complete a minimum of 45 quarter credit hours for the master's degree. At least 36 quarter credit hours of graduate-level course work and research (courses numbered 700 and above) must be earned in residence at RIT.
3. Achieve a program cumulative grade point average of 3.0 (B) or better.
4. Complete a thesis/project/dissertation or other appropriate research or comparable professional achievement, at the discretion of the degree-granting program.
5. Pay in full, or satisfactorily adjust, all financial obligations to the university.

Note: The dean and departmental faculty can be petitioned, in extraordinary circumstances, to review and judge the cases of individual students who believe the spirit of the above requirements have been met yet fall short of the particular requirement. If the petition is accepted and approved by the faculty, dean, and provost and vice president for academic affairs, a signed copy will be sent to the registrar for inclusion in the student's permanent record.

Definition of grades

Grades representing the students' progress in each of the courses for which they are registered are given on a grade report form at the end of each quarter of attendance. The letter grades are as follows:

- A Excellent
- B Good
- C Satisfactory
- D and F grades do not count toward the fulfillment of program requirements for a master's degree.

The grades of all courses attempted by graduate students will count in the calculation of the cumulative grade point average. This program cumulative grade point average shall average 3.0 (B) as a graduation requirement. The dean of the college or his/her designee must approve all applications for graduate courses a student wishes to repeat.

Quality points

Each course has a credit-hour value based on the number of hours per week in class, laboratory or studio and the amount of outside work expected of each student. Each letter grade yields quality points per credit hour as follows:

- A Four quality points
- B Three quality points
- C Two quality points
- D One quality point
- F does not count in computing the grade point average (GPA)

The GPA is computed by the following formula:
GPA = total quality points earned total quality hours

There are other evaluations of course work that do not affect GPA calculations. Only I and R (as described below) can be assigned by individual faculty members at the end of a quarter.

Registered (R)—This permanent grade indicates that a student has registered for a given course but has yet to meet the total requirements of the course or has continuing requirements to be met. The grade is given in graduate thesis/dissertation work. Completion of this work will be noted by having the approved/accepted thesis/dissertation title, as received by the registrar from the department, posted to the student's academic record. Full tuition is charged for these courses. Courses graded R are allowed in the calculation of the residency requirement for graduate programs.

Incomplete (I)—This notation is given when the professor observes conditions beyond the control of the student such that the student is not able to complete course requirements in the given quarter. This is a temporary grade that reverts to an F if the registrar has not received a change of grade directive from the professor by the end of the second succeeding quarter (including summer terms). Full tuition is charged.

Withdrawn (W)—This notation will be assigned in courses from which a student withdraws through the end of the sixth week of classes, or if a student withdraws from all courses in a given quarter.

Audit (Z)—This notation indicates a student has audited the course. An audit request form must be completed and approved by the department offering the course. The student need not take exams, and half tuition will be charged. A student can change from credit to audit or from audit to credit status for a course only during the first six days of classes. Audited courses do not count toward the residency requirement, do not get included in GPA calculations and do not count toward degree requirements.

Credit by examination (X)—This notation is assigned for the successful completion of various external or university examinations, provided such examinations cover or parallel the objectives and content of the indicated course. Credit must be assigned in advance for any credit received through registration for the indicated courses. Courses graded X do not count toward the residency requirement. A maximum of 12 quarter credit hours is allowed for graduate courses. Exceptions to the maximum transfer credit or credit-by-exam for graduate programs can be granted by the associate provost for academic programs in unusual circumstances, upon appeal from the dean of the college involved.

Waived—Waived courses are those courses eliminated from the list of requirements that a student must take to graduate. For graduate students, required courses may be waived because of previously completed academic work, but in no case shall the resulting graduate program requirements be reduced below 45 quarter credit hours.

In addition, waiver credit for graduate courses can be applied only toward required, not elective, courses. The process of waiving courses and thereby reducing graduate program requirements is not to be confused with the process of exempting certain requirements that are then replaced by an equal number of credit hours in the specified program.

Changing grades

Once a grade has been reported by a faculty member, it is not within the right of any person to change this unless an actual error has been made in computing or recording it. If an error has been made, the faculty member must complete the appropriate form. The completed form must be approved by the head of the department in which the faculty member teaches. When approved, the form is then sent to the registrar. There is, however, an appeal procedure for disputed grades through the Academic Conduct Committee of the college in which the course is offered. A final appeal can be sent to the university's Hearing and Appeals Board.

Academic probation and suspension

Any matriculated graduate student whose program cumulative GPA falls below a 3.0 after 12 quarter credit hours will be placed on probation and counseled by the departmental adviser concerning continuation in the graduate program.

Those students placed on probation must raise their program cumulative GPA to the 3.0 level within 12 quarter credit hours or be suspended from the graduate program.

Should it be necessary to suspend a graduate student for academic reasons, the student may apply for readmission to

the dean of the college or his designee upon demonstration of adequate reason for readmission.

Standards for student conduct

The RIT community intends that campus life will provide opportunities for students to exercise individual responsibility and places high priority on self-regulation by its members. All members of the community are responsible for encouraging positive behavior by others, as well as preventing or correcting conduct by others that is detrimental to RIT's educational mission and values.

As an educational community, RIT strives for a campus environment that is free from coercive or exploitative behavior by its members. Moreover, it sets high standards that challenge students to develop values that enhance their lives professionally and will enable them to contribute constructively to society.

RIT enjoys a diversity of backgrounds, lifestyles and personal value systems among those who compose the academic community. Students, however, are expected to observe and respect the policies and standards of the university and the right of individuals to hold values that differ from their own and those expressed by RIT. Students are encouraged to review the *Student Rights and Responsibilities Handbook* for information regarding campus policies and expectations of student conduct.

Students must recognize that they are members of the local, state and federal communities, and that they are obliged to live in accord with the law without special privilege because of their status as students or temporary residents.

RIT offers a number of services for graduate students. Those described in the following pages are among the most frequently used.

Student Services

RIT libraries

RIT libraries are comprised of three separate entities. In addition to Wallace Library, the Cary Collection and the RIT Archives are all housed within Building 5 on the RIT campus. Recently added resources include the Publishing and Scholarship Support Center (PSSC) and the Business and Entrepreneurship Resources Area.

Wallace Library is a high-technology multimedia resource center, which serves as the main library on campus. Its vast information resources are conveniently available via the Internet, and are a particular boon to busy graduate students. The library's online menu provides access to a wide selection of current electronic resources in Web-based and text formats. Users can easily access the library's online catalog, search electronic databases and surf the Internet. The staff offers hands-on instructional sessions for using various resources. Specialized class instruction can be scheduled upon request. Reference librarians are available during the week and on weekends to provide individual assistance at the RE:SEARCH ZONE on the library's first floor. In-depth assistance also is available by appointment. The Publishing and Scholarship Support Center provides a one-stop service for advice and assistance in preparing research, articles, books and other documents for publication.

Videotapes (VHS) and DVDs can be checked out at the circulation desk. Audio Books and wireless laptop computers also are available. The IDS (Information Delivery Services) department manages interlibrary loans, and patrons can request materials online through IDS Express. ConnectNY is a service that makes available the combined resources of (currently) seven academic libraries in New York State. Requests submitted online usually are fulfilled within 48 hours. The combined collection of ConnectNY member institutions exceeds 3 million items. The Rochester Regional Library Council's Access program allows graduate students to obtain a library card that offers access to other area libraries, including those of the University of Rochester and the State University of New York colleges in Geneseo and Brockport.

The Idea Factory is a multipurpose room on the first floor, featuring The Soap Box (for both impromptu and scheduled use), a living coral reef aquarium, an art gallery, numerous modular study tables and a conference area. Special library events are frequently held here, offering educational and recreational programs throughout the academic year. The Idea Factory is adjacent to the very popular Java Wally's café, a favorite spot for anyone interested in relaxing, studying or meeting in an informal setting. Also on the first floor is Wally's Book Nook, which features a constantly changing array of books on various topics of interest. Other recreational reading material is available in the 14-Day Collection.

The second-floor computer lab provides access to numerous state-of-the-art workstations, image scanning and color copying. Also located on the second floor, The Cary Library is a unique collection of more than 14,000 volumes of rare books illustrating fine printing and other materials detailing the history of printing, book design and illustration, papermaking and other aspects of the graphic arts. The RIT Archives collects, organizes, preserves and displays materials from the university's past. Located on the third floor of Wallace Library, it is housed in an environment that is temperature- and humidity-controlled for the preservation of paper and photographs. RIT Archives is the primary source for studying the history of the university.

The library is open more than 100 hours a week, with extended hours before and during finals. For library hours, call (585) 475-2046 (voice); for the RE:SEARCH ZONE, call (585) 475-2563 (voice/TTY) or (585) 475-2564 (voice). You can e-mail the library at 610wmlref@rit.edu. The circulation desk can be reached at (585) 475-2562 (voice) and (585) 475-2962 (TTY).

Information and Technology Services

www.rit.edu/its/
(585) 475-4357
Computing and network services at RIT are provided by Information and Technology Services (ITS).

Wireless, portal, and more

The campuswide network includes wireless capabilities in open public areas such as the Student Union, Crossroads Café, Wallace Library and in every college. Popular features are e-mail and access to the Internet, including Internet 2, and a second-generation Internet technology with increased broadband capabilities for better access to digital libraries, scientific instruments and other research applications. Many faculty have incorporated these features into their curricula.

A campuswide online portal is available at http://my.rit.edu. Users can customize their own site on the portal with personal Web links in addition to enjoying such standard features as access to student government and RIT sporting events, University News and the Student Information System, where individual student course information and grades are posted.

ITS, in conjunction with the Educational Technology Center, manages numerous computer labs and "smart" classrooms containing Windows and Macintosh workstations and printers. Most of these facilities are available to students for general computing use and to faculty for reserved class work. Lab assistants help people use the hardware and software available in the labs.

Computer security and safeguards

Computer and network use is guided by the RIT Code of Conduct for Computer and Network Use. This document, located at http://www.rit.edu/computerconduct, outlines RIT's official policy related to ethical use of computing and network resources. ITS has put into place multiple safeguards to protect RIT's network environment and the integrity of individual user accounts.

Computer accounts are issued to students, faculty and staff so that they can perform activities supporting educational goals

and internal RIT functions. Students can automatically generate a computer account through a link on the e-mail confirming their initial tuition deposit. Forms for faculty and staff accounts are available by contacting the HelpDesk: www.rit.edu/its/help/forms.

Computer training and consulting services
ITS also provides consulting services, seminars and computer training courses. Mobile learning assistants help faculty, staff and students with specific computer tasks. ITS also offers computer-based training modules covering a wide variety of topics. Students, faculty and staff can access numerous online courses in the areas of technology, e-business and business/interpersonal skills. For more information on computer-based training or to log onto the system, go to http://www.rit.edu/eLearningZone.

Student employment information
ITS employs more than 250 students and is one of the largest student employers at RIT. Student employment opportunities are available at the ITS HelpDesk, in Desktop Support, at colleges through Distributed Support Services and within Technical Support Services and Administrative Support Services. More specific information about job opportunities within ITS is available at http://www.rit.edu/its/about/student_employment. Additional information about student employment opportunities can be found at the Student Employment Office site at http://www.rit.edu/~967www.

Residential Networking (Resnet)
Resnet provides computer support to students living in residential housing at RIT. The Resnet team can assist students with getting their computers connected to the RIT network, accessing campus computing resources and troubleshooting computer software and hardware. Call Resnet at (585) 475-2600 (voice), (585) 475-4927 (TTY); email resnet@rit.edu or visit http://resnet.rit.edu

Access to the RIT Network from off-campus
RIT students, faculty and staff can obtain access to the RIT network from off campus through a virtual private network (VPN) or through dial-up. More information on these services is available at http://www.rit.edu/its.

Contacting the HelpDesk
The ITS HelpDesk is located in room 1113 of the Gannett Building (7B). Contact HelpDesk staff via telephone, e-mail, the Internet or TTY:

(585) 475-HELP (4357),
(585) 475-2810 (voice/TTY)
E-mail: helpdesk@rit.edu
Online: http://www.rit.edu/its/help

Service hours
Fall, winter, and spring quarter hours
Monday-Thursday: 7:30 a.m. to 9 p.m.
Friday: 7:30 a.m. to 5 p.m.
Saturdays: Noon to 6 p.m.
Sundays: Noon to 6 p.m.

Summer quarter, holidays, and quarter breaks
Monday-Friday: 7:30 a.m. to 5 p.m.
Saturday/Sunday: Closed

Cooperative Education and Career Services

The Office of Cooperative Education and Career Services offers a wide range of programs and services to support the career development and employment needs of all RIT students. The office offers one-on-one advising as well as job search seminars and presentations. It also provides online access to employment opportunities. Working relationships with thousands of employing organizations can help graduate students develop their individual job search plans. Graduate students are encouraged to meet with their assigned program coordinator in the Office of Cooperative Education and Career Services early to begin their career planning. Information is available through the office website at www.rit.edu/co-op/careers, or by visiting the office on the first floor of the Bausch and Lomb Building. Individual appointments can be made by calling (585) 475-2301.

Educational Technology Center

The Educational Technology Center (ETC) provides services that enhance and support the educational environment.

ETC's media production services produces educational and informational media for faculty and staff. These include video, multimedia/Web, graphics and photography/digital imaging production. Media production services also captions video and other digital media.

The classroom learning technologies department deals with many aspects of classroom technology. Support covers the delivery and setup of projectors (slide, overhead and video/data) as well as TV/VCR/DVD carts; access to and training on installed classroom equipment; and the operation of equipment in academic auditoriums. ETC also supports the installation and maintenance of computer and video projection equipment and podiums in classrooms and lecture halls. Instructional services provides equipment and technical support to RIT student clubs and organizations.

The Media Resource Center provides media support to faculty, staff and students. The staff works with faculty to identify media within the collection and locate new media to support their curriculum needs. The collection consists of a variety of media formats, including videotape, DVD, audiotape and an art history slide collection. The various media formats are available for use in the classroom or the center's viewing area. Requests for captioning RIT-owned media (ETC or department collections) are coordinated by the center's staff.

ETC arranges an array of communication feeds including webcasts and satellite downlinks.

ETC is located on the lower level of Wallace Library. More than 70 students assist with production, classroom technology support and office duties. Individuals are invited to drop in and explore these resources. For further information, call (585) 475-2551 or visit www.rit.edu/~613www/etc.

Counseling Center

The RIT Counseling Center is located on the second floor of the August Center. The center offers a variety of services to hearing, deaf and hard-of-hearing RIT graduate students. These include:

- Personal/Psychological Counseling
- Crisis Intervention
- Career Counseling
- Career Resource Center
- Discover (Computer-Assisted Career Guidance)
- Testing
- Consultation
- Referral Services

Counseling Center hours are 8:30 a.m. to 4:30 p.m., Monday, Tuesday and Friday, and 8:30 a.m. to 7 p.m. Wednesday and Thursday, except during finals weeks, break weeks and summer quarter. During these periods, the hours are 8:30 a.m. to 4:30 p.m., Monday through Friday. For more information about counseling services, call (585) 475-2261 (voice/TTY), (585) 475-6897 (TTY), or check out our website at www.rit.edu/counseling.

Center for Religious Life

www.rit.edu/~320www/

The Center for Religious Life is unique in the RIT community. Recognizing the balance of mind and spirit, the center's interfaith staff provide worship and observances within diverse religious and cultural traditions. Several religious clubs also gather each week throughout the campus. Nondenominational Christian, Southern Baptist, Catholic, Muslim, Jewish, Hindu, Lutheran and Orthodox Christian are among the many communities serving campus needs and interests. In a time of intellectual and spiritual growth, the center establishes an affirming environment for students, faculty and staff to explore and discuss values informed by religious beliefs.

The Kilian J. and Caroline F. Schmitt Interfaith Center

RIT's Interfaith Center, a gift of Kilian and Caroline Schmitt and other generous donors, is located on the east side of the Student Alumni Union. It is a focal point for the diverse religious traditions within the university, housing two chapels, meetings rooms and offices for the campus ministry staff.

For more information, contact the coordinator of the Interfaith Center by phone at (585) 475-2135 (voice/TTY) or e-mail at efs0368@rit.edu.

Academic Support Center

The Academic Support Center provides instruction in reading, study skills, mathematics and writing. These services are available at no additional charge during the center's regular scheduled hours to all graduate students at the university and may be scheduled at the center, located on the second floor, north end, of the administration building. For more information about Academic Support Center services, call (585) 475-6682, or visit our website at www.rit.edu/SA/ASC.

Student Health Center

The Student Health Center provides primary medical care on an outpatient basis. The staff includes physicians, nurse practitioners, registered nurses, health educators, an alcohol/drug counselor and an interpreter for the deaf. Services are available by appointment. Health education programs are provided also.

The Student Health Center is located on the walkway linking the academic and residence hall areas of the campus. Students are seen Monday through Thursday, 8:30 a.m. to 7 p.m., and Friday, 8:30 a.m. to 4:30 p.m., by appointment. Emergencies are seen as need requires. Hours are subject to change and are posted.

The university requires students to maintain health insurance coverage—which they may purchase either on their own or through RIT—as long as they are enrolled at RIT.

The quarterly student health fee is mandatory for all full-time undergraduate students. Graduate and part-time students may pay either the quarterly fee or a fee for service. Some laboratory work ordered through the Student Health Center is not covered by this fee; there is a charge for this service. Prescription medicines may be purchased from local pharmacies or, for some specific prescriptions, from the Student Health Center. The health fee does not include prescription medications.

Questions about the Student Health Center should be directed to the office at (585) 475-2255 (voice) or (585) 475-5515 (TTY). Questions regarding the health insurance available through RIT should be directed to University Health Plans at (800) 437-6448.

RIT Ambulance

RIT Ambulance is a New York State certified volunteer ambulance service that serves the campus community, including its adjoining apartment complexes. The organization, an auxiliary of the Student Health Center, is governed by RIT students and staff and is staffed by emergency medical technicians. Twenty-four-hour ambulance service is available seven days a week. If for some reason RIT Ambulance is not available, there may be a charge for services provided by another corps.

For *emergency* assistance/transport, RIT Ambulance can be dispatched through Campus Safety at (585) 475-3333 (voice) or (585) 475-6654 (TTY).

Health records

Medical records are confidential. Information will not be released without the written consent of the student. Exceptions to this rule are made only when required by the public health laws of New York State, a court ordered subpoena or in a life threatening situation.

New York State and RIT immunization requirements

New York State Public Law 2165 requires that all matriculated students enrolled for more than six quarter credit hours in a term and born after January 1, 1957, must provide RIT's Student Health Center with proof that they have received the appropriate immunizations against measles, rubella and mumps. Immunization requirements include two measles vaccinations, at least one month apart, with a live virus after January 1, 1968, and after the first birthday; and one vaccination each against mumps and rubella, after January 1, 1969, and after the first birthday. RIT requires all students under 26 years of age who live in campus housing and are enrolled for at least four credit hours to be immunized against meningitis (meningococcal disease). Other immunizations required by RIT include hepatitis B, DPT, polio, Td booster, and PPD (for students from high-risk areas). Additional information concerning these requirements, the necessary documentation and where it must be sent is included with the Admissions Office acceptance packet and also is available from the Student Health Center office.

Emergencies, Escort Service

In case of emergency, call the university's 24-hour emergency number, (585) 475-3333 (V/TTY). For routine security services, call (585) 475-2853 (V/TTY), which is staffed 24 hours a day.

Public Safety strongly encourages students to use the Mobile Escort Service, available seven days a week, 11:30 p.m. to 3 a.m., on a timed basis. Call (585) 475-2853 (V/TTY), or use the blue-light courtesy call boxes located throughout the campus.

Information about Public Safety services, security procedures and crime statistics can be found in the Public Safety Report, which can be obtained by calling (585) 475-6963. Our services also are explained on our website: http://finweb.rit.edu/campussafety.

The Advisory Committee on Public Safety will provide, upon request, all campus crime statistics as reported to the United States Department of Education. The designated RIT contact person can be reached at (585) 475-6620. Campus crime statistics also can be found at http://ope.ed.gov/security/search.asp.

Parking and Transportation Services

The Office of Parking and Transportation is responsible for administering the parking and transportation services at RIT. The office's policy requires that all vehicles operated on campus by students, faculty and staff must be registered within 10 days of arrival on campus. Students do not need to be the owner of the vehicle to register it. Navigating a large campus that provides parking for thousands of students, employees and visitors daily can be challenging. With that in mind, transportation services are provided for all constituents. A shuttle service makes regularly scheduled stops at all RIT apartments, NTID and academic areas throughout the school year.

The Parking and Transportation Services office is located in Grace Watson Hall and is open Monday through Friday from 8 a.m. until 5 p.m. during the academic year. Summer hours may vary.

Bus and shuttle services: Transportation Services operates a van service for those with impaired mobility. The service runs Monday through Friday, 7 a.m. to 6 p.m., during fall, winter and spring quarters. The transportation division also provides vans for use by student groups, clubs and organizations. For more information, call the transportation office at (585) 475-7300 or the front desk at (585) 475-2074.

Parking permits and vehicle registration: All vehicles operated on campus must be registered with the parking office annually. Vehicle registration decals must be properly displayed on each vehicle. Fines are imposed for those in violation of RIT parking and traffic regulations. The vehicle registration process can be completed online at www.rit.edu/parking.

Handicap parking permits: RIT honors ADA-approved handicap parking permits from every state. Handicap parking permits can be obtained at your local municipalities for handicap permits. Resident students can apply for a New York state permit at the Town of Henrietta. The parking office does issue a one-week temporary handicap permit

Campus Connections

Campus Connections, RIT's bookstore, is located on the west side of the Student Alumni Union and sells everything from clothing to textbooks and computers. You also may make purchases online at bookstore.rit.edu. After completing your course registration process you will be prompted to order your books online. They will be packed and waiting for you at the pick-up window. (Be sure to sell your books back at the end of the semester, too!)

The bookstore accepts cash, checks, MasterCard, VISA and RIT's Tiger Bucks as payment.

Housing Operations

Serving nearly 7,000 students, RIT's campus housing offers many living options to meet the diverse needs, interests and backgrounds of RIT students.

RIT Inn and Conference Center

The RIT Inn and Conference Center is a smoke-free facility and offers students fully furnished double rooms with private baths. Included in each room is a TV with standard cable service, a phone with free local service, high-speed Ethernet and air

conditioning. Students have access to a heated indoor/outdoor pool, sauna, whirlpool, fitness center and laundry room. Full shuttle service to campus also is available. Students with cars receive a reserved parking pass to the lot of their choice. RIT Inn housing is available to graduate students on a space-available basis.

Apartment Housing

RIT has five apartment complexes with nearly 1,000 apartment and townhouse units. The five complexes—Colony Manor, Perkins Green, Racquet Club, Riverknoll and University Commons—differ in layout and design. Apartments range in size from one-, two- and four-bedroom units; townhouses have two or three bedrooms.

Although the majority of apartment residents are undergraduates, some graduates can be found in each apartment complex. Apartment contracts run from September through May. Security deposits are not required. A modified meal plan also is available to apartment residents through RIT's Food Service Department. University apartment housing is available to graduate students on a space-available basis. For further information on RIT housing, contact Housing Operations at http://housing.rit.edu, or call (585) 475-2572 (voice) or (585) 475-2113 (TTY).

Housing Connection

A service of Housing Operations, Housing Connection is designed to meet the general housing needs of the RIT community. Housing Connection is the only on-campus clearinghouse for apartment residents in need of additional roommates, providing a continually updated listing of available roommates and their specific interests.

Located in Housing Operations in Grace Watson Hall, Housing Connection provides free maps, information pamphlets and telephones for users of the service. A trained staff member will assist you in your search for housing or roommates. For more information, go online at www.rit.edu/~hcwww, stop in or call (585) 475-2575.

International Student Services

With several programs receiving worldwide recognition, RIT enrolls more than 1,300 full-time international students from approximately 100 countries.

International Student Services is located in the Center for Student Transition and Support and serves as a resource for all deaf and hearing international students, as well as for members of the campus community seeking cross-cultural help. The staff advises students on immigration issues, helps them adjust to academic and cultural expectations in the United States and provides cross-cultural programs. In addition, the office coordinates off-campus programs through the Rochester International Council.

International student clubs on campus offer social activities throughout the year. Campus housing options include International House, a special-interest residence hall floor offering a community experience for both international and American students.

International Student Services offers orientation each quarter. In the fall, the Peer Adviser Leader program matches up returning students with new students to help with their adjustment to RIT and the United States.

The International Student Services office is located on the upper level of the Student Alumni Union. For more information, call (585) 475-6943 (voice/TTY), or visit our website at www.rit.edu/internationalservices.

Margaret's House

Child Care Programs

Margaret's House is a state-licensed and nationally accredited child care center offering full-day quality care and education for children 8 weeks to 8 years of age. It includes a district-approved full-day kindergarten as well as after school, vacation and summer programs. It is open to children of RIT students, faculty and staff, and to members of the greater Rochester community. Margaret's House is located on campus and is open year round. Call for information and registration materials.

- Infant and toddler programs: 8 weeks to 36 months
- Preschool programs: 3- and 4-year olds
- Full-day kindergarten/after-school programs: 5- to 8-year olds
- "Lil" Kids on Campus summer program for children entering grades 1 through 4

Contact Roberta DiNoto at (585) 475-5176 (voice/TTY) or rxdhcc@rit.edu.

Kids on Campus Programs

Kids on Campus provides a variety of innovative academic workshops along with sports activities. Programs are characterized by a dynamic, project-oriented approach to learning. Kids on Campus is for students entering grades 5 through 10. A full-day program is offered during July.

Kids on Campus programs are offered to all Rochester-area students. Call for information and registration material and check the website at http://kidsoncampus.rit.edu. Contact Susan Kurtz at (585) 475-5987 or sfkldc@rit.edu.

Veterans Services

Courses and programs at RIT are approved for the education of veterans under the Veterans Readjustment Benefits Act, the Rehabilitation Acts and the War Orphans Act.

To receive benefits, an eligible veteran or dependent must submit an application for the VA Certificate of Eligibility. This application must be sent to the VA Regional Office in Buffalo, N.Y., well in advance of the beginning of the starting quarter. These applications are available at local VA offices, or on campus from the Office of Part-time Enrollment Services.

To ensure a smooth transition and successful academic program completion, start your benefits paperwork early. For benefits assistance or information, call (585) 475-6641.

Commission for Promoting Pluralism

The Commission for Promoting Pluralism was established to formulate a plan of action that would address seriously and deliberately the subject of pluralism and community-building in every part of the university. Its evolution is the result of an identified need for RIT constituents to deepen their respect and appreciation for all people in the RIT community and beyond. This institutional focus attempts to:

- proactively identify and eliminate barriers that restrict equality throughout the RIT community;
- develop and implement programs that promote commitment to equality and justice in campuswide activities; and
- develop and nurture a support system that increases participation by all members of the RIT community.

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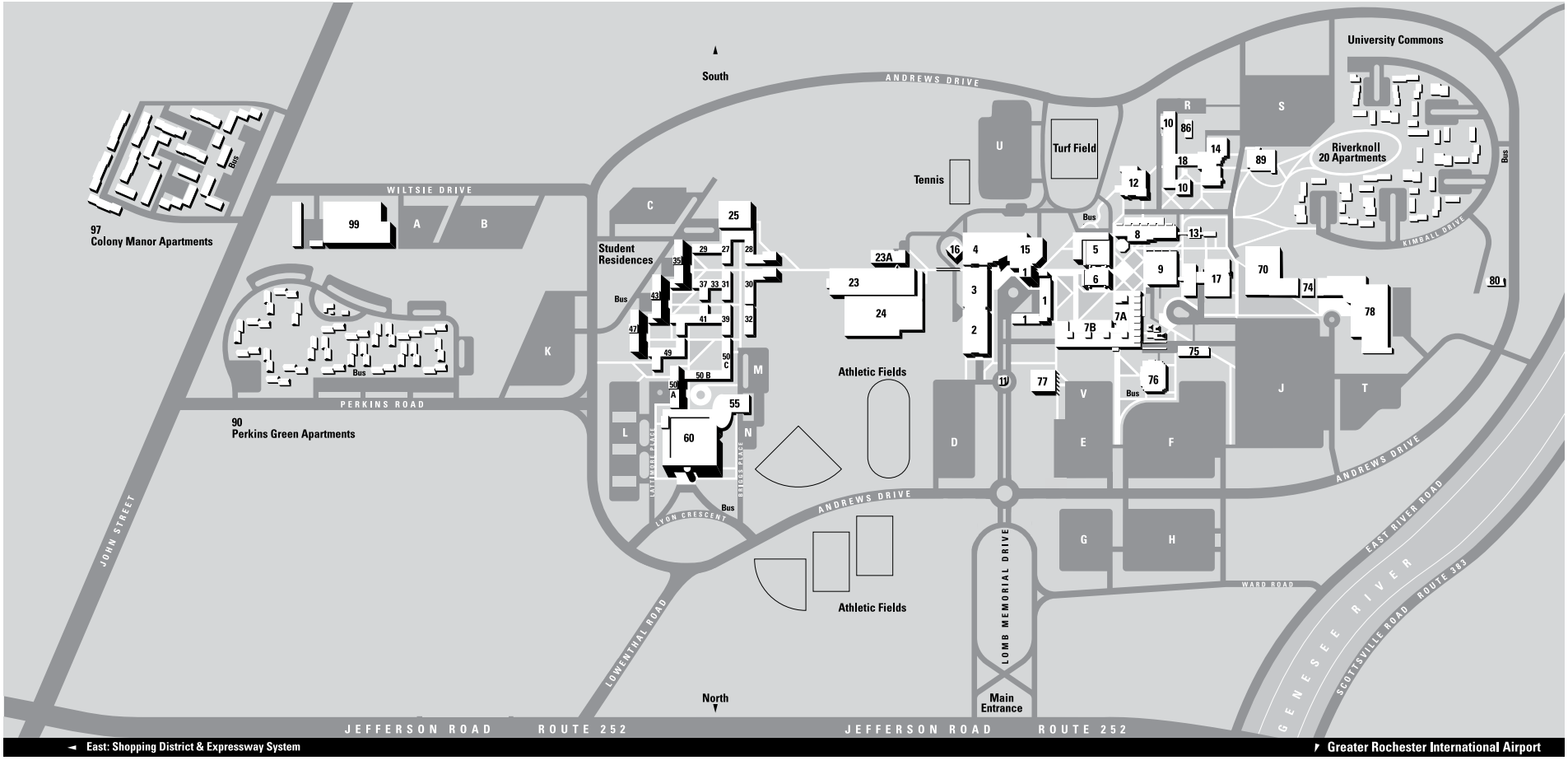

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Activity Center
25 Grace Watson Hall
55 Hettie L. Shumway Commons
60 Lyndon Baines Johnson
Building
70 College of Applied
Science and Technology,
B. Thomas Golisano
College of Computing and
Information Sciences
74 Laboratory for Applied
Computing
75 Center for Bioscience
Education and Technology
76 Chester F. Carlson
Center for Imaging Science
77 Bausch & Lomb Center
78 Louise Slaughter Building
86 Building 86
89 Crossroads Building
99 Facilities Management

RIT Student Residences

20 Riverknoll Apartments
90 Perkins Green Apartments
97 Colony Manor Apartments
27 Francis Baker Hall
29 Francis Baker Hall
28 Fraternity and Sorority Housing
30 Fraternity and Sorority Housing
32 Fraternity and Sorority Housing
31 Eugene Colby Hall A, B
33 Eugene Colby Hall C, D, E
37 Eugene Colby Hall F, G
35 Kate Gleason Hall
39 Helen Fish Hall A, B
41 Helen Fish Hall C, D, E, F
43 Nathaniel Rochester Hall
47 Sol Heumann Hall
49 Carleton Gibson Hall
50A Mark Ellingson Hall
50B Peter Peterson Hall
50C Alexander Graham Bell Hall,
University Commons

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