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GENERAL INFORMATION

MILWAUKEE SCHOOL OF ENGINEERING
ACADEMIC CALENDAR 2002-2004

Fall Quarter (11 Weeks)	**2002**	**2003**
Registration	May 1 - Sept. 6	May 7 - Sept. 5
Labor Day	Monday, Sept. 2	Monday, Sept. 1
Classes Begin 8 a.m.	Monday, Sept. 9	Monday, Sept. 8
End of Fall Quarter 5 p.m.	Saturday, Nov. 23	Saturday, Nov. 22
Commencement Exercises	Saturday, Nov. 23	Saturday, Nov. 22

Winter Quarter (11 Weeks)	**2002-2003**	**2003-2004**
Registration	Nov. 6 - Nov. 27	Nov. 5 - Nov. 26
Thanksgiving Day	Thursday, Nov. 28	Thursday, Nov. 27
Classes Begin 8 a.m.	Monday, Dec. 2	Monday, Dec. 1
Christmas Recess Begins 5 p.m.	Saturday, Dec. 21	Saturday, Dec. 20
Classes Resume 8 a.m.	Monday, Jan. 6	Monday, Jan. 5
End of Winter Quarter 5 p.m.	Saturday, March 1	Saturday, Feb. 28
Commencement Exercises	Saturday, March 1	Saturday, Feb. 28

Spring Quarter (11 Weeks)	**2003**	**2004**
Registration	Feb. 12 - March 7	Feb. 11 - March 5
Classes Begin 8 a.m.	Monday, March 10	Monday, March 8
Easter Recess Begins 10 p.m.	Thursday, April 17	Thursday, April 8
Classes Resume 8 a.m.	Monday, April 21	Monday, April 12
End of Spring Quarter 5 p.m.	Saturday, May 24	Saturday, May 22
Commencement Exercises	Saturday, May 24	Saturday, May 22

Summer Quarter

The schedule of classes may vary during the summer term. A variety of attendance options are offered from six- to 11-week sessions. Contact the Registrar's Office at (414) 277-7215 to receive a Timetable of Classes and further information.

All new students will be notified concerning registration dates.

UNIVERSITY OVERVIEW

Vision Statement

MSOE will always be at the forefront of professional education with emphasis on both theory and technology, coupled with intensive laboratories and career practice.

Mission Statement

MSOE provides a sustained interactive educational climate for students to become well-rounded, technologically experienced graduates and highly productive professionals and leaders.

Institutional Principles

The fundamental beliefs of Milwaukee School of Engineering are the following:

- The focus is on the individual student.
- Lifelong learning is essential for success.
- Dedicated faculty with relevant, up-to-date experience are the heart of our teaching process.
- Scientific and mathematical reasoning and processes are essential.
- Applied research and evolving and interdisciplinary technologies are vital in exploiting opportunities.
- The development of communication skills is needed to function effectively.
- The student experience is strengthened by interaction with the business, industry and health care fields.
- The development of leadership and entrepreneurial characteristics is essential.
- Students, faculty, staff and volunteers all share the responsibility of learning.
- Strong personal values are necessary for success.
- The alumni strengthen the institution through their counsel, encouragement and support.
- Freedom with responsibility is the foundation of free enterprise.
- There is strength in diversity.
- Global awareness must be reflected in all activities.
- Initiation and acceptance of change is required to anticipate and capitalize on opportunities.

History

At the turn of the 19th century, American industry began a period of rapid expansion. This accelerated the use of electrical and mechanical power. As a result, new occupations emerged in technical fields. Engineers and technicians with knowledge and skill were badly needed, but few people were available who had a combined technical training and formal education. Industry's need spurred the development of progressive programs of technical education.

In this context, Oscar Werwath organized the School of Engineering of Milwaukee in 1903. Werwath was a practicing engineer who was a graduate of European technical schools. He was the first person to plan an American engineering educational institution based on an applications-oriented curriculum. Milwaukee industries were vitally interested in this kind of training and called on Werwath to provide education and training for their employees.

From the beginning, leaders of business and industry cooperated in the institution's development, and a close relationship was established that has continued throughout MSOE's history. These early supporters realized that their future depended upon educational institutions that could prepare men and women to fill the newly created engineering and managerial positions.

In 1932, MSOE became a private, nonprofit, nonstock institution governed by a Board of Regents comprising leaders from business, industry and the professions. MSOE is an independent coeducational institution that is incorporated under the laws of the State of Wisconsin.

Today, MSOE offers 16 bachelor's degrees and six master's degrees.

Location

MSOE is located on the prestigious east side of downtown Milwaukee and just a few blocks from Lake Michigan. This central location gives students easy access to Milwaukee's business and industrial centers. The location also provides access to Milwaukee's major cultural and artistic facilities including: the Milwaukee Repertory Theater, the Marcus Center for the Performing Arts, the Bradley Center, the Milwaukee Public Museum, and the Midwest Express Center, to name but a few. The Lake Michigan lake front and the Henry W. Maier Festival Park (Summerfest) grounds provide additional cultural and recreational opportunities.

In addition to on-campus programs, MSOE also offers courses leading to master's degree programs in engineering and engineering management in Appleton, Wis., and selected courses at other sites around the state. Refer to the "Location Options" section of this catalog for further details.

Graduate Degree Programs

MSOE offers six Master of Science Degree programs:

- Engineering (MSE)
- Engineering Management (MSEM)
- Environmental Engineering (MSEV)
- Medical Informatics (MSMI)*
- Perfusion (MSP)
- Structural Engineering (MSST)

*Offered jointly with Medical College of Wisconsin.

Class sizes tend to be small, averaging nine students per class.

Questions about any of the graduate programs offered by MSOE may be directed to the individual program directors (see the particular graduate program description within this catalog for name and phone number of program director), or the Enrollment Management Department at (414) 277-6763 or (800) 332-6763.

All of these programs are explained in detail in later sections of this catalog.

Undergraduate Degree Programs

MSOE's undergraduate degree programs are described in a separate publication, the *Undergraduate Academic Catalog*. To view the *Undergraduate Academic Catalog* go to www.msoe.edu or contact the Enrollment Management Department at (414) 277-6763 or (800) 332-6763.

Accreditation

MSOE is accredited by the Commission on Institutions of Higher Education of the North Central Association of Colleges and Schools (NCA, 30 N. LaSalle St., Suite 2400, Chicago, IL 60602-2504, (312) 263-0456).

The Master of Science in Perfusion program is accredited by the Commission on Accreditation of Allied Health Education Programs (CAAHEP, 35 E. Wacker Dr., Suite 1970, Chicago, IL 60601-2208, (312) 553-9355).

Affiliations

MSOE holds institutional membership in the Wisconsin Association of Independent Colleges and Universities, the American Society for Engineering Education, the American Medical Informatics Association, the College Entrance Examination Board, the College Scholarship Service Assembly, the National Collegiate Athletic Association – Division III, the Council for the Advancement and Support of Education, Associated Schools of Construction, the College Board, the National League for Nursing and the American Association of Colleges of Nursing.

MSOE is also a member of the Metropolitan Milwaukee Association of Commerce, the Greater Milwaukee Visitors and Convention Bureau, and the Better Business Bureau of Greater Milwaukee.

The Academic Year

The official academic calendar of MSOE is published in the front of this catalog. The academic year is divided into three 11-week quarters, September through May, followed by a summer quarter that is used in some academic programs.

Location Options

Milwaukee Campus

With the exception of some of the classes in the MSMI program, all graduate programs are offered on MSOE's main campus, located on Milwaukee's east side. The MSMI program is offered jointly by MSOE and the Medical College of Wisconsin, and courses are offered at both sites. The MSOE campus is convenient to the interstate system. In the evening, parking is free to registered students.

Southeastern Wisconsin

For the MSEM program, in addition to MSOE's main campus, courses are offered in several locations in southeastern Wisconsin, including Racine/Kenosha, Brookfield/Waukesha and Port Washington/Sheboygan.

Fox Valley Region

Courses leading to the MSEM and the MSE degrees are offered in Appleton, Wis. Students may obtain admission information by calling (800) 332-6763.

On-site Company Locations

On-site offerings are feasible for companies with 10 or more employees who share a common educational need. Course work for the MSE and MSEM programs is currently conducted at on-site company locations in the Milwaukee vicinity. In some cases, students not necessarily employed by a particular company are permitted to enroll in courses on-site at the company. For more information regarding on-site offerings, contact the director of corporate education, and manager of outreach sites (414) 277-6763.

Internet Courses

Graduate courses have been offered via the Internet. Questions regarding the specifics of access, requirements and use should be directed to the faculty member or department chair for a course listed in the Timetable of Classes as an Internet offering.

Research Facilities

The ***Applied Technology Center™ (ATC)*** is the research arm of the university. It serves as a technology transfer catalyst among academia, business and industry, and government agencies. The close association between MSOE and the business and industrial community has long been one of its strengths; applied research serves as a renewable resource in this linkage.

- Rapid Prototyping Center
- Center for BioMolecular Modeling
- Fluid Power Institute™
- Electrical and Computer Programs
- Photonics and Applied Optics Center
- High Impact Materials and Structures Center
- Construction Science and Engineering Center
- High Speed Video and Motion Analysis

The ***Rapid Prototyping Center (RPC)*** is a joint effort of industry, government and MSOE that is dedicated to the application of proven technologies to novel challenges. MSOE is the only university that has a laboratory devoted to all five commercially-available rapid prototyping systems – stereolithography (SLA), laminated object manufacturing (LOM), selective laser sintering (SLS) fused deposition modeling (FDM) and laser machining and engraving. Rapid prototyping historically has been a tool for reducing product development cycle times. The RPC continues to advance the state-of-the-art in this area, using computer-based manufacturing techniques and complementary processes to reduce the time and cost of industrial products ranging from functional models to full-scale production. The RPC also is extending the use of rapid prototyping through research projects as diverse as biomolecular and biomedical modeling to architectural modeling. Rapid prototyping programs at MSOE currently include the Rapid Prototyping Consortium that comprises more than three dozen industrial and educational members, the Research Experience for Undergraduates, and a research-based rapid prototyping curriculum. MSOE received 40 patents from Procter & Gamble – one of the company's largest donations ever – which is the basis for a major research undertaking by the RPC.

Established in 1991, the Rapid Prototyping Consortium continues MSOE's tradition of building strong ties to business and industry. The Consortium includes industrial companies and educational institutions that cooperate in understanding the Consortium's vitality and success is a high level of industrial parts design and fabrication activity. The Consortium actively is involved in state-of-the-art research in rapid tooling. Companies that take advantage of the facilities and expertise within the Consortium become stronger and more competitive. Member companies include or have included SC Johnson, Harley-Davidson, Snap-on, Northeast Wisconsin Technical College, Master Lock, Kohler, Waukesha Engine, the IDEX Companies, STA-RITE, J.W. Speaker, Dickten & Masch Manufacturing, Gardner-Denver, MSC Technologies, Ford Motor Co. and Amway Corp.

The National Science Foundation funds the Research Experience for Undergraduates program. It facilitates student exploration in the field of rapid prototyping and cuts across virtually all disciplines. Undergraduate students are recruited from throughout the country to research rapid prototyping applications in the biomedical, architectural, aerospace, biomolecular, manufacturing and electronics industries.

MSOE's 12-module rapid prototyping curriculum is a major collection of rapid prototyping knowledge based on research performed at MSOE and elsewhere. Through the curriculum, students are engaged in multi-disciplinary, team-oriented projects conducted at the cutting edge of a wide variety of different engineering fields.

The ***Center for BioMolecular Modeling*** provides the creation of accurate 3-D molecular models for education and research purposes. Work currently is being conducted for the National Institutes of Health, the National Science Foundation and science education groups.

The ***Fluid Power Institute™*** was established in 1962 as one of the first of its kind in the country and has remained a pioneer in motion control and fluid power education and technology transfer activities. It has expended into electrohydraulic interface studies and currently has active programs in fluid power systems design, applications of fluid power to manufacturing, computerized fluid dynamics (CFD), electromagnetic actuators and sensors, component evaluation, and filtration and contamination testing. From a survey of all U.S. universities, MSOE was selected by Caterpillar – together with Purdue University – as a partner in a long-term Master Sponsored Research Agreement in the field of electrohydraulics.

Electrical and Computer Programs include projects in which the primary technologies are software, computer hardware and electronic or electrical systems. Selected capabilities to create, simulate, breadboard, analyze and test electrical or software-based solutions to real world requirements are available.

The ***Photonics and Applied Optics Center*** features a wide array of state-of-the-art optical photonic apparatus and instrumentation. The Center includes large optical tables, HeNe lasers, laser diodes, a 30-mW argon-ion laser, optical power meters, computer-controlled grating monochrometers, optical time-domain reflectometers, a large variety of fiber-optic components and piezofilm/angular rate sensors. Spectral analysis, communication sensing, and many other optical and photonic applied research projects can be undertaken.

The ***High Impact Materials and Structures Center*** is developing concepts for blast-resistant cargo containers capable of mitigating explosions on aircraft flights for the Federal Aviation Administration (FAA). Participating faculty have significant industrial experience and knowledge in the areas of shock-holing, dynamic structural analysis, materials testing and advanced materials design. Design recommendations involve fabricating the container using advanced composites, providing the greatest protection and ruggedness with the least weight and cost to airlines. The university plans to consolidate design information and make it available to companies through a national materials database. The analytical methods and experimental approaches developed at MSOE can be applied to several areas, including high-speed machining of materials, large forging processes and analysis of accident effects.

The ***Construction Science and Engineering Center*** provides leadership and support to the building design and construction industries through a variety of channels. The Construction Science and Engineering Center is the combination of the applied research activities of the faculty of the Architectural Engineering and Building Construction Department, and the full range of activities in the Construction Science and Engineering Center Laboratory. Activities include:

- developing and testing new structural materials, components and systems;
- creating information technology solutions;
- hosting continuing education programs; and
- ensuring that MSOE graduates are prepared to implement new technologies when entering industry.

The ***High Speed Video and Motion Analysis*** system has the ability to digitally capture – and immediately play back – events in the 1,000 to 12,000 frames per second range, enabling the user to analyze situations otherwise impossible with conventional video or with the eye. Since the system is portable, it can be taken to any point of interest. Powerful motion analysis software can be used to track and graph up to nine points in the visual field.

Types of Projects

Interdisciplinary capabilities provide a major advantage and can span fields such as engineering, science, business, computers and technical communication. Faculty, staff and students who undertake applied research projects represent all aspects of the university's curricula – architectural, biomedical, computer, industrial, software, electrical and mechanical engineering and technology, plus construction management, nursing, mathematics, physics and chemistry, business, and technical communication. The research projects involve expertise in a variety of areas, such as CAD-CAM, plant layout, environmental engineering, finite element stress/thermal/fluid dynamic analysis, materials, product and process design, wind tunnel testing, and many others. ATC research assistantships involve both undergraduate and graduate students working on student projects and internships.

Modes of interaction include directly funded projects, consultation, federally funded Small Business Innovation Research (SBIR) and Small Business Technology Transfer Research (STTR) grants, consortia work, technology licensing and subcontracts. Applied research is done by faculty with industrial experience – often with research assistants, and student and class projects in engineering and business disciplines – coordinated with company and faculty advisers. Student internships provide part-time or summer employment and future employment opportunities for students. Referrals serve as an initial contact point for networking with others to optimize expertise and facilities for technology transfer.

The Applied Technology Center™ undertakes more than 250 company-sponsored projects annually supporting business, industry and governmental sectors with design, development and evaluation of products, processes, and manufacturing systems. Staff can construct and evaluate prototypes and assist in providing technology transfer, helping to fulfill the global objectives of applying engineering talents for the betterment of life for all people.

Research Assistantships

MSOE offers a limited number of graduate research assistantships. Selection is based upon available funds, project personnel requirements and student qualifications. Feb. 1 is the application deadline for an assistantship that is awarded for the subsequent fall quarter. Assistantships may be available at other times of the year, based on additional funding and program activity.

Graduate research assistants are assigned to the ATC. All assistantship candidates must be accepted for graduate study by MSOE, and submit a letter of interest detailing areas of expertise along with a current resume to the following address: Graduate Admission, Enrollment Management Department, 1025 North Broadway, Milwaukee, WI 53202-3109, USA. Allow at least 60 days for processing the application once all materials are received.

Position Obligations and Benefits: This is a 12-month appointment, renewable for subsequent years based on funding, the student's work performance and academic progress. Students will normally receive both of the following awards:

- ***Research Assistantship:*** Student typically will be assigned a specified number of hours of research or ATC project work per week over 12 months.
- ***Tuition Scholarship:*** Student must take at least six credits of course work per academic quarter (summers optional), leading to the M.S. degree in two-to-three years. No tuition will be charged for courses needed for the degree, providing they meet graduate degree program requirements. Each tuition scholarship award will be made based on a student's academic record, potential to succeed in the program and related work experience.

No other (outside) employment is allowed. To be eligible for the research assistantship, applicants must be enrolled as graduate students at MSOE by virtue of course work or continuous enrollment. No teaching or classroom-related work will normally be expected of research assistants. Occasionally, a graduate student will assist in running a laboratory.

Students must maintain satisfactory graduate student academic standing to retain their position.

Research with Human Participants

The ***Institutional Review Board (IRB)*** is an administrative body established to protect the rights and well being of human participants recruited to participate in research activities. MSOE complies with requirements set forth in Title 45, Part 46 of the Code of Federal Regulations (45 CFR 46), known as the "Common Rule," regardless of the source of project funding.

All students, staff and faculty at MSOE planning on conducting research involving human participants must submit an IRB protocol for review and approval by the MSOE Institutional Review Board. Review and approval must be completed before research has begun. The review ensures the research plan adequately has protected the rights and well being of human participants. If the investigator is a student, the research must be performed under the supervision of a MSOE faculty or staff member who by his or her signature assumes responsibility for the conduct of that research with respect to the proper safeguards of the rights of participants.

Research is defined (45 CFR 46.102(d)) as "a systematic investigation, including methodology, development, testing and evaluation, designed to develop or contribute to generalizable knowledge." This definition includes formal investigations from which the results will be publicly disseminated, pilot projects, exploratory research and research undertaken by students for purposes of classroom work, independent study, project work, or theses.

Human Participant is defined (45 CFR 46.102(f)) as "a living individual about whom an investigator conducting research obtains data through intervention or interaction with the individual, or identifiable private information." Intervention generally includes both physical procedures by which one gathers data and manipulations of the subject or subject's environment. Private information includes information about behavior that occurs in a context in which the subject can reasonably expect that no recording is taking place or information the subject has provided for a specific purpose can reasonably expect will not be made public.

IRB protocol packets are available in the Applied Research and Grants Office, S-149. Contact Ann Bloor, grant project administrator, at (414) 277-7237 for more information or assistance in writing the protocol.

Library Resources

The Walter Schroeder Library is a service-oriented facility committed to serving the research, study and other information needs of MSOE's students, faculty and staff. Housing more than 60,000 volumes in support of the university's specialized curricula, the library features a collection that consists of books, magazines, newspapers, standards, senior design projects, microfiche, videos and other media programs. The library's catalog, Horizon, can be accessed via the campus network, as well as via the Web at www.msoe.edu/library. The library additionally catalogs and houses master's theses and essays completed in graduate programs at MSOE.

In addition to its specialized collection, the library provides a number of services and resources for members of the MSOE community. An extensive array of online databases is available at the library's Web site. Online databases particularly helpful to graduate students include the ABI/Inform business and management database, Applied Science & Technology, Ei Compendex Engineering database, FirstSearch, Environmental Sciences & Pollution Management database, and the IEEE Computer Society Digital Library. Many of these databases provide the full text of articles published in leading journals and magazines. The library also provides electronic books through such resources as the Books24x7 e-book database. All Web-based databases are remotely accessible for members of the MSOE community.

Library services particularly helpful for graduate students include interlibrary loan and document delivery, database training, online reference help, and extensive research and documentation help. The library belongs to a number of resource sharing consortia that enable it to obtain materials from other libraries from around the world. The library additionally is responsible for maintaining and providing support for the documentation and style format guidelines that are employed in MSOE's graduate programs. The guidelines are available at the library's Web site.

Audiovisual equipment and materials are available through the Audiovisual Center in the library, which also houses the unique and valuable "MSOE MMAC Business and Management Video Collection."

Group study rooms, photocopiers, Internet research desktop computers and the Gene Carter Desktop Media MacIntosh Computer Laboratory also are available in the library.

Computer and Communication Services Department

The Computer and Communication Services Department (CCSD) is responsible for the planning, development, maintenance and administration of the university's computing resources. CCSD is comprised of two main branches: the academic, dealing with educational functions, and the administrative, dealing with such things as student records, financial aid and telecommunications.

Students are assigned their own computer accounts while attending MSOE. These accounts enable students to send and receive Internet and local e-mail, access other Internet applications, and use of PC network and systems applications. Students may also have a personal Web page, which links from the MSOE home page, www.msoe.edu, if they wish.

Help Desk is located in room S-301. Call (414) 277-7288, or fax (414) 277-7495 or (414) 277-7508.

Placement Services

The Placement Office provides placement assistance to graduate students and alumni. Services include job listings, a reference library, career and job search videos, the Career Net Web site and graduate school information. The Placement Office also can assist in providing salary information, resume and cover letter assistance, developing a job search strategy, and improving interview skills.

The Placement Office coordinates the university's internship program, sponsors the annual Career Fair and hosts employers who come to campus to conduct employment interviews. Part-time and summer job listings are available.

The Placement Office is located in the Student Life and Campus Center, Room CC-370.

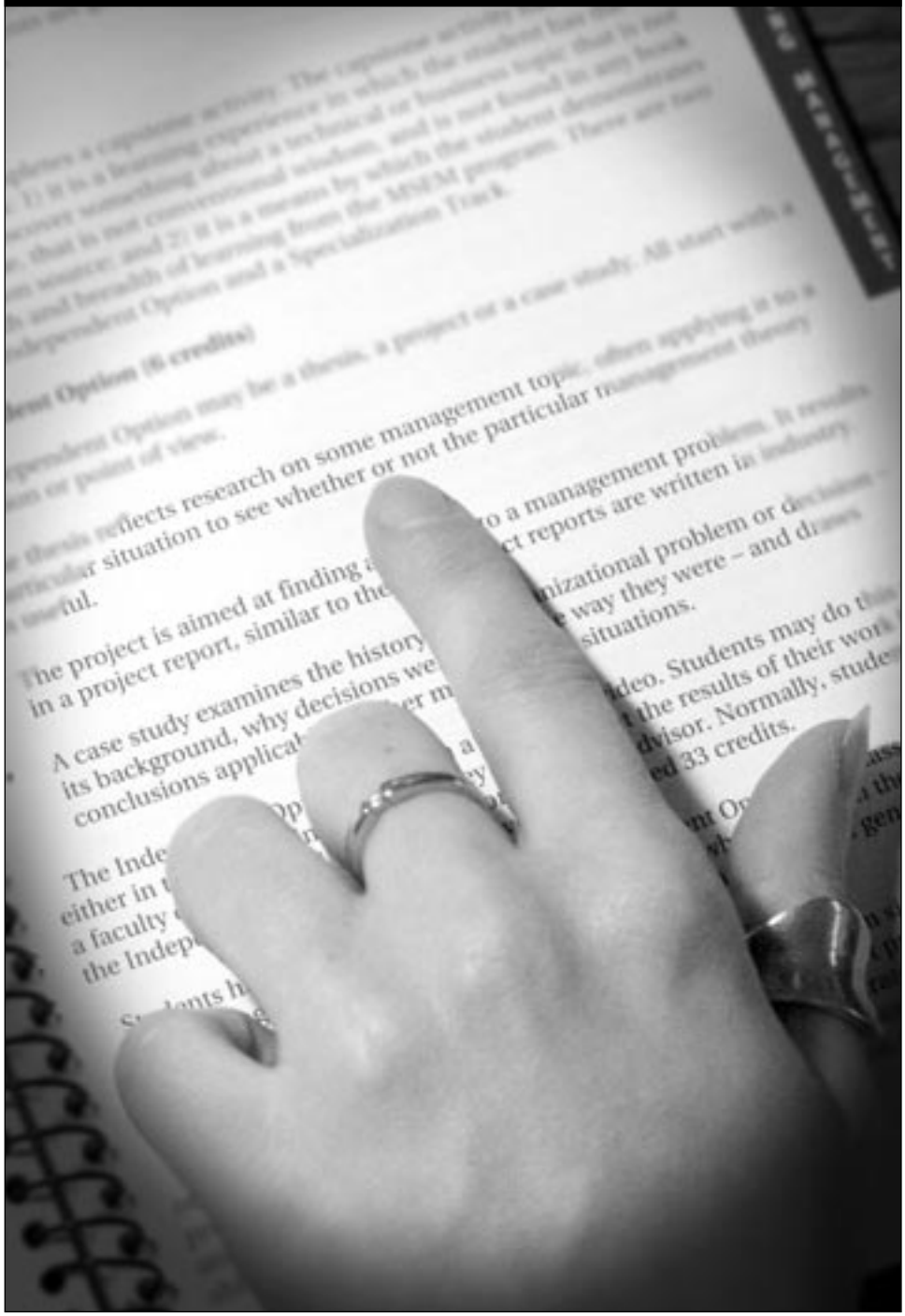
Graduate Student Housing

MSOE operates three residence halls located just a few blocks from classrooms and laboratories. These facilities offer quiet floors, suites and a full-service food operation. Although undergraduate students comprise the largest segment of the resident population, the residence halls do offer an on-campus option to the graduate student. The Housing Department can provide more information on what is available and how personal needs might be accommodated.

Renting off-campus housing from one of the many independently owned rental units near the university provides an alternative.

B

GRADUATE ADMISSION REQUIREMENTS



GENERAL REQUIREMENTS

Admission materials may be obtained from the Enrollment Management Department at (414) 277-6763 or (800) 332-6763. The address is listed later in this catalog under "Application Procedures."

General requirements for all graduate programs at MSOE include the following (also see specific program requirements):

1. Completion of a baccalaureate degree in a discipline appropriate for the graduate program to which the applicant seeks admission (see "Program-specific Requirements" section).

2. An academic record that indicates potential achievement in graduate studies. See program specific requirements pertaining to grade point average (GPA) and the need for standardized examinations, such as the Graduate Record Examination (GRE).

3. Two letters of recommendation.

4. Completed application and fee.

5. Official transcripts sent directly from all colleges and/or universities previously attended. A fee will be assessed for the translation of each transcript that is in a language other than English.

6. For applicants whose native language is not English, language proficiency must be demonstrated by one of the following methods:

    a. Submit an official transcript indicating receipt of a baccalaureate or graduate degree from a U.S. college/university or other institution where the language of instruction is English.

    b. Submit an official test score from the Test of English as a Foreign Language (TOEFL) with a score of 550 or higher.

    c. Submit proof of satisfactory completion of Level 109 of intensive English study at any English as a Second Language (ESL) Center in the United States.

7. International student applicants who will require immigration documents issued by MSOE must submit a certified bank statement or notarized *MSOE Financial Certificate,* detailing the availability of finances for the first year of study (including tuition and living expenses). If transferring from another institution that has issued immigration documents, an *MSOE Transfer Form* also must be submitted.

PROGRAM-SPECIFIC REQUIREMENTS

Master of Science in Engineering (MSE)

1. A bachelor of science degree in engineering, engineering technology or a closely related area.

2. Specific course requirements include one course in computer programming (e.g., Fortran or C++ programming), one year of calculus, one course in differential equations, two courses in physics and one course in chemistry. Additionally, the following courses are required: one course in statics, one course in dynamics, one course in thermodynamics, one course in circuit analysis, and one or more courses in digital logic and microprocessors. It is expected that the applicant has earned a letter grade of "C" or better in each of these required undergraduate courses.

3. Test scores from the GRE general test if an applicant's undergraduate GPA is less than 3.00 (on a 4.00 scale). Test scores must be submitted prior to regular acceptance into the MSE program. Applicants are expected to submit scores that indicate potential for success in the MSE program, including scores from the "Quantitative" and "Analytical" test sections that are each in the upper 50 percentile of those tested.

4. Prior to registering for any classes, the accepted applicant is required to speak with the MSE program director, either by phone or in person, to plan a course of study.

Master of Science in Engineering Management (MSEM)

1. A baccalaureate degree in engineering, engineering technology, science, business, management or a related area.

2. At least three years of professional, full-time work experience in engineering or management. This requirement may be waived for applicants who will be working full-time in such a position while attending the program.

3. Computer literacy, knowledge of word processing and spreadsheet software, and a personal computer (laptop recommended) with a modem and private Internet access.

4. Two letters of recommendation. If employed, at least one of the letters should be from the applicant's employer or manager.

5. Test scores from the GMAT or GRE if the applicant's undergraduate GPA was below 2.80 (on a 4.00 scale). Test scores must be submitted prior to regular acceptance into the MSEM program. Applicants are expected to submit scores that indicate potential for success in the MSEM program.

6. Completion of an advisory briefing within the first year of enrollment is highly recommended. The briefing may be completed in either a group session or individual conference, either by phone or in person, with the MSEM program director.

Master of Science in Environmental Engineering (MSEV)

1. A bachelor of science degree in architectural engineering, civil engineering, mechanical engineering or a closely related area.

2. Specific course requirements include one year of calculus, two courses in physics, and one course in each of the following: general chemistry, inorganic chemistry, statistics, differential equations, fluid mechanics and thermodynamics. A "C" or better must have been earned in each of these required courses.

   Most students entering the program who hold a bachelor of science degree in a traditional engineering field from an ABET-accredited institution are expected to have the required undergraduate courses. Students who hold an engineering degree but lack some of these courses, or students who hold other technical degrees, may need to complete deficient undergraduate course work in order to meet all the admission requirements. These students may be permitted to begin course work on a conditional basis, and are generally expected to complete all such requirements within one year. Such admission decisions are made on a case-by-case basis.

3. Test scores from the GRE general test if an applicant's undergraduate GPA is less than 2.80 (on a 4.00 scale). Test scores must be submitted prior to regular acceptance into the MSEV program. Applicants are expected to submit scores that indicate potential for success in the MSEV program.

4. Prior to registering for any classes, the accepted applicant is required to meet with the MSEV program director, either by phone or in person, to plan a course of study.

Master of Science in Medical Informatics (MSMI)

1. Minimum undergraduate degree GPA of 3.00 (on a 4.00 scale).

2. GRE or GMAT general test scores having percentiles that average 60 percent or better, or a Medical College Admission Test (MCAT) average of nine on the individual scores. (This requirement is waived for individuals with a graduate degree.)

3. Transcripts should show proof of undergraduate course work in college algebra, introduction to statistics, introduction to computers, computer programming and medical terminology.

4. If your native language is not English, a score of 580 or better must be achieved on the Test of English as a Foreign Language (TOEFL). There are additional application filing requirements for international students.

5. Prior to registering for any classes, the accepted applicant is required to speak with the MSMI program director, either by phone or in person, to plan a course of study.*

*Please note that applications are evaluated in their entirety. If applicants are deficient in one or more areas, they still are encouraged to apply and we may be able to recommend ways to complete the prerequisites and requirements.

6. Three reference letters. If employed, at least one of the letters should be from the applicant's employer or manager.

7. A personal essay stating why the applicant wishes to pursue this degree.

Master of Science in Perfusion (MSP)

Academic Requirements:

1. Applicants must have earned a bachelor of science degree in an appropriate discipline with an undergraduate GPA of at least 2.80 (on a 4.00 scale).

2. Required undergraduate course work must include at least one course in human physiology (or anatomy and physiology) and one class in calculus. Recommended course work includes biochemistry, physics and statistics.

3. GRE general test scores having percentiles that average 50 percent or better.

4. Three letters of recommendation, two of which must be from faculty members who can judge the applicant's academic abilities.

Clinical Requirements:

1. Applicant must have observed at least two clinical cases under the direction of a Certified Clinical Perfusionist prior to the personal interview. These can be arranged by the clinical program director.

2. Submit to the Clinical Committee a current resume.

3. Successful completion of a personal interview with the Clinical Committee, composed of the clinical program director and at least two clinical faculty members.

Master of Science in Structural Engineering (MSST)

1. A bachelor of science degree in an architectural, civil, or structural engineering program, or a closely related degree.

2. Specific course requirements include indeterminate structural analysis, structural steel design, reinforced concrete design and soil mechanics. Applicants who hold an engineering degree, but lack some of the specific course requirements, or applicants who hold closely related degrees, may need to complete deficient undergraduate course work. Applicants may be permitted to begin course work on a probationary status. Such decisions are made on a case-by-case basis.

3. Test scores from the GRE general test may be required from applicants whose undergraduate GPA is less than 2.80 (on a 4.00 scale). In such cases, test scores must be submitted prior to regular acceptance into the Master of Science in Structural Engineering program. Applicants may be permitted to begin course work as nonmatriculated students if the test scores have not been submitted by the time of initial enrollment. Applicants are expected to submit scores that indicate potential for success in the program.

4. Prior to registering for any classes, the accepted applicant is required to speak with the program director, either by phone or in person, to plan a course of study.

TYPES OF ACCEPTANCES

Full Acceptance

A student who has satisfied all requirements for admission will achieve full acceptance.

Probationary Acceptance

Probationary acceptance is used in cases where there is some uncertainty in the applicant's ability to succeed in the program, such as marginal undergraduate performance, and it is therefore appropriate to carefully monitor the applicant's performance. The probationary status ends when the conditions stated on the probationary acceptance letter have been met; for example, completion of two terms with at least a "B" average. Until full acceptance, probationary students may have restrictions imposed on the graduate courses they are permitted to take. Students on probation must consult quarterly with their respective graduate program director prior to registering for the next quarter's classes.

Conditional Acceptance

Students that have satisfied admission requirements but are missing required prerequisite course work may enroll in graduate courses on a conditional acceptance status. Students must successfully complete all prerequisite course work to be considered for full acceptance into a graduate program. Conditional acceptance is not a guarantee of full acceptance into a graduate program.

Nondegree Status

Nondegree status is available for those who wish to take graduate courses but not pursue a degree. Applicants should submit a graduate application marked "Nondegree," a $30 application fee and an official transcript showing receipt of a bachelor's degree. Nondegree students are expected to meet the same requirements that are expected of regular graduate students in the courses they take, receiving grades and graduate credit for courses completed.

Students who are under the nondegree status may apply for official acceptance at any time. Credits earned while under the nondegree status will be reviewed to determine if they will be counted toward satisfying program requirements. Not more than three courses (nine credits) taken as a nondegree student are transferable to a degree program.

Nonmatriculated Student Status

Applicants may be eligible to register for one term as a nonmatriculated student. The nonmatriculated student status allows a student to begin course work without being accepted into an academic program. Students should contact the Enrollment Management Department to inquire about eligibility.

Registration as a nonmatriculated student is no guarantee of subsequent acceptance into a graduate program. Registration as a nonmatriculated student allows the student to take only one term's course work. Subsequent registrations are expected to be under full or probationary acceptance status.

INTERNATIONAL STUDENT APPLICANTS

Nonimmigrant international students holding the F1 visa are required to take a course load of at least nine credit hours as a condition of their visa. The student must document that he or she has sufficient funds for living expenses. Additional funds must be available for dependents.

MSOE has a very limited number of research assistantships and does not provide other financial aid or scholarships for nonimmigrant, alien graduate students, nor does it employ teaching assistants.

The United States Department of Immigration does not permit students from other countries to work during their first year of school. Permission to work part time (up to 20 hours per week) after the first year can be granted only by the Department of Immigration, and only on the basis of a change in financial circumstances that would make it impossible to continue in school without income from part-time employment.

Prior to the release of the Immigration Form I-20, a deposit of $100 is required of all accepted international applicants who are not sponsored by a corporation or their government. The deposit is refundable if the student does not enter the United States by using the I-20 form issued by MSOE. If the student enters the United States by using the I-20 form, but does not enter MSOE, no refund is made.

International students should have a superior command of both written and spoken English. Language proficiency must be demonstrated as mentioned previously. International graduate student applicants should submit all application materials at least 90 days prior to the start of the academic term in which they wish to enroll.

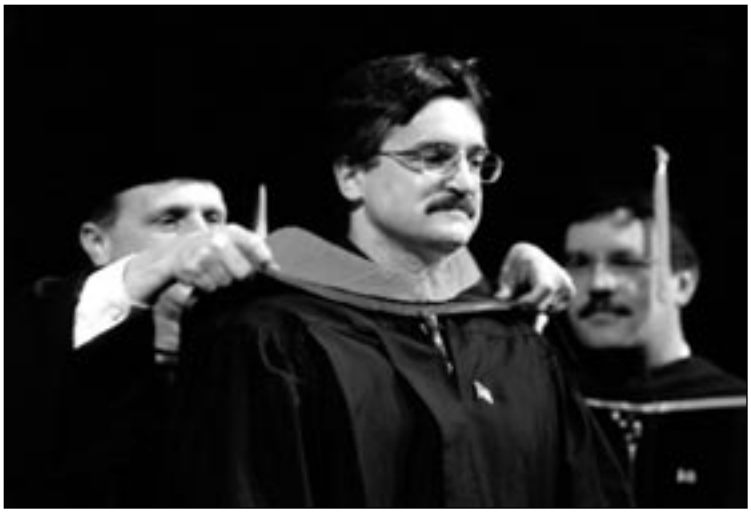
APPLICATION PROCEDURES

Applicants should submit an application, official copies of all undergraduate and graduate course work, letters of recommendation, application fee and appropriate test scores to the following address:

Graduate Admission
Enrollment Management Department
Milwaukee School of Engineering
1025 North Broadway
Milwaukee, WI 53202-3109
USA

The application and letters of recommendation may be submitted online at www.msoe.edu/grad/. Any questions may be directed to (800) 332-6763.

Upon receipt of all materials, application files are reviewed by the graduate admission committee. Students will be promptly notified of their acceptance status. International graduate student applicants should refer to the previous section for additional information.



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ACADEMIC REGULATIONS AND POLICIES

REGISTRATION

All new students are required to register in person prior to the start of the academic quarter. Students should check the Timetable of Classes for that quarter or contact the Enrollment Management Department for specific dates and times to register. During registration, a student's curriculum is reviewed, course selection is done, and parking permits and student identification cards are issued. Please note that some programs (e.g., the MSEV program) require that the student confer with the program director to choose an appropriate program of study prior to registering. The student needs to significantly plan in advance of registration to meet with the program director.

Current students may register in person, by mail or by fax. Registration forms are sent to students about a month before the start of each quarter. Tuition payment is required as outlined in the "Graduate Tuition" section of this catalog.

MSOE reserves the right to revise admission rules, rules regarding the granting of degrees, tuition and fees, and any other regulations affecting its students at any time. MSOE will exercise the normal means of communication announcing revisions. MSOE also reserves the right to exclude, at any time, any student whose conduct or academic standing is regarded as undesirable.

STUDENT FINANCIAL SERVICES
(WWW.MSOE.EDU/FINAID)

MSOE's Student Financial Services Office is available to assist graduate students in obtaining financial aid, exploring alternative loan products and coordinating individualized payment plans. The following information is a brief summary of available financial programs, information on applying for financial aid and payment plan information. We encourage all students to visit our Web site at www.msoe.edu/finaid for more detailed information. If you have any questions or want further information, feel free to contact Student Financial Services at (800) 778-7223 or finaid@msoe.edu.

How to Apply for Aid

Apply for a PIN (Personal Identification Number) from the U.S. Department of Education (DOE). This process can be completed online at www.pin.ed.gov. The PIN is used as your electronic signature when applying for aid. You should receive your PIN from the DOE within two weeks of application.

Once you have your PIN, you can apply for aid by completing the Free Application For Federal Student Aid (FAFSA). You may do so online at www.fafsa.ed.gov. If you wish to apply in the traditional manner with a paper application, feel free to contact our office.

Eligibility

Admitted graduate students who are not in default or owe a repayment on any federal aid program are eligible for need-based and non need-based federal student loans. A student must be enrolled in a minimum of three graduate credits per quarter to be eligible for student loans, and deferment of student loans.

Loan Programs

Subsidized Stafford Loans

- Eligibility for Stafford Loans is based on your need as determined by your application for aid.
- You borrow through a lender (bank, credit union, etc.) and the DOE guarantees the loans. Feel free to review our preferred lender list on our Web page.
- The DOE pays your interest while you are in school or deferred status.
- There is a six-month grace period prior to entering repayment.
- The interest rate is variable and set yearly on July 1 by the government but can never go higher than 8.25 percent.
- Interest payments may be tax deductible.
- Annual limit for subsidized Stafford is $8,500.

Unsubsidized Stafford Loans

- Eligibility is based on cost vs. need.
- Interest begins to accrue at the time of disbursement.
- Annual limit is $18,500 (less any subsidized amount borrowed).
- All other criteria is the same as the subsidized Stafford Loan.

Graduate Student Tuition Payment Plans

MSOE offers a variety of payment options to graduate students.

Payment in Full

Financial Aid

Monthly Payment Plan

Direct Billing to Employer

Tuition Reimbursement

All options require the completion of a payment plan agreement. To review the details of available payment options, the agreement can be obtained via the Web at www.msoe.edu/finaid and clicking on the Payment Plan Agreement link or by contacting the Student Accounts Office.

Students are required to be current according to their chosen payment option in order to register for subsequent terms.

Refund Policies

Students NOT Receiving Financial Aid

Prior to the start of classes	100%
During the first week of the quarter (*Minus $50 withdrawal fee)	100%
During the second week of the quarter	80%
During the third week of the quarter	40%
During the fourth week of the quarter	20%
After the fourth week of the quarter	No Refund

*Students withdrawing completely during the first week will be assessed a $50 fee.

Students Receiving Title IV Financial Aid

Refunds are calculated for a student who totally withdraws from the university. A student is considered to have withdrawn when ALL classes for which a student is registered in any given term are subsequently dropped. Title IV aid is defined as any financial aid directly administered or regulated by the U.S. Department of Education or its third party service providers.

If a recipient of Title IV aid withdraws before completing 60 percent of the term, MSOE is required by law to calculate the amount of Title IV aid the student did not earn. The amount of unearned aid equals the difference between aid that was disbursed to the student or could have been disbursed to the student for the term and the amount of Title IV aid that was earned. Refunds are calculated on a percentage basis through the 60th percentile of any given term.

Graduate Tuition

	2001-2002	2002-2003
Per Credit Hour	$440	$462
Perfusion Full Time*	$7,250	$7,605
Application Fee	$30	$30
Transcript Translation Fee (other than English)	$725	$760
Directed Study (per credit hour)	$650	$690
Audit Fee	3/4 of normal tuition for the course	
Continuation Fee (GC-899)	$100	$100

*Perfusion students will be required to purchase liability insurance. The cost of this coverage varies from year to year. More information on costs may be obtained from the program director.

PROCEDURE FOR CHANGING GRADUATE PROGRAM

A student wishing to change from one graduate program of study to another must submit a new application for admission, obtained from the Enrollment Management Department. New letters of recommendation will be required, and the student will be subject to any other application requirements for the program to which the student is applying. If the student's new application is accepted, the student's previously completed course work will be evaluated for transfer into the new program (see "Transfer of Graduate Credit" section). Only those registrations subsequent to acceptance into the new program will be counted in the student's cumulative GPA.

GRADING

Graduate students are expected to earn at least a "B" grade in all course work attempted. Graduate students are not allowed to repeat a class for which a letter grade has been earned unless given permission by the program director. If a graduate course is repeated, then both grades will count toward the student's cumulative GPA. MSOE uses the following grading system for graduate level courses:

Letter Grade	Numerical Equivalent	Interpretation
A	4.00	Excellent
AB	3.50	Above Expectations
B	3.00	Meets Expectations
BC	2.50	Below Expectations
C	2.00	Minimally Acceptable for Graduate Credit
F	0	Failure

For those courses in the Master of Science in Medical Informatics program (i.e., courses with the MI-prefix), MSOE uses the following grading system:

Letter Grade	Numerical Equivalent	Interpretation
A	4.00	Excellent
A-	3.70	Significantly Above Expectations
B+	3.30	Somewhat Above Expectations
B	3.00	Meets Expectations
B-	2.70	Somewhat Below Expectations
C+	2.30	Below Expectations
C	2.00	Significantly Below Expectations
C-	1.70	Minimally Acceptable for Graduate Credit
F	0	Failure

All letter grades listed in the above tables that are received for graduate courses completed at MSOE are included in the calculation of the average. To receive the degree, the student must attain a 3.00 cumulative GPA.

A letter grade followed by an asterisk is a temporary grade indicating incomplete work. The letter preceding the asterisk indicates the grade the student will receive if the work is not completed. An incomplete grade is given at the discretion of the instructor. It is the responsibility of the student to make arrangements within the first two weeks of the following quarter (not including summer) to complete the course. The student must submit the required work to complete the course within the time deadline set by the instructor, but this may not be later than the end of this same quarter. If the student has not completed all work for the course after this period of time, the asterisk will be dropped and the temporary letter grade will become the permanent grade.

Students who are unable to complete course work due to business travel, health or other factors are urged to either arrange with the instructor for an incomplete grade or officially drop the course. Otherwise, an "F" grade may be assigned for the course. See the Timetable of Classes for information on drop dates.

ACADEMIC PROGRESS REQUIREMENTS

MSOE expects all students to complete their academic objectives as outlined under the "Grade Point Requirement" and the "Maximum Time Period" sections that follow. In addition, students are expected to follow the prescribed sequence of courses for the degree program selected, observing all course prerequisites and corequisites.

Grade Point Requirement

A student is expected to maintain a cumulative GPA of at least 3.00 in any graduate program. The cumulative GPA is calculated on the basis of all graduate courses completed or attempted at MSOE with final grades to which grade points are assigned. This would exclude, for example, a project course graded on a pass/fail basis when a pass (P) grade is earned. The cumulative GPA will include courses completed at the Medical College of Wisconsin (MCW) for students in the MSMI program. The cumulative GPA will be recorded on grade reports and on the student's permanent record each quarter. A student also is expected to maintain a program GPA of at least 3.00, calculated on the basis of all MSOE graduate courses applicable toward the degree being pursued (including those at MCW for students in the MSMI program).

A student whose cumulative GPA falls below 3.00 in any given quarter will be placed on academic probation. Each graduate-level program may impose restrictions on registration privileges for students on academic probation.

A student whose cumulative GPA falls below the minimum given in the table below, where "N" is the number of graduate credits over which the GPA is based, will be subject to academic termination.

N = Number of Graduate Course Credits for Cumulative GPA	Minimum Cumulative GPA
5 or less	2.00
Between 6 and 20, inclusive	2.30 + (1/30)N
21 or more	3.00

Individual graduate programs may impose additional requirements (for example, a minimum program GPA) that, if not met, would also cause a student to be subject to academic termination.

Grade Appeals and Termination from a Graduate Program

A student who receives a letter grade of "F" in a graduate class may be subject to enrollment termination.

A student who wishes to dispute any grade in any graduate class, including a grade of "F," must appeal to the graduate program director of the program in which the course involving the disputed grade is offered. The decision of the program

director regarding the disputed grade can be appealed to the department chairperson having responsibility for the course involving the disputed grade. This decision can be appealed to the vice president of academics. The decision of the vice president of academics in the grade dispute matter is considered final.

A student who has been terminated from a graduate program due to academic difficulty may appeal the termination decision to the Graduate Student Advancement Subcommittee of the Graduate Programs Council (GPC). The student must resubmit a written petition to the Registrar's Office, addressed to the Graduate Student Advancement Subcommittee of the GPC. The decision of the GPC's Graduate Student Advancement Subcommittee will be final.

Maximum Time Period

A student in the MSE, MSEM, MSEV or MSST has a maximum of seven years from his/her initial enrollment in a graduate course to complete all degree requirements. A student in the MSMI program has a maximum of five years to complete all degree requirements. A student in the MSP program is expected to complete the program's requirements at the end of the six consecutive quarters of enrollment, including summer, of his/her initial matriculation and has a maximum of two years to complete all degree requirements. Any student failing to complete all degree requirements within the deadlines described should consult with his/her program director and request a time extension (described below).

Time Extensions

Students having a valid reason for being unable to meet deadlines established by MSOE for completion of the graduate degree programs (see above for specific time limits) may appeal in writing to the program director for an extension of time of up to one year. The decision of the program director may be appealed to the Graduate Programs Council. An appeal for an extension of more than one year must be approved by the GPC's Graduate Student Advancement Subcommittee.

The request for an extension must explain why the deadline was not or will not be met and propose substitute deadlines.

DIRECTED STUDY ENROLLMENT

In the event that a student is unable to schedule a specific course, he/she may be eligible to register for the Directed Study program. This program provides one-on-one instruction with an MSOE faculty member. Generally, permission for such registration is granted only if the course is essential to the student's program of study and if he/she is registered for his/her last quarter before graduation or is within nine credits of graduation. Permission will be granted subject to the availability of appropriate faculty. A student seeking this registration may obtain the proper form from the Registrar's Office. Students must contact the appropriate program director for approval. The Directed Study program is not available to MSEM students because of the wide variety and frequency of course offerings.

POLICY ON STUDENT INTEGRITY

As an institution of higher learning, MSOE is committed above all to the educational development of its students as responsible and principled human beings, and is an institution accountable in this regard to all whom it serves and by whom it is scrutinized. MSOE has a priority interest in promoting personal integrity and in ensuring the authenticity of its graduates' credentials.

The university is similarly mindful that both the professions and business and industry have, for a long time, been concerned with the ethical, no less than the professional, practice of their members and employees. It follows, therefore, that students of MSOE – preparing for professional careers and leadership roles that are founded on responsibility and trust – must observe and be guided by the highest standards of personal integrity both in and out of the classroom.

The expectations of the university with respect to academic and classroom integrity are reflected in, but not limited to, the following guidelines:

1) The student must recognize that even a poorly developed piece of work that represents his or her best efforts is far more worthwhile than the most outstanding piece of work taken from someone else.

2) Assignments prepared outside of class must include appropriate documentation of all borrowed ideas and expressions. The absence of such documentation constitutes "plagiarism," which is the knowing or negligent use of the ideas, expressions or work of another with intent to pass such materials off as one's own.

3) The student should consistently prepare for examinations so as to reduce temptation toward dishonesty.

4) A student may not share examination answers with others for the purpose of cheating, nor should he or she, through carelessness, give them an opportunity to obtain the same.

5) The student should know that a person of integrity will not support, encourage or protect others who are involved in academic dishonesty in any way, and will furthermore attempt to dissuade another student from engaging in dishonest acts.

The institutional policy that follows includes prescribed procedures for the assigning of penalties by instructors in instances of academic dishonesty as well as procedures for student appeals of such actions. A student who in any way acts dishonestly in class assignments or examinations or who submits a plagiarized or unoriginal work to an instructor shall be subject to sanctions up to and including an "F" grade for the assignment, examination and/or the course at the discretion of the instructor of the course. The numerical value of the "F" will be assigned by the instructor. If the instructor assigns an "F" for the course, the student will not be allowed to drop the course. If the instructor assigns an "F" for academic dishonesty, the student has the right to appeal following established procedures. Upon recommendation of the instructor or at his own initiation, the vice president of Academics may decide that repeated or extremely serious acts of dishonesty may be grounds for more severe disciplinary action up to and including student expulsion.

The student will be notified by the faculty member either within three academic working days of the faculty member's awareness of the problem or at the next class session attended by the student. The faculty member will notify the student using the form designed for notification. A copy of this notice will be sent to the department chairperson and the vice president of Academics. The vice president of academics will retain all such reports in a permanent file.

The procedure outlined in steps 1-7 below will be used if a student wishes to appeal a faculty member's judgment that academic dishonesty has occurred.

1) The student will have three academic working days after delivery of the written notification to initiate an appeal to the chairperson of the department in which the faculty member serves. The student will be deemed to have waived his/her right to appeal unless he/she files the appeal with the department chairperson within these three academic working days. The statement of appeal must specify each denial of the faculty member's decision and the substance of the contentions upon which the student intends to rely in his/her appeal. Filing notices of appeal in accordance with these provisions shall not suspend the operations of the sanction previously declared in the case by the faculty member. The student will remain in class during the entire appeal process.

2) The department chairperson will have three academic working days in which to review the appeal. The sole purpose of the department chairperson's review is to determine if sufficient evidence exists that the student was engaged in academic dishonesty. The chairperson must inform the student and faculty member of his/her judgment within those three academic working days.

3) The student or faculty member may further appeal to the vice president of academics within three academic working days.

4) The vice president of academics shall convene an academic review board to hear the student's appeal within a reasonable time (if possible, within three academic working days of the appeal). The academic review board shall be made up of two department chairpersons selected by the vice president of academics, and one faculty member selected by the vice president of academics and agreed upon by the person initiating the appeal. The vice president of academics will be a nonvoting chairperson. The faculty member assigning the penalty and his/her department chairperson may not be on the board.

5) The sole purpose of the academic review board is to determine if sufficient evidence exists that the student was cheating. The academic review board shall render its decision after all sufficient evidence has been presented, but in a time period not to exceed three academic working days from the commencement of its proceedings. The decision of the academic review board in appeal cases is final and cannot be further appealed under procedures established herein.

6) All appeals established by this procedure must be in writing.

7) The student may bring a representative to any meeting established under this procedure. The faculty member may also have representation at any meeting. If a student wishes to appeal the penalty, such an appeal must be in writing and must follow the procedure on graduate "Grade Appeals" and "Termination from a Graduate Program" appearing elsewhere in this catalog.

CONTINUOUS REGISTRATION

Graduate students are required to be continuously registered until graduation after initiation of the master's project, thesis or other capstone activity. Students who initiated the master's project, thesis or other capstone activity and are not registered for three or more graduate credits in a quarter must register for GC-899 and pay the Continuation Fee associated with this course. Registration in the GC-899 will appear on the students transcript as a no credit course with no effect on the student's GPA. Students in the Master of Science in Perfusion program are required to be continuously registered for four quarters per academic year after initiation of the master's thesis. Students in other programs are not required to be registered for the summer program.

ACADEMIC ADVISING

Each degree program at MSOE has a designated program director who acts as mentor and academic counselor for all students in that program. Incoming students are provided with a catalog and program outline. For those students who meet all of the graduate admission requirements, the program outline identifies all required courses and the exact credit breakdown related to electives.

Most of the graduate programs require new students to meet with the program director prior to registering for the first course to ensure that the new students understand the curriculum and future scheduling procedures. Students are encouraged to call the program director or faculty adviser whenever they have questions on the program. In subsequent quarters, students whose cumulative grade point average falls below a specified minimum (normally 3.00) will be required to consult with the program director prior to registration.

The program director, designated faculty advisers, department chairpersons and the registrar work together to ensure that students in a particular degree program make satisfactory progress without violating prerequisites. Any attempt by students to schedule substitute courses not required or allowed may be questioned at the time of registration and will, in general, not satisfy the program requirements.

It is recommended that students with a designated adviser meet with him/her during each spring quarter to review their current academic program. At that time, they may discuss with the adviser a provisional study program for the next academic year.

COURSE PREREQUISITES

In choosing courses, students are expected to have the prerequisite work for each selected course. Prerequisites have been determined for each course so that the quality of instruction and content can be of the appropriate level for graduate education in that course. The prerequisite is assigned so that students taking a course will have adequate preparation and background to ensure the learning of new material. Students may encounter difficulties if they do not meet the prerequisites.

STUDENT ATTENDANCE POLICY

MSOE expects all graduate students to attend regularly and promptly all lectures, laboratories and other sessions of courses for which they are registered.

Graduate students are expected to attend and contribute to all class sessions. However, the faculty recognizes that business travel or other factors may force students to miss some classes. Students should notify their instructor as early as possible if they will be forced to miss a class, and they should make arrangements to make up any missed work. Unexcused absences may result in a lowering of the grade or being dropped from the course.

ADDING/DROPPING COURSES AND CHANGING SECTIONS

If a change of schedule is necessary, this may be done in the Registrar's Office before 4 p.m. on Friday of the first week of classes. **Students may neither add a course nor change sections after 4 p.m. on Friday of the first week.** This policy also must be followed by students taking courses available on a credit/noncredit basis who want to change from credit to noncredit status or from noncredit to credit status.

A student may drop a course and receive a grade of "X" after the first week and **before the close of business on Monday of the eighth week of classes.** Drop forms are available in the Registrar's Office. These must be completed, properly signed and received by the Registrar's Office before the deadline for dropping courses. Tuition refunds will be based on the date the completed form is received by the Registrar's Office, not on the date of last class attendance.

All students are responsible for their academic schedule. Students should not rely on instructors to drop them for nonattendance.

Students enrolled at off-campus locations are required to meet the same deadlines. Forms for adding/dropping courses are available on the Registrar's Office Web site and may be sent via facsimile to the Registrar's Office. For instructions, call the Registrar's Office at (414) 277-7215.

WITHDRAWAL FROM ALL CLASSES

Students who wish to drop all classes must complete a withdrawal form, which is available in the Registrar's Office. **This must be done before 4:30 p.m., on Friday of the 10th week of classes.** Tuition refunds will be based on the date of official withdrawal, NOT on the date of last class attendance. The official withdrawal date is the date that the completed form is received by the Registrar's Office. Should a student fail to meet the withdrawal deadline, he/she will be responsible for tuition for all scheduled classes and will receive final grades in all of them.

Students enrolled at off-campus locations are required to meet the same deadlines. Forms for withdrawing from all classes are available on the Registrar's Office Web site and may be sent via facsimile to the Registrar's Office. For instructions, contact the Registrar's Office at (414) 277-7215.

TRANSFER OF GRADUATE CREDIT

A maximum of nine credit hours (or three courses, whichever is less), of approved graduate work taken at another institution may be transferred with the consent of the appropriate program director. A course completed at another institution must meet the following conditions to be accepted for credit: (1) it was taken for graduate credit; (2) a grade of "B" or better was earned; and (3) it is essentially equivalent to a specific graduate course in the program at MSOE to which the student is applying (not to a generic course such as independent studies). Applicants should send a letter to the program director identifying the course(s) they wish to transfer and the MSOE course(s) for which they propose to substitute.

The letter also should contain any catalog course descriptions and course syllabi for the proposed transfer courses to assist the program director in assigning transfer credit.

AWARDING OF TWO MASTER'S DEGREES (MSE AND MSEM)

A student may pursue both the MSE and MSEM either concurrently or separately. For students pursuing both degrees, some credit may be shared between the two programs as described below:

Students Enrolled in Both Programs Before Fall 2000

Up to nine credits may be shared between the MSE and MSEM programs as follows:

1. Students may either use EN-700 (MSE) to satisfy the requirements for EM-630/EM-694 (MSEM), or may use EM-630/EM-694 (MSEM) to satisfy EN-700 (MSE).

2. Students may use one three-credit MSE course to satisfy three of the elective credits in the MSEM.

3. Students may use one three-credit MSEM course to satisfy the three elective credits in the MSE program.

Students Enrolled in Both Programs in/After Fall 2000

Up to six credits may be shared between the MSE and MSEM programs as follows:

1. Students may use one three-credit MSE course to satisfy three of the elective credits in the MSEM.

2. Students may use one three-credit MSEM course to satisfy the three elective credits in the MSE program.

AUDITING A CLASS

To audit a course, a student must be accepted by MSOE as a regular or nondegree graduate student. The student must have an appropriate background in the course subject area. At the completion of the audit, no letter grade is issued and no graduate credit is awarded. A notation is made on the student's transcript of successful/unsuccessful audit based upon the course requirements. The tuition rate for audit of graduate level course work is specified in the Timetable of Classes for any given quarter.

UNDERGRADUATE/GRADUATE COURSES

Courses whose numbers start with "5" are generally open both to undergraduate students and graduate students. The instructor will typically give additional assignments to the graduate students.

Undergraduate/Graduate courses have a double designation. Students taking them for graduate credit register under the 500-level designation. Those taking them for undergraduate credit, including graduate students fulfilling prerequisite requirements, register under a 400-level designation. Graduate tuition is charged for such courses having the 500-level designation.

Undergraduates who meet the grade point requirements for graduate study may enroll in 500-level courses and receive graduate credit, so long as they have not already taken the equivalent undergraduate course.

Receiving Graduate Credit for an Undergraduate Course

MSOE recognizes that on occasion a graduate student having a free elective in his/her graduate program may wish to enroll in an undergraduate course that contains subject matter of particular interest to the student, and to receive graduate credit for so doing. MSOE also recognizes that graduate students need to be held to a higher academic standard than do undergraduate students. The following policy shall therefore be in effect regarding graduate students wishing to receive graduate credit for attending an undergraduate course:

In the quarter preceding the one in which the undergraduate class is offered, the graduate student shall contact his/her graduate program director and request a graduate independent study form. The student shall then contact the instructor of the undergraduate course in question, and will explain his/her desire to obtain graduate credit for the course. The graduate student will ask the instructor if he/she is willing to assign and grade an additional project or projects to supplement the standard undergraduate course materials, in order to raise the level of the course to that of a graduate offering. The student also will request permission to attend the lecture and/or lab portions of the course, along with its undergraduate enrollees. If the instructor and the department chair of the department offering the course so agree, then the student will ask the instructor to complete the independent study form, which stipulates all requirements for completing the course for graduate credit. The student should submit the original, signed, independent study form to the registrar. The student will then register for the course just as he/she would for any graduate independent study course. Upon completion of all stipulated requirements, the instructor will award the student a grade for the course, and the student will receive graduate credit for that course.

The above procedure will not apply to courses that already carry an undergraduate/graduate (U/G) designation. Such courses can be taken for graduate credit simply by registering for the appropriate course number, as discussed above.

Students wising to transfer in course work from another institution for graduate credit may only do so if the course work carries a U/G or G designation, as stated in that institution's official catalog.

FULL-TIME STATUS

MSOE graduate students are classified as enrolled full time if they are registered for nine or more credit hours as of the close of business on Friday of the first week of the quarter.

GRADUATION REQUIREMENTS

Degrees are conferred at the end of the fall, winter and spring quarter. Attendance at the appropriate Commencement Exercises is required for all master's degree candidates.

Students must indicate to the Registrar's Office their intention to graduate as stated in the "Graduation Procedures" section that follows. Candidates for graduation must have completed or be enrolled in all courses required for graduation.

Master's Degree Requirements

1. Satisfactory completion of all courses prescribed for the particular area of study in which the degree is to be granted.

2. A cumulative grade point average of 3.00 or higher in graduate course work that is applicable toward the degree being granted.

3. Completion of all prescribed courses while at MSOE, except where permission is granted by the program director to transfer a maximum of nine graduate credits or three courses, whichever is less, into the graduate program.

4. Satisfactory completion of a master's thesis, oral presentation or other projects when prescribed, for the specific degree being sought.

5. Attendance and participation in Commencement Exercises.

6. Completion of all requirements within the allotted maximum time period as prescribed for each program.

GRADUATION PROCEDURES

1. Each student must apply for graduation by completing a *Graduation Application* form and submitting it to the Registrar's Office no later than the end of the seventh week of the quarter preceding the quarter in which the student expects to graduate. Graduation applications are available from the Registrar's Office or on the Registrar's Office Web site.

2. For those who submit a *Graduation Application* form by the above stated deadline, the Registrar's Office, in conjunction with the program director, will do preliminary graduation checks before the end of the first week of the quarter in which the students plan to graduate, and notify them by mail if additional courses are required.

3. A student completing graduation requirements by the end of a quarter, but who has not submitted a *Graduation Application* form by the above stated deadline, may participate in the Commencement Exercises with approval of the program director. The diploma for the student may, however, be delayed.

D

GRADUATE PROGRAM DESCRIPTIONS

MASTER OF SCIENCE IN ENGINEERING (MSE)

The MSE program enables the graduate engineering professional to solve problems by drawing from the fields of mechanical engineering, electrical engineering and software engineering. The emphasis of this program is on the integration of technologies rather than focusing on one discipline, although students choose an Engineering Option which, together with the Engineering Project, can provide some degree of concentration.

The MSE is aimed toward engineers who are involved with industrial projects. Students are expected to take engineering courses both within and outside their discipline. Courses cover such topics as material properties, probability and statistics, systems analysis, advanced mechanics, data communications, computer assisted engineering and software engineering. A capstone engineering project is included as part of the program.

In addition to the availability of the MSE program in Milwaukee, the courses also are available in the Fox Valley area in Appleton, Wis. Specific courses also are presented at company locations as requested.

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Faculty:

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The Program

The MSE program is an interdisciplinary program, spanning electrical engineering and mechanical engineering, and including other technical areas as outlined in the curriculum content section below. It is based on the philosophy that there is a need for engineers who can use a variety of disciplines to solve technical problems. Traditionally, graduate education in the United States has focused on creating specialists – people who can advance the frontiers of knowledge in a narrow field. The MSE program's major emphasis is on the application of engineering skills and knowledge. Engineering concepts and theory are conveyed through the applications presented.

The course work may include a combination of lecture and laboratory. Some of the courses include computer laboratories. Each course typically meets once per week for 11 weeks during one of the three quarters of the regular academic year. Occasionally, select classes will meet twice weekly.

The required Engineering Project can either draw from the multiple disciplines studied within the program or can focus more on technical areas within the student's chosen Engineering Option.

Program Goals

The graduate of the MSE program will:

1. have a solid foundation in mathematics and in the disciplines of electrical engineering and mechanical engineering

2. have a deepened understanding of principles in a chosen area of engineering to better prepare him/her for professional practice

3. have an ability to apply engineering principles to practical problem solving

4. have demonstrated analytical skills applicable to problems involving complex engineering systems and components

5. have an ability to formulate and carry out a significant engineering project

6. have the ability to effectively present and communicate technical concepts, both orally and in writing

The Curriculum Format

The program is designed for individuals with bachelor's degrees in engineering, engineering technology or other closely related areas. Each student works with the program director to plan a course of study tailored to his or her needs. Individual degree requirements are dependent upon the type of bachelor's degree. Students with a bachelor of science degree in mechanical or electrical engineering, mechanical or electrical engineering technology, or a substantially similar degree from an accredited program are typically required to complete a total of 45 graduate credits. Students with other bachelor's degrees are generally required to complete a total of 54 graduate credits.

The Curriculum Content

To ensure that each student has an interdisciplinary program while allowing the program to be tailored to the student's needs, there are certain minimum credit requirements from each of the following disciplines:

Mathematics
MA-611 Engineering Mathematics I (three credits)
MA-612 Engineering Mathematics II (three credits)

Systems Engineering
One course from list (three credits):
GE-703 Simulation and Modeling
GE-705 Computer Assisted Engineering

Electrical Engineering
Typically required if B.S. degree is not EE or EET (nine credits):
EE-502 Systems Analysis and Control
EE-513 Linear Integrated Circuits
EE-520 Electromagnetics and Transmission Lines

Mechanical Engineering
Typically required if B.S. degree is not ME or MET (nine credits):
ME-512 Transport Processes
ME-514 Thermodynamic Applications
ME-521 Science of Engineering Materials

Engineering Option
Select four-course option sequence (EE, FP or ME) (12 credits)

Computer Engineering
CS-780 Software Engineering (three credits)

Technical Elective – Mathematics, Physics or Engineering
One MA, PH, CS, EE, EV, GE, IE or ME course (three credits)

Engineering Project
EN-700, GE-797 and GE-798

Engineering Option

Students select an Engineering Option of at least four courses (12 credits) from one of the areas identified below. The Engineering Option provides each student with the opportunity to extend their level of expertise in a specific technical area. The courses which constitute each option follow:

Electrical Engineering (EE)[1]
EE-724 Digital Data Communication
(Complete any three of the following four courses)
EE-871 Modern Control Systems
GE-706 Digital Control Systems
EE-813 Advanced Electronic Systems
EE-814 VLSI Circuit Design

Mechanical Engineering/Materials (ME)[1]
ME-703 Advanced Mechanics
(Complete any three of the following four courses)
ME-821 Corrosion and Degradation of Materials
ME-822 Structure and Properties of Engineering Materials
ME-861 Finite Element Analysis for Mechanical Engineering
ME-862 Advanced Mechanical System Design

[1]Engineering Option offered in Milwaukee and Appleton.

Fluid Power Engineering Option (FP)
ME-703 Advanced Mechanics
ME-871 Mathematical Modeling of Fluid Power Systems
ME-872 Theory of Fluid Power Dynamics
ME-873 Design of Feedback Control for Fluid Power Systems

The Fluid Power Engineering Option is available but not offered as a regularly scheduled sequence of courses. The option is offered only on a special petition basis. A group of at least eight students must petition to the MSE program director requesting that the option be scheduled. The petition must be submitted by the end of week one of the quarter immediately before the quarter in which the option will begin. The petition will be reviewed and a decision to offer the option will be based upon ensuring that sufficient enrollment be maintained in each of the courses offered. Due to the specialized nature of the laboratory requirements, this option will be available only in Milwaukee if offered.

Engineering Project

The Engineering Project (six credits) is required of all MSE students. In consultation with a faculty adviser, each student develops an engineering project or other suitable technical study that incorporates concepts learned in the program.

Summary of Typical Program Requirements

	Undergraduate Background		
	Mechanical	Electrical	Other
Discipline	**Graduate Credits Required**		
Mathematics (MA)	6	6	6
Systems Engineering (GE)	3	3	3
EE-500-level	9	0	9
ME-500-level	0	9	9
Engineering Option (EE, FP or ME)	12	12	12
Computer Engineering (CS)	3	3	3
EN-700	3	3	3
Technical elective	3	3	3
Engineering Project	6	6	6
Total Credits Required	45	45	54

Model Part-time, Five-year Track[1] (V4.3.1)

		QUARTER CREDITS Fall	Winter	Spring
First Year				
MA-611	Engineering Mathematics I	3		
MA-612	Engineering Mathematics II		3	
GE-7XX	Elective (Systems Engineering)			3
Second Year – Students with BSME - Typical Sequence[2]				
EE-502	Systems Analysis and Control	3		
EE-513	Linear Integrated Circuits		3	
EE-520	Electromagnetics and Transmission Lines			3
Second Year – Students with BSEE - Typical Sequence[2]				
ME-514	Thermodynamic Applications	3		
ME-521	Science of Engineering Materials		3	
ME-512	Transport Processes			3
Third Year				
	EE/ME Option - First Course[3]	3		
	EE/ME Option - Second Course[4]		3	
	EE/ME Option - Third Course[4]			3
Fourth Year				
	EE/ME Option - Fourth Course[4]	3		
CS-780	Software Engineering		3	
	Graduate-Level elective[5]			3
Fifth Year				
EN-700	Technical Communication (Engineering Project Proposal)	3		
GE-797	Engineering Project I		3	
GE-798	Engineering Project II			3
	TOTAL CREDITS 45			

[1]Note: This track applies to students who begin in:
- Fall of an even-numbered year in Milwaukee.
- Fall of an odd-numbered year in Fox Valley.

A similar track (V4.3.2) exists for students who begin in alternate years.

[2]Students entering the program need to have their undergraduate records examined to determine MSE course requirements at the 500-level. Students entering the program with a degree other than BSEE or BSME typically need more than 45 total credits for graduation.

[3]EE/ME option - First course is EE-724 for EE option, ME-703 for ME option.

[4]The second, third, and fourth courses for the EE/ME option must be selected as specified under the Engineering Options section of the Graduate Catalog.

[5]Electives cannot be EE-502, EE-513, EE-520, ME-512, ME-514, or ME-521.

MASTER OF SCIENCE IN ENGINEERING MANAGEMENT (MSEM)

The MSEM is a technology-oriented management program designed to meet the needs of engineers, business managers, and other professional and technical personnel progressing into management or needing an understanding of management issues to better perform their current job functions. Graduates of the program also are prepared to move into general management positions in a wide range of industries.

The MSEM is based on the philosophy that, for companies to grow and compete internationally, their management needs a deep understanding of both technology and management.

Faculty members have extensive business experience. In addition to their academic qualifications, most are employed in the discipline they teach. Areas of particular emphasis include management of organizations, management of engineering projects, production management, managing research groups, financial management, technical sales and marketing, technical entrepreneurship, quality management, business policy and strategy, construction management, and international business.

A required master's thesis or capstone specialization course track allows the student to apply the program material to practical business problems. Either of these capstone activities provide a learning experience in which the student has the opportunity to discover something about a technical or business topic that is not readily accessible and apply the knowledge to a practical situation. They allow students to demonstrate their depth and breadth of learning from the MSEM program. Alumni cite this opportunity as one of the most valuable components of the program in their career advancement.

In addition to offering the program in Milwaukee, the degree program is offered in the Appleton, Wis., area. Courses also are available at several other locations in southeastern Wisconsin including Brookfield/Waukesha, Racine/Kenosha and Port Washington/Sheboygan. Some courses are available via the Internet.

Classes are usually small, in the range of 10 to 15. Occasionally, in popular courses, the size may reach the maximum enrollment limit of 25.

Courses meet for three hours, one evening each week, for 11 weeks during each of the three quarters of the regular academic year. During the summer, courses generally run between five and eight weeks.

The courses include lectures, discussions, student presentations and other activities. Some courses may take place in a computer laboratory or TV-style studio or be offered via the Internet. Guest speakers sometimes appear in class to share their experiences. Class participation by all students in the discussions is essential.

The course work requires, in addition to going to class, reading the text and management journals, as well as other books that may be assigned by the instructor; writing term papers and book reports if required; and completing similar work designed to show the student's mastery of the topic.

Students should expect at least two-to-three hours of additional individual or group study for every hour of class time. Formal written exams are used in some courses. Many courses require projects to be completed by small teams of students.

Students enrolled continuously in the program take between two and five years to complete the degree, depending on whether they take more than one course at a time and whether they take summer courses. Students are allowed up to seven years, but are advised against doing so in their own interest. The "Model Part-time Tracks" following in this catalog illustrate typical programs for a student taking one course all four quarters.

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Faculty:

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Program Goals

The graduate of the MSEM program will have:

1. an ability to use the techniques, skills and modern management tools
2. an ability to lead and contribute in multidisciplinary teams in a multicultural environment
3. an understanding of professional and ethical responsibility
4. an ability to communicate effectively
5. the broad education necessary to apply management solutions in global and social contexts
6. a recognition of the need for, and an ability to engage in, lifelong learning

Required Curriculum

All students are expected to complete the nine required courses, EM-600 through EM-670, and EM-800, prior to movement into more advanced courses. These courses are listed on the following pages. Since the required courses are taught at the graduate level, students are generally not exempt due to somewhat similar undergraduate courses.

Capstone Activity

Each student completes a capstone activity. The capstone activity has two primary objectives: 1) it is a learning experience in which the student has the opportunity to discover something about a technical or business topic that is not readily accessible, that is not conventional wisdom, and is not found in any book or other common source; and 2) it is a means by which the student demonstrates his or her depth and breadth of learning from the MSEM program. There are two choices: the Independent Option and a Specialization Track.

1. Independent Option (6 credits)

The Independent Option may be a thesis, a project or a case study. All start with a proposition or point of view.

- The thesis reflects research on some management topic, often applying it to a particular situation to see whether or not the particular management theory is useful.
- The project is aimed at finding a solution to a management problem. It results in a project report, similar to the way project reports are written in industry.
- A case study examines the history of an organizational problem or decision – its background, why decisions were made the way they were – and draws conclusions applicable to other management situations.

The Independent Option results in a paper or a video. Students may do this study either in teams or as individuals. They then present the results of their work before a faculty committee with guidance from a faculty adviser. Normally, students start the Independent Option after they have accumulated 33 credits.

Students have the choice of starting the Independent Option in a class (EM-798) and finishing on their own (EM-805) or of doing the whole study on their own (EM-804). Students work closely with an adviser from the faculty, generally chosen for expertise in the subject area.

The Independent Option distinguishes the MSEM degree from similar degrees at other universities where work of this level of significance is not produced. It provides the student with a tangible document that demonstrates to employers, and potential employers, the student's basic management knowledge and the ability to apply management principles to specific situations.

2. Specialization Tracks (9 credits)

The Specialization Tracks consist of three consecutive courses that concentrate on a single area of management. Two of the courses could be available electives. The third would be a capstone course. The following tracks are offered:

Quality

"Quality" is a complex combination of results involving satisfying the customer, providing on-time delivery, complying with regulatory requirements, continually improving the value of products and services, being profitable and, at the same time, maintaining the quality of work-life and more. It is quite obvious that such a complex list of desired achievements is not the result of a simple process but is the result of a very complex, holistic, dynamic and heuristic process involving everyone within an organization on an on-going basis. Quality is achieved, maintained and improved through the way a business is operated – in essence through its management processes. This track emphasizes how quality is achieved as a part of the management process rather than as a separate process superimposed on the management process.

Courses in the Quality Specialization Track include the following:
EM-746 Quality Management and Engineering
One course from the following list:
EM-762 Development and Redesign of Organizations
EM-770 New Product Management
EM-747 Advanced Manufacturing Technology
EM-845 Managing for Quality Capstone Course

Marketing

The Marketing Specialization Track gives MSEM students added experience and insight into one of the most critical ingredients of managing a successful and profitable organization. More and more organizations are moving from being technology-driven to becoming marketing-driven in order to effectively compete in today's global markets.

Courses in the Marketing Specialization Track include the following:
Two courses from the following list:
EM-770 New Product Management
EM-771 International Marketing
EM-775 Marketing Strategies
EM-870 Marketing Capstone Course

Operations Management

The Operations Management Specialization Track addresses the systems that make and provide goods and services in a typically dynamic, ever-changing environment. Successful operations managers effectively utilize resources to meet today's demands while orchestrating the changes needed to meet future customer and market needs.

Courses in the Operations Management Specialization Track include the following:
EM-712 Decision Support for Operations Management
EM-747 Advanced Manufacturing Technology
EM-840 Operations Management Capstone Course

Program Management

The Program Management Specialization Track is intended to provide the student with the skills to handle programs and projects within the firm. This track gives the engineering manager the ability to provide alternative solutions to programs and projects, prepare justifications, plan for the implementation of projects and programs, manage and control programs and projects, and, lastly, provide postmortem feedback on the process.

Courses in the Program Management Specialization Track include the following:
EM-721 Cost and Capital Investment
EM-790 Total Project Management
EM-890 Program Management Capstone Course

Organizational Management

The Organizational Management Specialization Track is designed to give the student an opportunity to integrate the knowledge, skills and tools of managing/leading the qualitative process and human resource functions of an organization.

Courses in the Organizational Management Specialization Track include the following:
Two courses from the following list:
EM-735 Managerial Communication
EM-762 Development and Redesign of Organizations
EM-766 Bargaining and Negotiating
EM-767 Team Management
EM-768 Human Resources Management
EM-860 Organizational Management Capstone Course

Electives

Students pick sufficient electives for a total of 48 credits for those choosing the Independent Option and 51 for those choosing a Specialization Track.

Students may take one of these electives from another MSOE graduate program without prior approval. Students planning to take additional courses in another program should get advanced approval from the program director. This should include a one-page statement of how the proposed electives support a student's MSEM project goals.

COURSES		**CREDITS**	
		Independent Option	**Specialization Track**
EM-600	Management Principles	3	3
EM-610	The Application of Statistics	3	3
EM-620	Finance and Accounting	3	3
EM-630	Principles of Research and Writing	3	3
EM-640	Operations Management	3	3
EM-650	Managing Information Technology	3	3
EM-660	Applied Organizational Behavior	3	3
EM-670	Marketing Management	3	3
	5 Elective Courses	15	15
EM-800	Strategic Management	3	3
	Thesis/Project/Case	6	
	3 Track Courses		9
	TOTAL CREDITS REQUIRED	**48**	**51**

Model Part-time Track (V4.1)

Independent (Thesis) Option

		QUARTER CREDITS			
		Fall	Winter	Spring	Summer
First Year					
EM-630	Principles of Research and Writing	3			
EM-600	Management Principles		3		
EM-610	The Application of Statistics			3	
EM-xxx	Free Elective				3
Second Year					
EM-620	Finance and Accounting	3			
EM-640	Operations Management		3		
EM-650	Managing Information Systems			3	
EM-xxx	Free Elective				3
Third Year					
EM-660	Applied Organizational Behavior	3			
EM-670	Marketing Management		3		
EM-800	Strategic Management			3	
EM-xxx	Free Elective				3
Fourth Year					
EM-xxx	Free Elective	3			
EM-xxx	Free Elective		3		
EM-798	Independent Option: Phase I			3	
EM-805	Independent Option: Phase II				3

TOTAL CREDITS 48

Model Part-time Track (V1.0)

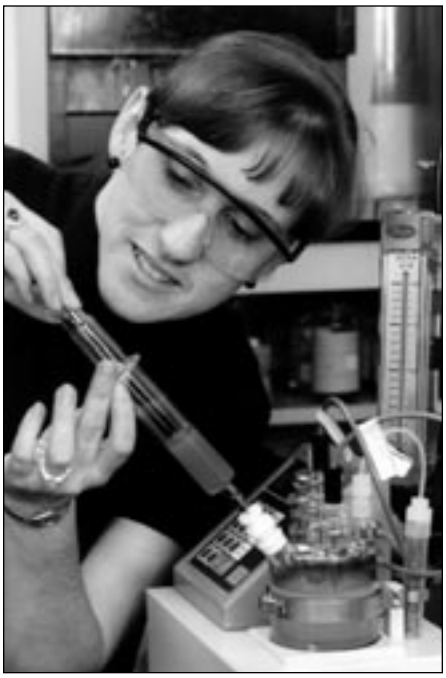
Specialization Track (Capstone Option)

The specialization track (capstone option) follows the same track as the Independent (thesis) Option for the first three years. The fourth and fifth years are as follows:

Fourth Year					
EM-xxx	Free Elective	3			
EM-xxx	Free Elective		3		
EM-xxx	Specialization Track Elective			3	
EM-xxx	Specialization Track Elective				3
Fifth Year					
EM-8XX	Capstone Course	3			

TOTAL CREDITS 51

MASTER OF SCIENCE IN ENVIRONMENTAL ENGINEERING (MSEV)



The MSEV program provides practicing engineers with instruction in environmental systems design and environmental management, allowing them to effectively address environmental regulations and issues that permeate today's workplace.

Engineers from such diverse areas as design, manufacturing, plant engineering or management often realize the need for a grounding in environmental engineering principles, an area in which their undergraduate background may have been lacking.

Course topics in the program include waste minimization and pollution prevention, environmental law, air pollution control, solid and hazardous waste management, water and wastewater treatment, plant safety, environmental auditing and life cycle cost analysis for environmental systems. Courses are taught by faculty having extensive industrial experience as well as academic credentials in relevant technical areas. Classes meet evenings, one night per week, so individuals working in industry may work and attend classes concurrently.

The culmination of the MSEV is the completion of a two-quarter capstone design project in which an environmental problem is selected and a comprehensive solution is proposed. The proposed solution must meet all technical standards and regulatory guidelines as prescribed, and a cost analysis must be included. A comprehensive written report must be defended before a faculty review committee.

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Faculty:

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The Program

The MSEV is a program designed to provide instruction in environmental systems design and environmental management issues. It is tailored to the student who already has a bachelor of science degree in one of the traditional engineering disciplines, such as architectural, chemical, civil, industrial, electrical, manufacturing or mechanical. In today's industrial world, environmental issues permeate and affect virtually every technical and business decision.

Practicing engineers in a variety of positions – manufacturing design, research and development, management, and plant engineering – need a firm grounding in the various aspects of environmental engineering in order to perform effectively on the job. The MSEV builds upon the student's already solid foundation in engineering principles and presents topics in areas such as waste minimization and pollution protection, environmental law and regulations, air pollution control, solid and hazardous waste management, wastewater and water treatment techniques, water resources management, plant safety and OSHA issues, environmental risk assessment, and life cycle cost analysis.

The program requires that students complete 45 credits of graduate course work. Each course typically meets one evening per week for 11 weeks during the regular academic year (fall, winter and spring quarter). Class sizes are kept small, in the range of eight to 20 students.

A two-quarter, six-credit capstone design project is required as part of the program. This project begins upon completion of the other course work in the program. The capstone design project includes the selection of an environmental problem to which the student proposes a comprehensive solution. The solution must meet all technical standards and regulatory guidelines as prescribed. A comprehensive written report must be defended before a faculty review committee. Selection of an actual environmental problem based upon the student's current or previous industrial experience is strongly encouraged.

Program Goals

The Master of Science in Environmental Engineering (MSEV) program goals are as follows:

1. To provide individuals already holding B.S. degrees in engineering and the physical sciences with the additional technical training necessary to enable them to make technically sound environmental decisions during the operation of modern manufacturing and/or construction facilities.

2. To provide individuals already holding B.S. degrees in engineering and the physical sciences with the additional management training necessary to enable them to make legally and economically sound environmental decisions in the operation of modern manufacturing and/or construction facilities.

3. To provide individuals already holding B.S. degrees in engineering and the physical sciences with the experience needed in order to learn to satisfy the complex requirements that must be met when providing a comprehensive, integrated design solution to a real-life environmental problem.

The Curriculum Format

An outline of the program's requirements is presented in the following section. The program requires a total of 45 graduate credits. In addition to 30 credits of required courses, the student can choose 15 credits of electives. The capstone design project makes up six of the 45 MSEV graduate credits required for graduation.

The Curriculum Content

Required Courses	Credits
EV-611 Applications of Chemistry in Environmental Engineering	3
EV-612 Biology for Environmental Engineers	3
EV-614 Microbiology for Environmental Engineers	3
EV-730 Solid and Hazardous Waste Minimization	3
EV-752 Risk Assessment and Environmental Auditing	3
EV-756 Environmental Project Program Management and Life Cycle Cost Analysis	3
EV-760 Environmental Law for Environmental Engineers	3
EV-710 Environmental Statistics and Modeling	3
EV-890 Environmental Engineering Systems Design I	3
EV-892 Environmental Engineering Systems Design II	3

Elective Courses (pick any 5 of 8)	Credits
EV-720 Municipal Wastewater Treatment	3
EV-722 Hydrogeology and Groundwater Pollution	3
EV 724 Industrial Water Pretreatment and Stormwater Management	3
EV-726 Water Resources Management	3
EV-740 Air Pollution Control	3
EV-750 Plant Safety/OSHA Issues	3
EV-754 Soil Science and Remediation Technologies	3
EV-799 MSEV Independent Study*	3
Total Quarter Credits	45
*Maximum of 3 credits per student counted toward the MSEV degree	

Model Part-time, Three-year Track (V1.3)

		QUARTER CREDITS Fall	Winter	Spring
First Year				
EV-611	Applications of Chemistry in Environmental Engineering	3		
EV-612	Biology for Environmental Engineers	3		
EV-614	Microbiology for Environmental Engineers		3	
EV-760	Environmental Law for Environmental Engineers		3	
	Electives (EV-720, EV-740, EV-754, EV-799[1])			0 or 3
Second Year				
EV-710	Environmental Statistics and Modeling	3		
EV-730	Solid and Hazardous Waste Minimization	3		
	Electives (EV-724, EV-726, EV-750, EV-799[1])		3 or 6	
	Electives (EV-720, EV-740, EV-754, EV-799[1])			0 or 3
EV-756	Environmental Project Program Management and Life Cycle Cost Analysis			3
Third Year				
Elective	(EV-722, EV-799[1])	0 or 3		
EV-752	Risk Assessment and Environmental Auditing	3		
EV-890	Environmental Engineering Systems Design I[2]		3	
EV-892	Environmental Engineering Systems Design II[2]			3
	TOTAL CREDITS 45			

[1] Enrollment in EV-799 is subject to instructor availability and program director approval
[2] Capstone design project

- The student is to choose 5 of 8 electives.
- Given the possibility of students taking a variety of electives, depending on interest, and taking required courses in a variety of sequences, the above sample track is not unique, but represents one of many possible tracks that the student, in consultation with the program director, may choose as his/her program of study.
- Electives must have enrollment of five students or more to be offered.

Model Part-time, Five-year Track (V1.3)

		QUARTER CREDITS Fall	Winter	Spring
First Year				
EV-611	Applications of Chemistry in Environmental Engineering	3		
EV-612	Biology for Environmental Engineers	3		
EV-614	Microbiology for Environmental Engineers		3	
	Elective (EV-720, EV-740, EV-754, EV-799[1])			3 or 6
Second Year				
EV-730	Solid and Hazardous Waste Minimization	3		
EV-760	Environmental Law for Environmental Engineers		3	
	Elective (EV-720, EV-740, EV-754, EV-799[1])			0 or 3
Third Year				
EV-710	Environmental Statistics and Modeling	3		
	Elective (EV-724, EV-726, EV-750, EV-799[1])		0 or 3	
EV-756	Environmental Project Program Management and Life Cycle Cost Analysis			3
Fourth Year				
EV-752	Risk Assessment and Environmental Auditing	3		
	Elective (EV-724, EV-726, EV-750, EV-799[1])		0 or 3	
	Elective (EV-720, EV-740, EV-754, EV-799[1])			0 or 3
Fifth Year				
	Elective (EV-722, EV-799[1])	0 or 3		
EV-890	Environmental Engineering Systems Design I[2]	3		
EV-892	Environmental Engineering Systems Design II[2]		3	

TOTAL CREDITS 45

[1] Enrollment in EV-799 is subject to instructor availability and program director approval
[2] Capstone design project

- The student is to choose 5 of 8 electives.
- Given the possibility of students taking a variety of electives, depending on interest, and taking required courses in a variety of sequences, the above sample track is not unique, but represents one of many possible tracks that the student, in consultation with the program director, may choose as his/her program of study.
- Electives must have enrollment of five students or more to be offered.

MASTER OF SCIENCE DEGREE IN MEDICAL INFORMATICS (MSMI)

Joint Degree Offering

Our joint Master of Science in Medical Informatics program combines the strength of the **Medical College of Wisconsin,** a leading provider of medical education and research, and the expertise of **MSOE** in the disciplines of business and information technology. The faculty facilitates education through "real world" experiences to reinforce theory and concepts.

Working Definition of Medical Informatics

Medical informatics (MI) is the applied science at the junction of the disciplines of medicine, business and information technology, which supports the health care delivery process and promotes measurable improvements in both quality of care and cost-effectiveness.

MSMI Program Mission Statement

The mission of the MCW/MSOE Master of Science in Medical Informatics program is to provide an applied graduate educational experience that prepares professionals to participate in and lead multidisciplinary teams in the development, implementation and management of information technology solutions in health care.

Our working definition of medical informatics and mission statement emphasize the applied aspect of using informatics (information science) in the health care setting. This is somewhat different than other MI programs where there is a stronger emphasis on theory. We strive to provide a practical education that prepares students to effectively participate in development, implementation, and management teams charged with producing information technology solutions that improve patient care and reduce the cost of care.

Another element of our program that sets us apart from other MI programs is our emphasis on business principles. The projects that we envision our graduates working on are costly and complex. Justification for such projects can only come through the development of a compelling business case that is aligned with the overall organizational strategy. We want our graduates to be able to work with business and information technology experts to develop and defend the business case. Participating in multidisciplinary teams within a health care organization also requires an understanding of "soft" business management principles, as it is well known that impediments to successful projects mostly involve people and organizational issues.

Our program places a strong emphasis on project management skills. Again, the projects that we are preparing our graduates to participate in and lead are large, expensive and complex. Successful development and implementation of information technology solutions in the health care environment requires a strict business discipline and strong project management skills.

It is not the goal of the MSMI program to comprehensively cross train individuals from one medical informatics domain for another. We will not make doctors or

nurses into network engineers, database designers, or finance or management experts. Similarly, we will not prepare computer scientists or business experts for patient care. This is not our intent. Rather, our intent is to give our graduates the knowledge and skills to identify, recruit and work with expert resources needed for the successful project. Additionally, with six credits of electives, and a six-credit internship/research project, students have the opportunity to gain additional expertise according to their individual academic and career goals.

Finally, the MSMI program is designed with a focus on the adult learner (non-traditional student). These are students that come with an education and several years of working experience usually in one of the three primary domains described in our working definition. They can immediately see the implications and applications of the MI course topics. All of our core classes meet once a week during the evening so that working adults can fit the course work into an already busy schedule.

The program also is appropriate for the traditional graduate student. These traditional students should expect to gain a knowledge base and skill set that allows them to participate effectively on project teams and is marketable in the industry.

The medical informatics program benefits from the guidance of its external advisory committee – a standing committee of business and industrial leaders who help ensure program offerings stay current.

Program Director: John Traxler, MD, MBA, MSMI (MSOE)
(414) 277-2218, traxler@msoe.edu

Steven R. Krogull, MS (MCW)
(414) 456-4382, skrogull@mcw.edu

Faculty:

Dr. John Gassert, Robert Hankes, Dr. William Hendee, Thomas Jerger, Steven Krogull, Jerry Lieberthal, Dr. Jane Morley-Kotchen, Dr. John Traxler, Dr. Dennis Wanless, Dr. Raymond Zastrow

Program Goals:

Graduates of the medical informatics program should obtain:

1. the broad education necessary to apply informatics solutions
2. the ability to specialize within the field of applied medical informatics
3. the ability to work in the field of medical informatics
4. an ability to lead and contribute in multi-disciplinary teams
5. a recognition of the need for, and the ability to engage in lifelong learning
6. an understanding of professional and ethical responsibility
7. an ability to communicate effectively

Career Opportunities

Informatics solutions in the health care industry are proceeding at a rapid pace, as anyone working in this environment knows. The management of clinical and administrative data is changing from paper to electronic systems. The field of medical informatics is guiding this transition. This change is being driven by efforts from many sectors to improve the quality of care while reducing the cost of providing that care.

The technology has caught up to the vision but health care still lags behind other "information intense" industries in its use of information technology. There is a rapidly growing need for skilled professionals who understand information technology along with both the clinical and business aspects of health care. This creates a tremendous opportunity for those with the right training to work on teams that develop, implement, and manage information systems that can support health care delivery, medical research and education.

As a graduate of the medical informatics program, you will have the education and credentials needed to pursue career opportunities in a variety of settings:

- Health care provider organizations – hospitals, HMOs, clinics
- Software/hardware vendors that develop and install information systems
- Consulting firms
- Third party insurance companies
- Public health agencies
- Biomedical research

Medical College of Wisconsin (MCW)

The MCW is a private educational institution with a medical school that offers the M.D. degree; the Graduate School of Biomedical Sciences, which offers Ph.D., M.S. and M.A. degrees; and a specialized MPH program for physicians. The college traces its origin to two medical schools founded in Milwaukee in the 1890s. In 1913, these schools merged to become the Marquette University School of Medicine. In 1967, the medical school separated from Marquette to become a free-standing institution, subsequently named Medical College of Wisconsin.

Today, MCW is located on the campus of the Milwaukee Regional Medical Center, along with Froedert Memorial Lutheran Hospital, Children's Hospital of Wisconsin, Milwaukee County Mental Health Complex, Curative Rehabilitation Center, and the Blood Research Institute of the Blood Center of Southeastern Wisconsin. The college benefits from a close working relationship with these institutions, as well as with other Milwaukee institutions, including Zablocki Veterans Affairs Medical Center, Marquette University, University of Wisconsin-Milwaukee and Milwaukee School of Engineering.

MEDICAL COLLEGE OF WISCONSIN

The Schedule

- Students pursuing the program on a full-time basis are able to complete the program in five consecutive quarters of study. Part-time students may take up to five years for completion.
- Courses are offered in a predefined sequence and therefore admittance to the program in the fall quarter is recommended although not required.

Total Degree Credits: 54

Required courses: (48 credits)

MI-13200 A&B	Introduction to Medical Informatics I and II (6) (MCW)
MI-13201	Ethics in Medical Informatics (3) (MCW)
MI-693	Intermediate Statistics (3) (MSOE)
MI-11200	Introduction to Epidemiology (3) (MCW)
MI-787	Health care Systems Analysis and Design (3) (MCW)
MI-13204	Information Systems Project Management (3) (MSOE)
MI-783	Database Structures and Processing (3) (MSOE)
MI-885	Computer Network Design (3) (MSOE)
MI-743	Principles of Health care Management
MI-756	Health care Provision and Payment (3) (MSOE)
MI-788	Medical Informatics Case Study Seminar (3) (MSOE)
MI-13203	Health care Decision Support (3) (MSOE)
MI-786I	Medical Informatics Journal Club (1 credit – 3 req.) (MSOE)
MI-13299 A&B	Internship/Research Project

Electives: (6 credits)

Model Full-time Track (V5.0)

		QUARTER CREDITS			
		Fall	Winter	Spring	Summer
First Quarter					
MI-13200A	Introduction to Medical Informatics I	3			
MI-13201	Ethics in Medical Informatics**	3			
MI-11200	Introduction to Epidemiology	3			
MI-13204	Information Systems Project Management	3			
Second Quarter					
MI-13200B	Introduction to Medical Informatics II		3		
MI-693	Intermediate Statistics		3		
MI-787	Health Care Systems Analysis and Design		3		
MI-743	Principles of Health Care Management		3		
Third Quarter					
MI-783	Database Structures and Processing			3	
MI-885	Computer Network and Design			3	
MI-756	Health Care Provision and Payment			3	
	Elective			3	
Fourth Quarter					
MI-13299A	Internship/Research Project				3
MI-13299B	Internship/Research Project				3
	Elective				3
Fifth Quarter					
MI-788	Medical Informatics Case Study Seminar	4			
MI-13203	Health Care Decision Support	3			
	Elective	3			
MI-786I	Medical Informatics Journal Club*				
	TOTAL CREDITS 54				

**Ethics in Medical Informatics is being changed this year from 2 credits to 3 credits. In the fall of 2003, Medical Informatics Case Study Seminar is going to be changed from 4 credits to 3 credits.

*The Medical Informatics Journal Club (MI-786I) is offered every quarter (including summer). Student must enroll in the course three times to obtain a total of three credits.

Model Part-time Track (V5.0)

		QUARTER CREDITS			
		Fall	Winter	Spring	Summer
First Year					
MI-13200A	Introduction to Medical Informatics I	3			
MI-13204	Information Systems Project Management	3			
MI-13200B	Introduction to Medical Informatics II		3		
MI-743	Principles of Health Care Management		3		
MI-756	Health Care Provision and Payment			3	
MI-885	Computer Network and Design			3	
	Elective				3
Second Year					
MI-13201	Ethics in Medical Informatics	3			
MI-11200	Introduction to Epidemiology	3			
MI-693	Intermediate Statistics		3		
MI-787	Health Care Systems Analysis and Design		3		
MI-783	Database Structures and Processing			3	
	Elective			3	
MI-13299A	Internship/Research Project				3
MI-13299B	Internship/Research Project				3
Third Year					
MI-13203	Health Care Decision Support	3			
MI-788	Medical Informatics Case Study Seminar	4			
MI-786I	Medical Informatics Journal Club*				
	TOTAL CREDITS 54				

*The Medical Informatics Journal Club (MI-786I) is offered every quarter (including summer). Student must enroll in the course three times to obtain a total of three credits.

Part-time students may enroll in fewer courses each quarter than listed above, however, students are expected to complete all degree requirements within five years of beginning the program.

MASTER OF SCIENCE IN PERFUSION (MSP)

The MSP program is designed for full-time graduate students. A student who is currently a Certified Clinical Perfusionist (CCP) may be granted permission to enroll as a part-time graduate student in this program.

In keeping with the mission of the MSOE, the MSP program aims to provide our students with the highest quality of education available in the field of perfusion. The faculty of MSOE and clinical affiliates associated with the program are highly motivated and skilled at teaching the technical and challenging career of perfusion.

The main function of a perfusionist is to operate the heart lung machine, which has the role of taking over the function of the heart and lungs during heart surgeries such as coronary artery bypass grafting, heart valve replacement, heart transplants, lung transplants, and various other procedures requiring extracorporeal circulation.

As with most allied health professionals, advances in biomedical technology have broadened the scope of responsibilities assigned to the perfusionist. This requires a perfusionist to have a greater knowledge base upon graduation, and, even more importantly, he or she has to have the ability to perform and/or evaluate the research being done in the advancing areas.

The MSP curriculum contains approximately 45 academic quarter credits, including a master's thesis, and approximately 21 quarter credits of didactic and supervised clinical work. Each student is required to complete at least 125 surgical procedures under the supervision of the clinical faculty. The MSP program starts in the fall quarter of each academic year (September) and is six consecutive quarters (including a summer quarter) in length, if the student successfully completes all of the program requirements. The MSP program is only offered at the Milwaukee campus. Since the curriculum is accredited by the Commission on Accreditation of Allied Health Education Programs (CAAHEP), graduates are eligible to sit for the Certified Clinical Perfusionist's examination administered by the American Board of Cardiovascular Perfusion.

Most of the academic courses are scheduled to meet on the campus, but all students are required to provide their own transportation to the various affiliated clinical sites. Most of the affiliated institutions are located within 25 miles of the campus. Public transportation does not reliably allow the student to arrive at clinical sites, at the time specified, to perform their assigned duties.

The MSP program is currently affiliated with two surgical groups where adult CPB cases are performed. The Infinity Heart Institute, Chartered, serves as the main surgical affiliate. This surgical group performs approximately 1,200 CPB cases per year, the majority of which are performed at St. Luke's Medical Center, the main hospital affiliate. Infinity Heart also operates at the other affiliate hospitals – St. Francis Hospital, Sinai Samaritan Medical Center and St. Mary's Hospital. MSP students usually perform approximately 75 percent of the required adult CPB cases with Infinity Heart. Students are exposed to a wide variety of cases including CABG, valve replacements, redo-operations, VAD placement, heart transplantation, lung transplantation, liver transplantation, cath-lab assist cases (CPS) and deep hypothermia/circulatory arrest. The Infinity Heart perfusionists serve as didactic clinical instructors for the MSP program.

The other surgical affiliate is Milwaukee Heart Surgery Associates. This group operates primarily at St. Francis Hospital, Sinai Samaritan Medical Center and St. Mary's Hospital. Students perform the remaining 25 percent of their required adult CPB cases with Milwaukee Heart Surgery. This perfusion rotation allows the student to gain experience with long-term extra-corporeal support. The majority of the cases performed by this surgical affiliate are redo-CABGs and involve average pump runs of six hours. This provides a unique perspective of perfusion management and technique when dealing with a patient who has been on cardiopulmonary bypass for an extraordinary length of time. Milwaukee Heart Surgery Associates utilize Baxter Perfusion Services for all their CPB cases. The Baxter perfusionists are local and serve as clinical instructors for the MSP program.

Finally, the pediatric rotation is performed at Children's Hospital of Wisconsin under the direction of pediatric cardiothoracic surgeons. All 25 required pediatric cases are performed at this affiliated institution.

Program Director: Dr. Ronald Gerrits
(MSP) (414) 277-7561, gerrits@msoe.edu

Program Director: Professor Matthew Hietpas, CCP
(Clinical) (414) 277-7209, hietpas@msoe.edu

Medical Director: Alfred J. Tector, M.D.
(414) 277-7209

Academic and Clinical Faculty:

Dr. Jon K. Borowicz, Christopher Brabant, Scott Brown, Dr. Vincent R. Canino, Dr. Larry Fennigkoh, Dr. John D. Gassert, Dr. Ronald J. Gerrits, Michael J. Gough, Matthew Hietpas, Dr. David C. Kress, Nicole M. Michaud, Dr. Lisa M. Milkowski, Dr. Daniel T. Minkel, Dr. Alfred J. Tector, Dr. Charles S. Tritt, Patrick L. VanderWal

In order to make the relationship between affiliated hospitals, surgical groups, surgeons and clinical instructors clear, the information is grouped by hospital:

St. Luke's Medical Center (Aurora Health Care)

Affiliated Surgical Group:

Infinity Heart Institute, Chartered

Surgeons:
- Alfred J. Tector, M.D. (Medical Director)
- Terence M. Schmahl, M.D. (Associate Medical Director)
- Francis X. Downey III, M.D.
- David C. Kress, M.D.
- James E. Auer, M.D. (retired)
- Paul E. Seifert, M.D.
- Deborah L. Manjoney, M.D.

Instructors:
- Nicole M. Michaud, CCP
- Michael J. Gough, CCP
- Matthew J. Hietpas, CCP
- Mary Jo Bukovic, CCP
- John Horvath, CCP
- Michael J. Sparacino, CCP

St. Francis Hospital (Covenant Health Care)

Affiliated Surgical Groups:

Milwaukee Heart Surgery Associates, SC

Surgeons:
- W. Dudley Johnson, M.D. (Associate Medical Director)
- Jerry L. Franz, M.D.
- Ramuhalli Srivyas, M.D.

Baxter Perfusion Services

Instructors:
- Patrick J. Caracci, CCP
- Michael Harloff, CCP
- Steven Palen, CCP
- Dwayne Gehman, CCP

Infinity Heart Institute, Chartered

(Same as listed above)

Sinai Samaritan Medical Center (Aurora Health Care)

Affiliated Surgical Groups:

Infinity Heart Institute, Chartered
Milwaukee Heart Surgery Associates, SC
Baxter Perfusion Services

St. Mary's Hospital (Horizon Health Care)

Affiliated Surgical Groups:

Infinity Heart Institute, Chartered
Milwaukee Heart Surgery Associates, SC
Baxter Perfusion Services

Children's Hospital of Wisconsin

Surgeons:
S. Bert Litwin, M.D. (Associate Medical Director)
James Tweddell, M.D.

Instructors:
Patrick L. VanderWal, CCP
Terence McManus, CCP
Christopher Brabant, CCP

In considering an applicant, MSOE takes into consideration the overall academic performance as indicated by transcripts, test scores, personal interview, letters of reference, work experience, if applicable and other factors.

Completion of all admission criteria does not ensure that the applicant will be selected for admission into the program. Because of the extensive clinical experience required, the maximum enrollment is limited to 10 students per year. In general, applicants selected for admission to the program are the most qualified of all those who apply.

Prior to registration, each student, in consultation with the MSP program director and the clinical program director, will file a curriculum plan with the Graduate Programs Council.

Clinical Insurance Cost

Currently the cost of insurance covering the MSP students is approximately $8,000 per year. Each student is required to pay a one-time insurance fee of approximately $1,000.

Rules and Guidelines for Student Participation in Clinical Education

At the time a student is offered acceptance into the program, the student will receive a copy of the "Rules and Guidelines for Student Participation in Clinical Education." Applicants wishing to review this document prior to submission of an application should contact the clinical program director.

Program Goals

The goals of the MSP program are:

1. to provide the student with the opportunity to develop educational skills at the master's level. (The student is not only expected to master topics in mathematics, fluids, heat transfer, technology, instrumentation, life sciences, and medicine but is also required to demonstrate the ability to understand how these topics can be integrated to provide quality perfusion services to the patient).

2. to provide the student with the opportunity to master the didactic information and clinical skills needed to provide quality perfusion services to the patient

3. to provide the student with the opportunity to understand and make judgments related to ethical and legal issues related to the practice of the perfusion profession

4. to provide the student with the opportunity to demonstrate the ability to formulate, design, perform, analyze and communicate the results of a research project

5. to provide the student with the opportunity to understand and demonstrate the ability to perform the professional duties and responsibilities of a perfusionist

6. to provide the student with the opportunity to understand the need to continue their professional development through seeking professional certification, service to the community, and service to the learned professional societies which serve the needs of the perfusionist

Model Schedule of Courses (V2.3b)

		QUARTER CREDITS			
		Fall	Winter	Spring	Summer
First Quarter					
PE-640	Applied Biophysical Transport	3			
PE-673	Advanced Physiology I	3			
PE-701	Clinical Extra-Corporeal Perfusion I	3			
PE-642	Electronic Medical Instrumentation	3			
Second Quarter					
PE-674	Advanced Physiology II		3		
PE-646	Medical Statistics		3		
PE-675	Pathophysiology		3		
PE-702	Clinical Extra-Corporeal Perfusion II		3		
Third Quarter					
PE-670	Pharmacology			3	
PE-601	Analysis of Biological Systems			3	
PE-645	Blood Compatible Materials			3	
PE-704	Pediatric Extra-Corporeal Perfusion			3	
Fourth Quarter					
PE-647	The Design of Experiments				3
PE-648	Biodynamics: Circulation				3
PE-703	Clinical Extra-Corporeal Perfusion III				6
Fifth Quarter					
PE-700	Extra-Corporeal Perfusion Laboratory	1			
PE-681	Perfusion Seminar in Applied Topics	1			
PE-650	Seminar on Clinical Medicine	2			
PE-651	Seminar on Medical Ethics	2			
PE-705	Clinical Extra-Corporeal Perfusion IV	6			
Sixth Quarter					
PE-699	Master's Thesis[1]		6		
	TOTAL CREDITS 66				

[1]During this quarter, the MSP student is expected to do the following:

1) Complete all clinical cases as specified by the Clinical Competency Review Committee. Each student is required to complete a minimum of 100 adult and 25 pediatric cases.
2) Write and pass the Clinical Comprehensive Examination.
3) Complete and successfully defend the Master's Thesis.

MASTER OF SCIENCE IN STRUCTURAL ENGINEERING

The Master of Science in Structural Engineering program emphasizes building structural design and analysis, and meets the needs of architectural, civil or structural engineers who desire increased knowledge to design modern building structural systems.

Courses focus on structural design topics such as advanced design of structural steel members and systems; design of light gage metal members and structures, reinforced concrete members and structures, wood structures, masonry structures, foundations; and selection of structural systems. Courses on advanced structural analysis including applications of the finite element method, structural dynamics, and structural stability, also are presented to provide a broader theoretical background for structural design.

The program culminates with a two-quarter capstone project focusing on structural engineering. The project presents the opportunity for the student to integrate the concepts learned in the classroom into a specific application. The project may focus on design issues, research in an area of structural engineering, or other related topic with the approval of the Master of Science in Structural Engineering program director. At the conclusion of the project, a comprehensive presentation (oral and written) will be given to a faculty review committee.

Courses are taught by faculty with extensive practical experience as well as academic credentials. Course work has been planned to show practical applications of structural engineering theory. Classes meet in the evenings so students may work in industry and attend class simultaneously.

The Master of Science in Structural Engineering program assumes the student has completed an undergraduate curriculum that included mechanics of materials, indeterminate structural analysis, structural steel design, reinforced concrete design and soil mechanics.

The Master of Science in Structural Engineering program currently is being offered as either a full or part-time program and can be completed in five years or less.

Program Director: Dr. Richard A. DeVries, P.E.
(414) 277-7596, devries@msoe.edu

Faculty:

Dr. Richard A. DeVries, Dr. H. Peter Huttelmaier, Dr. Mahmoud Maamouri, Lori L. Mayerhoff, Christopher H. Raebel, Dr. Douglas C. Stahl, Dr. John A. Zachar

Program Goals

The Master of Science in Structural Engineering program will produce graduates who:

1. have the ability to efficiently design and analyze contemporary building structural systems
2. understand material, system and method options available to the structural engineer
3. understand practical applications of structural engineering theory
4. understand the professional and ethical responsibilities of a structural engineer

Model Part-time Five-year Track (V1.2)

		QUARTER CREDITS		
		Fall	Winter	Spring
First Year				
AE-610	Applied Finite Elements	3		
AE-616	Structural Stability		3	
AE-732	AISI Steel Design			3
Second Year				
AE-612	Structural Dynamics	3		
AE-614	Lateral Loads on Structural Systems		3	
AE-742	Foundation Design			3
Third Year				
AE-740	Reinforced Concrete Member Design	3		
AE-720	Masonry Design		3	
AE-750	Wood Design			3
Fourth Year				
AE-730	AISC Steel Design	3		
AE-760	Structural Systems Selection for Buildings		3	
AE-746	Reinforced Concrete Structure Design			3
Fifth Year				
	Elective	3		
AE-890	Capstone Design Project I		3	
AE-892	Capstone Design Project II			3

TOTAL CREDITS 45

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COURSE DESCRIPTIONS

	Lecture Hours Per Week	Lab Hours Per Week	Credit In Quarter Hours
AE-610 Applied Finite Elements	**3**	**0**	**3**

This course reviews indeterminate structural analysis and behavior, and introduces the application of the finite element method to structural analysis. Topics include element stiffness matrices for one- and two-dimensional finite elements, formulation and solution of stiffness matrix, and application of commercial software. (prereq: graduate standing)

AE-612 Structural Dynamics	**3**	**0**	**3**

This course provides the necessary background for effective analysis of structures subjected to earthquake ground motion by presenting the theory of structural dynamics for single- and multi-degree freedom systems. Students will learn how to solve the equations of motion using exact and approximate methods for structures undergoing free vibration, harmonic loading, impulsive loading and general loading including ground motion. (prereq: graduate standing)

AE-614 Lateral Loads on Building Structures	**3**	**0**	**3**

This course provides the theoretical basis for application of seismic and wind provisions in U.S. model codes. Topics include seismic load analysis options, seismic detailing requirements for concrete, steel and other structures, and wind load options in the most recent ASCE 7 document. (prereq: AE-612)

AE-616 Structural Stability	**3**	**0**	**3**

This course provides the theoretical background of structural stability for single members and multistory frames. Topics include torsional buckling of beams, plate buckling, stability of bracing systems and application of commercial finite element software. (prereq: AE-610)

AE-720 Masonry Design	**3**	**0**	**3**

This course provides the fundamental background for design of reinforced and unreinforced concrete masonry elements by addressing analysis and design from the perspective of material and assembly behavior. (prereq: graduate standing)

AE-730 AISC Steel Design	**3**	**0**	**3**

This course presents advanced topics in member design, plate girder design for buildings, multistory frame behavior and design, connection design, and design of steel structures. (prereq: graduate standing)

AE-732 AISI Steel Design	**3**	**0**	**3**

This course presents the fundamental behavior and design of cold-formed steel members in accordance with the methodology published by AISI. The course includes theoretical analysis of section elements, the design of flexural members, compression members, connections and diaphragms, and practical design problems. (prereq: AE-610)

AE-740 Reinforced Concrete Member Design	**3**	**0**	**3**

This course presents the fundamental behavior and design of reinforced concrete members. Topics include complete design of reinforced concrete beams and columns. (prereq: graduate standing)

AE-742 Building Foundation Design	**3**	**0**	**3**

This course covers the design of foundations for buildings. Topics include review of soil mechanics, combined footings, mat foundations, drilled piers, driven piles and cantilever retaining walls. (prereq: AE-740)

AE-744 Prestressed Concrete Design	**3**	**0**	**3**

This course covers the behavior and design of concrete members prestressed with either pre- or post-tensioning. Design criteria from both PCI and ACI are used for the design of flexural and combined axial and flexural members. (prereq: AE-740)

		Lecture Hours Per Week	*Lab Hours Per Week*	*Credit In Quarter Hours*
AE-746	**Reinforced Concrete Structure Design**	**3**	**0**	**3**

This course presents the behavior and design of two-way reinforced slab systems and the integration of beams, columns, walls and two-way slab members into complete structural systems. (prereq: AE-740)

AE-750	**Wood Design**	**3**	**0**	**3**

This course presents the behavior and design of wood members and connections for flexure, shear, axial, and combined flexure and axial loads. (prereq: graduate standing)

AE-760	**Selection of Structural Systems for Buildings**	**3**	**0**	**3**

This course uses case studies of successful structures and failures to introduce evaluation of structural systems with regard to performance, cost and constructability, and requirements of gravity force resisting systems and lateral force resisting systems. (prereq: graduate standing)

AE-799	**Structural Engineering Independent Study**			**3**

Independent study allows a student with a particular interest in a topic to undertake additional work outside of the classroom format. The student works under the supervision of a faculty member and undertakes studies that typically lead to a report. (Consent of program director or department chairperson needed. The maximum credits of independent study applied to a Master of Science in Structural Engineering degree is three. Credits may not be transferred from other institutions.)

AE-890	**Structural Engineering Design I***	**3**	**0**	**3**
AE-892	**Structural Engineering Design II****	**3**	**0**	**3**

This two-course sequence is the independent capstone project of the Master of Science in Structural Engineering program. The student will complete a project that presents a comprehensive solution to a structural engineering problem. The problem may be formulated by the student, be based on the student's industrial experience, consist of physical research or consist of an analytic solution. The project must be approved by the Master of Science in Structural Engineering program director or the AE&BC Department chairperson.

* ***AE-890 requirements include the following:*** Written Problem Definition and Project Scope, Problem Approval, Project Schedule, Formation of Review Committee, Progress Reports to Review Committee, Begin Solution to Problem. (prereq: consent of Master of Science in Structural Engineering program director)

** ***AE-892 requirements include the following:*** Completion of Solution, Preparation of Written and Oral Reports, Final Oral and Written Presentation to Review Committee (prereq: completion of AE-890)

CS-581	**Object-oriented Programming**	**3**	**0**	**3**

Object-oriented programming presents a relatively new and different approach to developing software systems. The purpose of object-oriented programming is to reduce programming time, the insidious side effects often present in structured programming and the cost of software maintenance. Through the use of objects, classes, inheritance and polymorphism, the development of a suitable software system is enhanced. The course develops all these concepts through the use of C++ and its system of predefined classes and system development libraries. (prereq: thorough knowledge of C language)

	Lecture Hours Per Week	Lab Hours Per Week	Credit In Quarter Hours

CS-588 C Programming Language **3** **0** **3**

This course is designed for engineers and technologists who use high-level programming languages as a tool, or who develop software-based products. Topics include characteristics and applications of the "C" language, operators, data types, statements, control flow, functions, structured programming, pointers, arrays, library functions, I/O and mixed language programming. (prereq: computer programming such as CS-185)

CS-780 Software Engineering **3** **0** **3**

The software engineering process is presented, including specifications, requirements analysis, feasibility studies, metrics, design, implementation, testing, validation and maintenance. Subjects covered include detailed analysis and design techniques. Students will participate in a team project to design, develop and test a software system. (prereq: graduate standing and computer programming such as CS-182 or CS-185)

CS-870 Database Systems **3** **0** **3**

This course introduces the theory and practice of database design and application, and basic concepts of database management systems. Both relational and object-oriented databases are studied. Topics include data manipulation languages, normalization, data protection, optimization, client/server systems and large multi-user systems. (prereq: graduate standing, CS-780 and computer programming such as CS-182 or CS-185)

CS-880 Design of Operating Systems **3** **0** **3**

The design and implementation of modern operating systems are studied. A historical perspective is provided prior to investigating the topics of operating system components, file system structures, process synchronization and scheduling, memory management, deadlock detection and avoidance, concurrency, protection and security, networks and distributed computing. (prereq: graduate standing, CS-890 and computer programming such as CS-182 or CS-185)

CS-890 Computer Architecture **3** **0** **3**

This course presents CPU design from the system level. Topics include performance issues, instruction set design, design of computational circuits, CPU design and I/O design. Improving CPU performance by using pipelining and cache memory will also be discussed. Design of the CPU control unit will be done using a hardwired and a microprogrammed approach. High performance systems using parallel processors will be introduced. (prereq: graduate standing, EE-290, EE-291 or equivalent courses)

EE-502 Systems Analysis and Control **3** **0** **3**

This course covers the modeling of systems with electric circuits or blocks representing system operators. The course also covers transient and steady-state responses of systems, feedback control systems, interconnection diagrams and an introduction to nonlinear systems analysis and state space techniques. (prereq: EE-252 and MA-235 or equivalents)

EE-513 Linear Integrated Circuits **2** **3** **3**

This course covers the analysis and design of linear integrated circuits. Progressing from basic operational amplifiers, a variety of comparators and counters, signal generators, rectifiers, differential amplifiers, bridge amplifiers, active filters, multipliers and integrated circuit timers are studied. The laboratory requires that each class of circuit be designed and evaluated. (prereq: EE-310 or ET-355 or equivalent)

	Lecture Hours Per Week	Lab Hours Per Week	Credit In Quarter Hours

EE-520 Electromagnetics and Transmission Line **3** **0** **3**

The study of optical fibers, microwave lines, RF circuits and high-speed digital circuits is based on an understanding of high-frequency transmission lines. The purpose of this course is to examine the concepts and theory behind high-frequency signal transmission. The course begins with the understanding of basic electrostatics and magnetostatics before moving into electromagnetic waves and propagation. This concept is then thoroughly developed from a circuits viewpoint in the study of transmission lines. The Smith Chart is utilized to graphically determine and display transmission line results. A computer field solver is used to enhance visualization of fields and aid in simulation. (prereq: CS-182 or CS-185, MA-235 and PH-230, or equivalents)

EE-521 Digital Communication Systems **3** **0** **3**

This course covers important concepts and signaling techniques commonly used in digital communication systems. Pulse modulation methods including PAM, PWM, PPM and PCM are studied. ASK, FSK and PSK modulations are also studied. Random processes are introduced and are used to model noise. The effects of noise on bit-error probabilities are analyzed for various systems. Other topics include the matched filter, correlation and an introduction to error-correction coding. (prereq: MA-262, EE-401 or consent of instructor) Note: Either EE-521 or EE-724 can be taken for graduate credit, but not both.

EE-522 Digital Signal Processing (DSP) **3** **0** **3**

This introduction to the digital processing of signals includes the topics of impulse sampling, discrete time system transfer functions, steady-state frequency response, analog filters, Z-transforms, and FIR and IIR digital filter design. Discrete and fast Fourier transforms are developed and applied. (prereq: EE-303 or consent of instructor)

EE-523 Applications of DSP **2** **2** **3**

This course builds upon the EE-522 DSP lecture course. It is heavily laboratory and applications oriented, enabling the student to implement powerful algorithms on actual DSP hardware utilizing the assembly language of the DSP chip. Such algorithms as FIR and IIR digital filters, adaptive and multirate filters (interpolator), and discrete and fast Fourier transforms are programmed. The hardware is capable of processing audio signals in real time, effectively demonstrating the power of the techniques. Both software and hardware design techniques are considered. (prereq: EE-522, EE-291 or consent of instructor)

EE-524 Data Communications **3** **0** **3**

This course is designed to provide the student with the technical aspects of data communication. It extends the concepts of communication system theory, applying them to data communications situations. Topics include: data coding, error detecting and correcting techniques, data format, spectral analysis of baseband and modulated signals, modems, interface standards, multiplexing and computer communication network concepts. (prereq: EE-303 or consent of instructor)

EE-525 Radio Frequency Circuit Design **2** **2** **3**

The objective of this course is to develop an understanding of fundamental radio frequency (RF) design techniques and the difficulties encountered in RF design. After an overview of RF systems, microstrip transmission media and impedance matching are covered. This is followed by the design of filters, amplifiers, mixers and oscillators in the RF region. Computer-aided engineering software is utilized in the laboratory to help realize actual RF circuit designs. (prereq: EE-520 or consent of instructor)

	Lecture Hours Per Week	Lab Hours Per Week	Credit In Quarter Hours
EE-529 Microwave Engineering	**2**	**2**	**3**

This course emphasizes microwave transmission lines, especially microstrip, coax and rectangular waveguides. The theory is developed for each line in order to gain insight into transmission characteristics and operation. This is followed by a study of microwave resonant circuits, non-reciprocal ferrite devices and other microwave components. Fundamental and modern high frequency measurement techniques and components are covered in the laboratory. (prereq: EE-520 or consent of instructor)

EE-544 Power Electronics	**3**	**0**	**3**

In this course, the student is given background in device selection and power conditioning circuits that have application at high power levels. Topics covered emphasize the use of various active devices in inverters, converters, motor drives and power conditioning circuits. Topics include nonlinear magnetic circuits, and the use of integrated circuitry in closed-loop power systems. (prereq: EE-502 or consent of instructor)

EE-547 Power System Analysis I	**3**	**0**	**3**

This course is designed to give the students a solid foundation in classical methods and modern techniques in power system engineering. Methods of power system analysis and design, particularly with the aid of a personal computer, are presented. Topics include: the concepts of complex power, balanced three-phase circuits, transmission line parameters, transmission line performance and compensation, system modeling and per-unit analysis, circuit theory as applied to power systems, and load flow analysis. (prereq: EE-230, EE-502, or consent of instructor)

EE-549 Power System Analysis II	**3**	**0**	**3**

This course is a continuation of EE-547, which provides students with a working knowledge of power system problems and computer techniques used to solve some of these problems. Topics include: symmetrical three-phase faults, symmetrical components, unsymmetrical faults, technical treatment of the general problem of power system stability and its relevance, introduction to relaying principles and practice, and power system protection. (prereq: EE-547 or consent of instructor)

EE-560 Quality in Electronic Systems	**3**	**0**	**3**

Critical to all engineers is an understanding of the meaning of quality and the impact that understanding has on how tasks, engineering and otherwise, are performed. Through the entire gamut of activities resulting in industrial products, the engineer is a key factor of every process and has the responsibility of assuring that quality is implemented in an intentional, deliberate manner. This course seeks to instill the required understanding of quality via experiential activities, demonstrate its impact, and develop the needed statistical and organizational tools and techniques for quality analysis. (prereq: EE-513 and MA-262 or consent of instructor)

EE-562 Communication Systems	**3**	**0**	**3**

The concepts common to high frequency communication systems are covered initially in this course. The actual signal transmission performance is emphasized over signal processing aspects. This includes the study of scattering parameters, noise, typical system components, antennas, radio wave propagation and high frequency transmission line performance. The theory behind link performance is then developed and is illustrated in a satellite communications system and other RF communication systems to consolidate the concepts in this course. (prereq: EE-401, EE-520 or consent of instructor)

EE-564 Fiber Optic Communications	**3**	**0**	**3**

The course is designed for introducing fiber optics and their applications. It covers the structure and characteristics of optic fibers and the operational and physical properties of various optical components. Optical communications systems and the application of optic sensor systems are also covered. (prereq: EE-513, EE-520 or consent of instructor)

		Lecture Hours Per Week	Lab Hours Per Week	Credit In Quarter Hours
EE-574	**Programmable Controllers**	**2**	**2**	**3**

This course provides the theory and hands-on experience necessary to enable the student to design programmable controller system applications. This course highlights the systems approach as an aid to understanding modern industrial programmable controllers. Coverage begins with a review of controller basics and conventional approaches and proceeds through the concept of programmable logic including the use of microprocessors as controller elements. In addition, programming, input/output elements, peripherals, and standards and codes that govern interfacing aspects are covered. Development, design and understanding of analog input/output devices are also covered. The use of PCs as a device to program PLCs will be developed. The material is reinforced by laboratory sessions that provide the opportunity to learn to develop several popular system applications. (prereq: EE-290 or consent of instructor)

EE-579	**Digital Control Systems**	**3**	**0**	**3**

This course extends the classical control techniques from continuous control systems to the area of sampled data and discrete-time control systems. These systems are analyzed using z-transform and state-space techniques. The sampling theorem, reconstruction, frequency response, system design and digital compensators are also covered. (prereq: Laplace transforms and a control systems course such as EE-370) Note: Either GE-706 or EE-579 may be taken for graduate credit, but not both.

EE-581	**Fuzzy Sets and Applications**	**3**	**0**	**3**

This course introduces the student to the basic concepts of modeling uncertainty in systems through the use of fuzzy sets. The underlying concepts of fuzzy sets are introduced, and their role in such applications as semantic interpreters, control systems and reasoning systems is presented. Students gain first-hand experience with fuzzy sets through programming assignments and a short research project. (prereq: EE-290 or equivalent)

EE-584	**Neural Networks**	**3**	**0**	**3**

This course introduces the student to the basic concepts of modeling and simulating adaptive and learning systems using neural networks. The underlying concepts of neural networks are introduced, as well as a number of common topologies and learning rules. Students gain first-hand experience of neural networks through computer assignments and a short research project. (prereq: CS-200, EE-290 and MA-232, or equivalents)

EE-587	**Machine Vision**	**2**	**2**	**3**

This course introduces machine vision and its applications. Topics include lighting and optics, image formation and cameras. Image processing algorithms, processors and interfaces to other manufacturing systems are also covered. Laboratory sessions begin with introductions to various kinds of vision systems, followed by a group design project that develops and implements an inspection process. (prereq: consent of instructor)

EE-588	**Introduction to Artificial Intelligence and Expert Systems**	**3**	**0**	**3**

The objective of this course is to provide the student with an overview of topics in the field of artificial intelligence(AI). The course also provides the student with a working knowledge of designing an expert system and applying expert system technology in designing and analyzing engineering systems. The first part of the course covers historical background, knowledge acquisition and knowledge representation including propositional calculus, predicate calculus, semantic networks, frame systems and production rules. Various search techniques will be discussed. Fuzzy logic systems, neural network systems and computer vision systems will be briefly discussed in the second part of the course. Languages for AI problem solving such as Prolog and/or LISP will be introduced. The third part of this course will be devoted to the design of expert systems. Applications of expert systems in engineering system design and analysis will be stressed throughout. Case studies will be discussed. Students are encouraged to design expert systems for his/her own engineering applications, and an expert shell will be used to implement the design. (prereq: CS-150, MA-262 or consent of instructor)

	Lecture Hours Per Week	Lab Hours Per Week	Credit In Quarter Hours
EE-724 Digital Data Communication	**3**	**0**	**3**

This course covers basic and advanced techniques in digital data communication. Topics include random signals in noise, bandwidth, sampling, quantization, data formatting, matched-filter receivers, ISI, digital modulations, various methods of data communication, error probability, source and channel codings. (prereq: graduate standing, a course in systems analysis including transforms and transfer functions such as EE-202 or EE-502, MA-231, or equivalents) Note: Either EE-521 or EE-724 may be taken for graduate credit, but not both.

EE-813 Advanced Electronic Systems	**3**	**0**	**3**

This course covers techniques associated with the design and modeling of electronic systems. Nonlinear effects in bipolar and field effect devices are introduced. Nonideal operational amplifiers are analyzed and modeled. Noise and distortion analyses are discussed for various types of electronic circuits. Electronic circuits employing nonlinearities (e.g. modulators, detectors, phase-locked loops) are analyzed. Industry-recognized programs such as SPICE are used throughout the course. (prereq: graduate standing, courses in circuit analysis and electronics, such as EE-201 and EE-310, or equivalents)

EE-814 VLSI Circuit Design	**3**	**0**	**3**

This course presents the structure and properties of MOS transistors, and VLSI circuit design techniques for both digital and analog circuits. Digital circuits designed include the use of logic gates, tri-state devices and multiplexers. Analog circuit designs include amplifier stages and the consideration of noise. The course includes the use of computer-based circuit analysis tools for the simulation of circuit behavior. (prereq: graduate standing, EE-202, EE-290, EE-310 and EE-412, or equivalents)

EE-871 Modern Control Systems	**3**	**0**	**3**

The purpose of this course is to introduce students to principles and practice of modern control engineering. Z-transforms are introduced and utilized in conjunction with the analysis of discrete-time control systems. State-space analysis for continuous-time systems is covered in detail. Techniques on nonlinear systems analysis are developed and applied utilizing computer methods. (prereq: graduate standing, Laplace transforms and a control systems course, such as EE-370)

EM-600 Management Principles	**3**	**0**	**3**

This course introduces the student to the four basic management functions (planning, organizing, leading and controlling) and provides the basic foundation for more advanced courses in the engineering management program. It explores both the history of management thought and the theories, models, applications and research results that provide the tools for today's manager. This course uses the case study method to illustrate how these principles are applied in actual organizations. (prereq: graduate standing)

EM-610 The Application of Statistics	**3**	**0**	**3**

Decision making, planning and the presentation of information can be significantly enhanced by the intelligent use of mathematical methods or statistics. This course introduces the student to statistical tools and how the tools are being used in business today, with the focus being on application rather than the mathematics and theory of the methods. Statistical tools used to describe collections of data, estimate parameters, make comparisons, develop mathematical relationships or models, control processes, predict outcomes and plan experiments are covered. Specific tools include frequency distributions, estimation, hypothesis testing, Chi-square analysis, regression and correlation analysis, analysis of variance, control charts, process capability analysis, sampling and the design of experiments. (prereq: graduate standing)

	Lecture Hours Per Week	*Lab Hours Per Week*	*Credit In Quarter Hours*

EM-620 Finance and Accounting **3** **0** **3**

This course introduces the student to the finance and accounting concepts that are necessary to effectively manage in the business organization of today. It entails looking at both theory and practice, and covers the enterprise from overall operations to projects. It includes acquiring a knowledge of and working with the financial statements as well as the principle aspects of financial planning and control. In addition, basic financial concepts covered include cash flow presentation and analysis, capital investment decision making, and both long-term and short-term financial decision making.

EM-630 Principles of Research and Writing **3** **0** **3**

This course prepares students to research and write reports for MSEM courses and in business. It provides students with practical experience in research techniques including using the library and electronic means of research, including the Internet. Primary emphasis is on written communication, including the writing process, the importance of audience and how situational factors affect communication. Other topics covered are organizing concepts, using editorial tools on work after it is written, and using visuals and graphics to complement written work. And, it reviews the skills and techniques needed to effectively present material in oral presentations. (prereq: graduate standing)

EM-640 Operations Management **3** **0** **3**

Operations management provides students with an understanding of how service and production organizations manage and control processing of customer requests from prior to confirmed customer need, through customer receipt of products and services. The course does not deal with the management and concepts of individual functions, such as engineering and sales. Instead, it views these functions as resources and investigates how to integrate the resources to best meet the organization's market needs. This includes the design and control of the business processes responsible for effectively applying resources (people, equipment, materials, etc.). Good operations management is vital for survival in today's markets that demand fast delivery, better quality and "lean" organizations. (prereq: graduate standing)

EM-650 Managing Information Technology **3** **0** **3**

This course discusses the role of information technology (IT) in the management of the firm. Major topics are as follows: how IT can contribute to the achievement of business goals; factors involved in choosing and deploying ITs for use within the firm; and what the firm must do to successfully operate and use IT. Actual case studies are utilized to illustrate how firms have successfully overcome common obstacles to effectively utilize IT. (prereq: graduate standing)

EM-660 Applied Organizational Behavior **3** **0** **3**

This course examines the application of human behavior, attitudes and performance within an organizational setting drawing on theory, methods and principles from such disciplines as psychology, sociology and cultural anthropology. The focus is on individual, group and organizational performance. As an advanced course in management, it is conducted in a seminar format drawing on the organizational experiences of students. In addition, extensive outside readings are required in preparation for interactive discussion among the students. Topics discussed in depth are research in organizations, motivation theories, job design, group dynamics, job/organization design, organizational politics, leadership theories and organizational change. (prereq: EM-600)

	Lecture Hours Per Week	Lab Hours Per Week	Credit In Quarter Hours
EM-670 Marketing Management	**3**	**0**	**3**

This course introduces the student to the concepts of industrial/business marketing and the marketing management process. Topics include the role of marketing in the business process; the determination of the marketing mix elements of price, promotion and distribution; analyzing market opportunities, segmentation and positioning; formulating and evaluating marketing strategies, plans and programs; and marketing's role in new products. This course perspective is from the role of marketing in a total customer satisfaction driven organization. (prereq: EM-600)

Elective Courses

General Management

EM-704 Technical Entrepreneurship	**3**	**0**	**3**

This course is designed to develop a thorough understanding of the requirements to successfully start and operate a manufacturing or service business. Students choose a new product and develop a comprehensive business plan for starting and operating a business. The plan includes complete information, including product selection, financing, marketing and organization. (prereq: EM-620, EM-670)

EM-708 Executive Management Simulation	**3**	**0**	**3**

This is a business simulation with a general management focus. It requires decisions to be made in all major functional areas of a business, at every point in time, in order to achieve successful results. The scope of the data provided is sufficiently broad to require individuals to work in teams with shared functional responsibilities in order to facilitate decision making. This closely resembles the most common organizational practice and is one of the better modes of instruction. These functional responsibilities can be rotated among students to increase the learning experience. Individuals must be able to assume responsibility for decisions in many areas including production levels, R&D investment, pricing, levels of promotional expenses, marketing activities, employment levels and some capital expenditure. Thus, all aspects of management are practiced during the running of the simulation. (prereq: EM-670)

EM-709 International Business and Finance	**3**	**0**	**3**

Other countries now harbor the bulk of our competition and make up the opportunity base for partnering and expansion. All technical managers must understand the impact of international corporations and cultures on their plans for products and services, or manufacturing. The course includes the following topics: the nature of international business and foreign trade; trade between nations; the multinational corporation and foreign investment; the foreign exchange markets; trade barriers; foreign legal, political and economic environments; the importance of international cultures; accounting and taxation issues; and the control of international businesses. (prereq: EM-600, EM-620)

Math and Modeling

EM-712 Decision Support for Operations Management	**3**	**0**	**3**

This course provides the student with the fundamentals of mathematical decision-making tools as they are used in operations management. Mathematical programming models including linear and integer programming for resource allocation and transportation models are covered. Mathematical forecasting techniques are reviewed. The student is introduced to the basics of simulation as applied to such operational problems as shop floor scheduling. Students need to have access to a recent version of a spreadsheet program which includes these models. (prereq: EM-610, EM-640)

	Lecture Hours Per Week	Lab Hours Per Week	Credit In Quarter Hours

Finance

EM-721 Cost and Capital Investment **3** **0** **3**

This course is intended to integrate with the other management courses by providing the techniques for quantifying business decisions and the selection of the best alternative. The course is based on the time value of money concepts and the interest formulas and their use, which include present worth, annual cost and IRR calculations. Topics in the course include alternative analysis, tax concepts, life cycle costs, cash flow analysis, decision trees, risk analysis, capital budgeting, lease/buy decisions and inflation analysis. (prereq: EM-620)

EM-722 Financial Management **3** **0** **3**

This course covers the role of the financial manager in a firm from both the short-term operational management perspective and the long-term strategic planning perspective. Topics include cash flows, risk and return, valuation, capital budgeting, leverage, capital structure, long-term debt, common and preferred stock financing, net working capital and short-term financing, cash planning, and mergers and acquisitions. (prereq: EM-721)

EM-724 Managerial Economics **3** **0** **3**

Basic microeconomic theory is introduced, including a review of the organization's environment and goals, demand, production and cost theory, and its integration under various market structures (perfect competition, monopoly, oligopoly and monopolistic competition). The application of this theory is made to issues of industry structure and managerial decision making with respect to pricing of goods and services, and of inputs to production decisions. The use of marginal and incremental cost analysis in making managerial decisions is discussed. (prereq: EM-620)

EM-725 Construction Financial Management **3** **0** **3**

Construction financial management is managing a business with the goal of making profit. Two viewpoints are considered – owner and contractor. Construction financial management begins with the bid process. It covers the management of the firm's resources, including net working capital, overheads, productivity, equipment costs and revenue recognition. Topics include bid strategy, construction accounting, the cost estimate, life cycle costing, cash flow analysis, profits, financial planning and tax planning. (prereq: EM-721)

EM-726 Advanced Managerial Costing **3** **0** **3**

This course considers the perspective of financial controls in industry from the standpoint of conventional accounting. This is placed in the current backdrop of organizational change that is sweeping the business climate. The agenda will consist of lectures, guest speakers, field trips and student project teamwork. Background material covers a broad spectrum of economic, industrial and social factors that are involved in technical change. Current operating controls used in industry and how they compare with long-term perspective are presented. On the long-term, the process deals with strategic planning, capital budgeting, inflation accounting and productivity. The course reviews the current trends that are taking place in financial reporting, such as activity-based accounting and other tools. (prereq: EM-722)

Communication

EM-735 Managerial Communication **3** **0** **3**

This course addresses theory and practice in the design of organizational structure, processes and systems to optimize communication. It demonstrates how improved communications can lead to improved productivity. Among the topics are the communication process, formal and informal communication, interpersonal communication, barriers to effective communication, silent communication and how to improve the communication process in organizations. (prereq: EM-630)

	Lecture Hours Per Week	Lab Hours Per Week	Credit In Quarter Hours
EM-744 Supply Chain Management	**3**	**0**	**3**

This course examines the modern concept of optimizing the entire supply chain, from raw material to customer. It considers each element going into supply chain management, including forecasting and planning, inventory, transportation, facilities and product availability. Throughout, it identifies pressures to suboptimize the supply chain, as each player attempts to optimize its own segment of the supply chain. (prereq: EM-650)

Operations

EM-745 Strategic Technology Development	**3**	**0**	**3**

This course considers problems and opportunities involving the philosophy of industrial research, product development and business strategy. It attempts to provide a better understanding of the process of technological innovation, and the need to identify and deal with managerial problems with real-world managerial decisions. Background is presented touching on broad economic, industrial and social factors that are involved in technical change. Practical consideration also is given to such areas as project management, technical planning, budgeting and many other aspects of managing technical organizations. (prereq: EM-610, EM-660)

EM-746 Quality Management and Engineering	**3**	**0**	**3**

Productivity and quality are the result of the sound management and use of available resources. The course introduces the fundamental principles for building and managing a total quality program. It includes definitions of the basic elements and subsystems for a total quality system; the organization for quality; and an introduction to the technologies of quality control, including quality control engineering, process control engineering, quality information, equipment engineering and reliability engineering. Various statistical methods and applications as they are related to analyzing, controlling and improving operations are identified and explained. (prereq: EM-610)

EM-747 Advanced Manufacturing Management	**3**	**0**	**3**

This course addresses the technological and operations issues facing today's manufacturing or service managers. The course provides students with the knowledge of the fundamental changes that are required to compete in the new industrial global market, changes that usually begin in manufacturing but extend throughout the entire organization. Aspects of identifying, evaluating, applying and managing new technology are a focal point of the course. In addition, students will develop and use a checklist for evaluating existing operations against world-class standards. (prereq: EM-640, EM-712)

EM-7472 Lean Manufacturing	**3**	**0**	**3**

This course uses a seminar format to involve students in learning about and applying the concepts of Lean manufacturing. This includes application of "pull" control, continuous improvement, improvement in material and information flow, value stream management and defining value from the customers' perspective. The course involves six full-day sessions, presented by leading practioners of Lean concepts. Each session includes opportunities for interaction and discussion. The challenges involved in evaluation, applying, and managing new technology and methods are a focal point of the course. Further, the course addresses the technological and operations issues facing today's manufacturing or service managers.

EM-7505 Leading Project Teams	**3**	**0**	**3**

This course examines the techniques of studying, analyzing, improving, managing and leading the growth, productivity, and development of individual and group competencies to enhance project performance. It includes the processes required to make the most effective use of the people involved with the project. The importance of involving team members in the linking and overlapping of process groups in various project phases is emphasized. This course helps managers deal with value dilemmas, conflict, resistance to change and project team-building skills. (prereq: EM-620)

	Lecture Hours Per Week	Lab Hours Per Week	Credit In Quarter Hours

Organizational Behavior

EM-762 [716]* Development and Redesign of Organizations **3 0 3**

Techniques of studying, analyzing and improving the growth, productivity and development of organizations to deal with today's problems and issues are explained and practiced. This course deals with techniques to develop the normal, healthy organization and also with more radical interventionist techniques needed for organizations with critical problems where time is of the essence. The importance of involving employees and of concern for the total systems effectiveness of the corporation are emphasized. This course helps managers deal with value dilemmas, conflict, resistance to change and team-building skills. (prereq: EM-660)

EM-766 Bargaining and Negotiating **3 0 3**

This course is designed to familiarize the student with strategies for managing conflict, and the processes involved in distributive and integrative negotiations. Other topics include influencing tactics, persuasion, power, third-party interventions and negotiating in a group context. Through the use of workshop formats, videos and role-playing activities, this course's intent is to improve one's negotiating skills in an organizational environment. (prereq: EM-660)

EM-767 Team Management **3 0 3**

This course addresses the fundamental aspects of teams: their formation, stages of development, groups vs. teams, types of teams, diversity, leadership and methods to improve their functioning. Hands-on activities are included to provide the student with the opportunity to learn and improve skills to be a more effective team member. Lastly, the course explores the organizational conditions necessary to support, develop and change. (prereq: EM-660)

EM-768 Human Resources Management **3 0 3**

This course is designed to acquaint students/managers with the critical role of human resources in modern industrial organizations. In addition, human resources management as a discrete management function is defined, and its contribution to organization effectiveness is developed. Particular emphasis is placed on the linkage between organization strategy and human resources strategy. The theoretical basis of various human resources programs is covered, as well as an overview of the legal and regulatory environment that affects human resources practices. Human resources aspects of quality and productivity programs are investigated. Workforce diversity and substance abuse issues are evaluated. Completion of this course should enable students/managers to assess the effectiveness of alternative human resources strategies and to understand how these strategies affect organization effectiveness. (prereq: EM-660)

EM-769 Alternative Reward Systems **3 0 3**

This course is designed to acquaint new managers with the role of reward and recognition systems within the broad context of motivation. In addition, determining the need for and timing of reward system modification within large-scale organization change efforts is assessed. Particular emphasis is placed on the linkage between reward systems and firm strategy, core competencies, organization structure (teams, etc.), and organizational culture. The evolving attention on identifying and defining individual competencies as a logical follow-on to firm core competence identification is investigated as a potential reward system driver. A review of several modern reward systems will be accomplished, such as small-group incentives, skill-based pay, competency-based pay, gainsharing, combinations of these, etc. Completion of this course should sensitize new managers to the evolving organizational role of modern reward systems. In turn, they will be capable of assessing issues of "fit" or linage between rewards and other critical organizational elements. (prereq: EM-660)

	Lecture Hours Per Week	Lab Hours Per Week	Credit In Quarter Hours

Marketing

EM-770 New Product Management **3** **0** **3**

This course is designed to develop a thorough understanding of the new product development process. The major stages of the process are ideation, concept evaluation, commercialization and on-going product management. The course uses multifunctional teams as the center of the new product development process. This team approach is consistent with, and integrates, the concepts of concurrent engineering, empowerment, total quality and customer/market driven strategy. (prereq: EM-620, EM-670)

EM-771 International Marketing **3** **0** **3**

As the geographical boundaries that have separated countries and continents are broken down by technological advances in communication and transportation, we are faced with global markets unlike those that industrial and technical enterprises have encountered in the past. Topics include the importance of geographical location; international business practices and opportunities; the legal, economic and political environments; international marketing intelligence; international product policy; international pricing, distribution and promotion; technology and the multinational enterprise; and coordinating international marketing. (prereq: EM-670 or EM-709)

EM-773 Technical Sales and Management **3** **0** **3**

This course examines selling and the management of a sales force. It emphasizes trade and industrial selling, but also deals with retail and direct-to-customer sales, including the selling of services. It involves the student in the sales process, product application consulting, as well as the legal, social, ethical and personal responsibilities of the sales engineer. It incorporates the nature and scope of sales management, time and territory administration, and it serves as the link between selling and marketing. Emphasis also is placed on selling as a process that benefits both buyers and sellers. (prereq: EM-670)

EM-774 Marketing Simulations **3** **0** **3**

This course takes the student through marketing decision making in a simulated global market environment. Students work in teams competing against one another with grades determined by their decisions. All decisions are reviewed at the end of the course as to their effectiveness. (prereq: EM-670)

EM-775 Marketing Strategies **3** **0** **3**

Getting close to the customer and building sustainable customer relationships through integrating sales and marketing is mandatory for success in today's highly competitive markets. The level of customer loyalty a firm builds directly influences sales growth and corporate profitability, and the strategies it uses to acquire new customers. This course examines the strategies that have proven effective in building customer loyalty, while at the same time, lowering sales costs. An essential element is to investigate the dual strategies of account penetration and cultivation. Another aspect focuses on using a marketing database for new customer acquisition. Other topics covered include relationship-based marketing techniques, integrated marketing and sales communication, marketing database management and the economics of marketing. (prereq: EM-670)

Law and Ethics

EM-780 Modern Business Ethics **3** **0** **3**

This course offers a survey of contemporary topics in business ethics germane to students' professional lives, and exercises for developing skills in ethical analysis. The course seeks a balance between theory and practice appropriate both to the level of the course and to the needs of its students. Readings are drawn from the established philosophical literature in the field. Case studies are generously employed both to explicate issues raised and to develop analytical skills. Topical areas that are likely to be raised in the students' professional experience are selected for discussion. (prereq: EM-660)

	Lecture Hours Per Week	Lab Hours Per Week	Credit In Quarter Hours

EM-782 Construction Law and Contracts 3 0 3

Material presented covers construction law, contracts and labor relations. Topics include Davis-Bacon Act, national labor relations, closed vs. open shop, dual shop, joint venture, national and international policies and contracts, and construction liability. (prereq: graduate standing)

EM-783 Environmental Law – Water and Soil 3 0 3

As a result of this course, the student should be able to gain an appreciation of the scope and magnitude of federal, state and local environmental laws in each medium, such as air, wastewater, soils, groundwater, and solid and hazardous wastes. They also learn to spot key issues as they arise in future employment, and to analyze problems to obtain defensible solutions. (prereq: graduate standing)

EM-784 Environmental Law – Air Quality 3 0 3

This course covers the current requirements and implications for organizations of the Clean Air Act as amended in 1990. It deals with emissions from processes and vehicles, permits and controls, as well as enforcement, violations and penalties. It is of interest to manufacturing industries, utilities and those organizations employing gasoline-powered engines, as well as all organizations that have employees commuting to work. (prereq: graduate standing)

Project Management

EM-790 Engineering Project Management 3 0 3

This course takes the student through a project from start to finish, working out the impact of the project on the corporation. This includes sales revenue forecasting, capital budgeting, analyses of feasibility, risk and sensitivity. The course also includes techniques of budgeting, planning, financing and controlling. Other issues including environmental impact review, obtaining permits if needed, selecting consultants and the contract bidding process. (prereq: EM-721)

EM-793 Construction Project Management 3 0 3

This course is designed to function as a supplement to EM-790, describing various options to owners undertaking construction projects. The course focuses on developing an understanding of various contractual relationships, industry standard contracts, responsibilities of parties from design inception, constructability, risk management, CPM management and claims. (prereq: EM-790)

EM-795 Managing and Implementing Projects 3 0 3

This course will present the theory supporting the project management process as well as a practical application to successfully implement projects. The course will combine a classroom and hands-on-approach to provide a student with the knowledge of defining and managing the scope of a project, preparing and managing a project plan, preparing and managing a project budget, evaluating and managing project risks, managing project issues, and closing and transitioning off the project. This course is the third in a sequence and is intended to be the summative project management course and provide opportunities for the student to successfully and creatively apply the tools and knowledge to manage a project in any industry. (prereq: EM-620, EM-7505)

EM-797 Topics of Engineering Management 3 0 3

This course addresses select topics in engineering management. (prereq: See the quarterly Timetable of Classes for topic.)

EM-798 Independent Option: Phase I 3 0 3

This course is intended to launch the student on the graduate thesis/project/case study. A variety of assignments are targeted at choosing a topic and adviser, developing an outline and bibliography, designing a research strategy and starting to write. This course is followed by EM-805. (prereq: 33 credits, thesis workshop recommended)

	Lecture Hours Per Week	*Lab Hours Per Week*	*Credit In Quarter Hours*

EM-799 MSEM Independent Study **3**

This option allows a student with a particular interest in a topic to undertake additional work outside of the classroom format. The student works under the supervision of a faculty member and undertakes a project and project report. (prereq: completion of 21 graduate quarter credits. The maximum total credits of independent study applied to the MSEM degree is six. Credits cannot be transferred from other institutions.)

EM-800 Strategic Management **3** **0** **3**

This course is designed to assist in understanding business policy, the recognition of both strategy formulation and implementation as distinct managerial activities. Business policy is generally viewed as having two major components: (1) strategic – the choice of purpose, molding organization character, and formulating broad plans and direction for the enterprise; and (2) administrative – implementation actions necessary to mobilize resources, carry out strategic decisions and achieve organizational goals. These matters of business policy are covered with text material, case studies, and assigned or selected readings. (prereq: all 600-level graduate courses)

EM-801 Executive Seminar **3** **0** **3**

This course consists of informal meetings with presidents and other executives of well-known companies. The objective is to expose the student to the current thinking of top management with respect to management problems at the corporate decision-making level. (prereq: 27 graduate quarter credits completed)

EM-804 Independent Option **6**

The student prepares a thesis, project or case study demonstrating proficiency in analyzing, solving and implementing the solution of a practical management problem. This option is prepared under the direction of a faculty adviser. (prereq: 33 graduate quarter credits completed)

EM-805 Independent Option: Phase II **3**

This course completes the last three credits of EM-798. The student continues working on the independent option with the adviser and completes the oral examination. There is no grade given. (prereq: EM-798)

EM-840 Operations Management Capstone **3** **0** **3**

Students will demonstrate their competency in operations management by undertaking an issue or problem facing operations managers and do an in-depth case study. In either case students will be involved in a rigorous and comprehensive project in the field of operations management. Students will provide a written document and make a class presentation.

EM-845 Managing for Quality Capstone Course **3** **0** **3**

This is a capstone course that completes the specialization track for managing for quality. It requires the student to demonstrate how quality or the lack of quality is the result of basic business processes within the business, including technical, business, economic and people processes. The first two or three sessions provide a general review of overall concepts and provide a basis for students to select topics for a project or case study. The remainder of the course focuses on projects or case studies developed by the students to demonstrate how management processes, methods and approaches affect quality. The projects or case studies require research, presentations and a term paper. Students are encouraged to select projects or case studies related to their work and their interests. The work may be done on an individual or team basis. (prereq: all required MSEM courses, EM-746 and one of the following courses: EM-747, EM-762 or EM-770)

	Lecture Hours Per Week	Lab Hours Per Week	Credit In Quarter Hours

EM-860 Organizational Management Capstone Course **3** **0** **3**

This course is designed to give the student an opportunity to integrate the knowledge, skills and tools of managing/leading the qualitative process and human resources functions of an organization. The student demonstrates the ability to identify a current organizational or departmental improvement opportunity, and develops a project plan utilizing the theory and practice that have been developed in the organizational management track courses to improve or change the organization. The student is required to utilize systems thinking and creative learning approaches to develop a plan that would define measurable and value-added outcomes for the organization. The course emphasizes soliciting peer review and feedback, teamwork, open discussion and critique, and the ability to produce and present for review a plan within a structured time frame. (prereq: all required MSEM courses, and one course from the following: EM-735, EM-762, EM-766, EM-767, EM-768)

EM-870 Marketing Capstone Course **3** **0** **3**

This course enables the student to demonstrate competency in marketing. The course involves undertaking a rigorous and comprehensive project, such as a marketing plan, case study or similar project. This can be an individual or team project. (prereq: all required MSEM courses, and two courses from the following: EM-770, EM-771, EM-775)

EM-890 Program Management Capstone Course **3** **0** **3**

The capstone course of the program management track covers the process of project and program management within a firm and how that process provides the firm with a competitive advantage in managing capital. Students prepare a capstone project paper. Topics include accountability, capital requests, cost justification, capital management, risk assessment of capital expenditures, and the post-mortem feedback to management on the process. (prereq: all required MSEM courses, EM-721, EM-790)

EN-700 Technical Communication **3** **0** **3**

This course is designed to help graduate students improve their effectiveness in communicating technical information. It covers written communication, communication styles within organizations, theory of communication, interpersonal communication, nonverbal components of communication, group leadership and oral presentation skills. Basic theoretical communication concepts are examined with emphasis on applying these within the organization. A proposal for the student's MSE Capstone Engineering Project is developed and presented. (prereq: graduate standing)

EV-611 Applications of Chemistry in Environmental Engineering **3** **0** **3**

Course topics include the following: (1) rates of chemical and biochemical reactions with applications in disinfection and biological treatment; (2) acid-base reactions and the carbonate system with applications in neutralization and pH control; (3) complexation reactions and chelation with applications in chemical coagulation and metals bioavailability; (4) precipitation and dissolution phenomena with applications in iron and phosphate removal and carbonate scaling; (5) oxidation-reduction reactions with applications in metals removal processes (e.g., hexchrome reduction), biochemical reactions and acid mine drainage; (6) a survey of organic chemistry and how organic compounds react and behave in the environment, including principles associated with air-water partitioning, solvent-water partitioning, and sorption phenomena with application in air stripping and adsorption; and (7) a survey of environmental laboratory procedures and analytical techniques in environmental chemistry for both inorganic and organic compounds. The role of the environmental engineer in environmental data collection is discussed, including the preparation of sampling and analysis plans and review of laboratory data packages. (prereq: graduate standing in MSEV program or department consent; coreq: EV-612 or consent of program director)

		Lecture Hours Per Week	*Lab Hours Per Week*	*Credit In Quarter Hours*
EV-612	**Biology for Environmental Engineers**	**3**	**0**	**3**

This course covers the classification and naming of living things, the structure and function of biologically important macromolecules and cells, metabolic pathways and protein synthesis, basic genetic principles and ecological principles. Particular attention is given to practical environmental issues. Each student participates in a small group project focusing on environmentally important organisms or phenomena. (prereq: graduate standing in MSEV program or department consent; coreq: EV-611 or consent of program director)

EV-614	**Microbiology for Environmental Engineers**	**3**	**0**	**3**

This course covers the basic morphology, biology and distribution of the major microbial groups: viruses, bacteria, fungi and protozoa. Distribution of pathogenic microorganisms (and their surrogates) in the environment, and the methods used for their quantification and control are examined. Microbial growth and metabolism, and the resultant molecular transformations, are studied. The activities of microbes in specific habitats (i.e., biofilms, rhizobia, aquifers) are explored. Particular attention is given to microbes used to help solve environmental problems and to those that create environmental problems. (prereq: EV-612)

EV-710	**Environmental Statistics and Modeling**	**3**	**0**	**3**

This course presents topics in statistics needed for statistical analysis and modeling of air, water and other environmental systems. It also presents the methodology for developing the statistical models themselves. Several relevant case studies are presented. (prereq: undergraduate course in introductory probability and statistics, and graduate standing.)

EV-720	**Municipal Wastewater Treatment**	**3**	**0**	**3**

Course topics include the following: (1) characterization of the various types of wastewater pollutants and survey of the chemistry of these various pollutants; (2) design considerations for municipal sewage collection systems, suspended solids removal, aerobic biological treatment, anaerobic biological treatment, land treatment, nitrification/denitrification, phosphorus control and sludge handling; and (3) the fundamentals of treatment process controls. A case study of the design and construction of an actual municipal sewage treatment plant also is made. (prereq: EV-614)

EV-722	**Hydrogeology and Groundwater Pollution**	**3**	**0**	**3**

Course topics include the following: (1) presentation of the hydrologic cycle – rainfall, water losses, and groundwater runoff and routing models; (2) the unit hydrograph concept; (3) flood flows; (4) reservoir design; (5) governing equations of groundwater flow through porous media; (6) interaction of surface and groundwater flows; (7) groundwater contaminant transport; (8) numerical methods for parameter estimation applications to groundwater models; (9) hydraulics of wells; (10) analysis of seepage through dams; (11) seepage from canals; and (12) land drainage systems. (prereq: graduate standing in MSEV program or department consent)

EV-724	**Industrial Water Treatment and Stormwater Management**	**3**	**0**	**3**

Course topics include the following: (1) review of treatment standards and regulations as mandated by the Clean Water Act, Resources Conservation and Recovery Act (RCRA) and various industrial standards; (2) presentation of the unit treatment processes for industrial water and wastewater pretreatment, including pH adjustment, coagulation and flocculation, activated carbon absorption, microfiltration, ultrafiltration, reverse osmosis, ion exchange, greensand filters/iron removal, evaporation, disinfection and oxidation with UV/ozone, settling tanks, and oil and hydrocarbon removal; and (3) a survey of the current stormwater permitting. Students perform case studies of water treatment systems from several industries as part of a required research project. (prereq: graduate standing in MSEV program or department consent)

	Lecture Hours Per Week	Lab Hours Per Week	Credit In Quarter Hours

EV-726 Water Resources Management **3** **0** **3**

Water resources management is a growing area in environmental engineering. Communities need to deal with both water quantity and quality issues on a regional and watershed basis. The purpose of the course is to give an introduction to water resources management including such topics as hydrology and hydrological modeling, surface water quality, stormwater management and treatment, and wetlands classification and migration. (prereq: graduate standing in MSEV program or department consent)

EV-730 Hazardous and Solid Waste Minimization **3** **0** **3**

The U.S. Congress passed the Pollution Prevention Act of 1990, which states that pollution should be prevented or reduced at the source whenever feasible. This course is an introduction to both hazardous (RCRA Subtitle C) and solid (RCRA Subtitle D) waste management and strategies for source reduction of these wastes. Students are expected to complete a project that involves defining a baseline situation (process maps, generator status, applicable laws and regulations, and current costs), researching alternatives, and proposing a strategy that effectively reduces wastes generated and reduces life-cycle environmental impacts, and is cost effective. (prereq: graduate standing in MSEV program or department consent)

EV-740 Air Pollution Control **3** **0** **3**

This course presents strategies for waste minimization and pollution prevention and introduces the student to the concepts of air pollution control design, and the regulatory and environmental concerns that drive the air pollution control industry. Students are led through the design process from basic theory through practical application and case studies. The sources of air pollution and the available control options are presented and discussed in detail. (prereq: graduate standing in MSEV program or department consent)

EV-750 Plant Safety/OSHA Issues **3** **0** **3**

Course topics include the following: (1) federal regulations governing worker occupational safety and health; (2) an overview of the Occupational Safety and Health Administration; (3) a brief survey of human anatomy, physiology and pathology of the lungs, skin, ears and eyes within the context of potential industrial pathogens, chemical irritants or physical hazards; (4) identification and evaluation of industrial hazards including solvents, particulates, dermatoses, industrial noise, radiation, temperature extremes, ergonomically incompatible equipment and biological hazards; (5) techniques for the control of hazards, including ventilation, protective equipment, noise reduction strategies, principles of ergonomic design and product substitutions; and (6) case studies in designing and implementing an industrial hygiene program for various types of industries, including a description of the necessary record keeping, paperwork and documentation required. (prereq: graduate standing in MSEV program or department consent)

EV-752 Risk Assessment and Environmental Auditing **3** **0** **3**

Course topics include the following: (1) a review of the environmental risk assessment process; (2) a review of environmental auditing procedures, including an introduction to ISO 14,000 and its impact on the environmental auditing process; (3) an overview of federal requirements relating to environmental assessments and impact statements; and (4) a project involving the conducting of an actual audit of a facility. (prereq: graduate standing in MSEV program or department consent)

	Lecture Hours Per Week	Lab Hours Per Week	Credit In Quarter Hours
EV-754 Soil Science and Remediation Technologies	**3**	**0**	**3**

This course presents an overview of techniques to be used to clean up existing pollutants in soil, water or air in the vicinity of hazardous waste sites. Emphasis is on the remediation of pre-existing pollution rather than on pollution prevention strategies. Topics to be covered include the following: (1) surface water control strategies such as capping of surface impoundments, floating lagoon covers, grading, revegetation, diversion and collection; (2) groundwater contaminant clean-up and control strategies such as groundwater pumping, subsurface drains, subsurface barriers, and groundwater treatment procedures such as air and steam stripping, carbon absorption, biological treatment, ion exchange absorption, chemical treatments and reverse osmosis; (3) soil remediation procedures such as in-situ bioremediation, chemical remediation, soil flushing and physical treatment techniques; (4) procedures for the control of gas emissions and fugitive dust control from surface impoundments and landfills; (5) waste, soil and sediment disposal techniques; (6) monitoring strategies for remediated sites and leak detection strategies; and (7) remediation of leaking underground storage tanks (LUST). (prereq: graduate standing in MSEV program or department consent)

EV-756 Environmental Project Program Management and Life Cycle Cost Analysis	**3**	**0**	**3**

Today's environmental manager is faced with numerous environmental issues, all of which must be managed simultaneously. For any one environmental problem within a business or manufacturing setting, there are a number of possible technical approaches to controlling or eliminating that problem. The environmental manager for that business must select the best technical option from among many. This course presents techniques for evaluating, on a life cycle cost basis, the merit of the various technical options. Included in any life cycle costing is discussion on estimating long- and short-term liability costs. These potential liability costs represent a large proportion of the overall exposure a company faces when implementing a program to manage environmental wastes. Since many companies rely on the advice of consultants to make environmental decisions, this course also presents techniques for evaluating the competency of various consultants and presents strategies for working with consultants. (prereq: graduate standing in MSEV program or department consent)

EV-760 Environmental Law for Environmental Engineers	**3**	**0**	**3**

This course presents case law and regulations relating to all areas of environmental compliance needed by the practicing environmental engineer. Specific topics include common law liability issues; insurance; the rule-making process; the Federal National Environmental Policy Act; surface and groundwater regulations, including the Clean Water Act (CWA), and the Oil Pollution Act; regulations relating to solid waste and recycling, and to hazardous wastes, including the Resource Conservation and Recovery Act (CRA); laws relating to brownfields redevelopment; Sara Title III and community-right-to-know laws; OSHA regulations; the Toxic Substances Control Act; department of Transportation (DOT) regulations relating to shipments of wastes; the Clean Air Act (CAA); and laws relating to new source construction and major source operation permits. The emphasis throughout the course is on teaching the student processes by which the rules are made, and on where to research existing regulations and laws, so that the student can adapt to the constantly changing status. (prereq: graduate standing)

EV-799 MSEV Independent Study **3**

Independent study allows a student with a particular interest in a topic to undertake additional work outside of the classroom format. The student works under the supervision of a faculty member and undertakes studies that typically lead to a report. (prereq: consent of program director or department chair. The maximum credits of independent study applied to an MSEV degree is three. Credits may not be transferred from other institutions.)

	Lecture Hours Per Week	Lab Hours Per Week	Credit In Quarter Hours

EV-890 Environmental Engineering Systems Design I **1** **0** **3**

This is the first quarter of a capstone design course in which the student selects an environmental problem requiring resolution and proposes a comprehensive solution. The solution proposed must meet all technical standards and regulatory guidelines. Facsimiles of any necessary regulatory paperwork must be completed just as if the project were to be actually implemented. Requirements of the first quarter of the course include the following: (1) problem definition; (2) literature review; (3) identification of primary and alternative solution strategies with consideration given to the relative risks and short- and long-term liabilities associated with each; and (4) completion of a work schedule detailing tasks to be performed during the detailed design and evaluation phase of the project in the second quarter of the course. Selection of an environmental problem based on the student's current or previous industrial work experience is strongly encouraged. (prereq: completion of all EV courses except EV-892 and written permission of the MSEV program director)

EV-892 Environmental Engineering Systems Design II **1** **0** **3**

This is the second quarter of a capstone design course in which the student selects an environmental problem requiring resolution and proposes a comprehensive solution. The solution proposed must meet all technical standards and regulatory guidelines. Facsimiles of any necessary regulatory paperwork must be completed just as if the project were to be actually implemented. Requirements of the second quarter of the course include the following: (1) performance of the detailed technical design for all hardware components of the project; (2) preparation of all required software, i.e., completion of all required regulatory documents; (3) preparation of a final written report detailing the project [The report shall include as a minimum – (i) background on the project and a description of the environmental problem being solved; (ii) a literature review of previously encountered problems of a similar nature and of any relevant technologies; (iii) a description of the solution methodology chosen for the project, including a discussion of any alternative strategies that were considered during the design phase; (iv) a presentation of the final design including details of the economics of the proposed design, as well as technical specifications and completed regulatory paperwork]; and (4) an oral presentation providing an overview of the project before a faculty review committee. (prereq: EV-890)

GC-899 Graduate Continuation **0** **0** **0**

Graduate students are required to be continuously registered until graduation after initiation of the master's project, thesis or other capstone activity. Students who initiated the master's project, thesis or other capstone activity and are not registered for three or more graduate credits in a quarter must register for GC-899 and pay the Continuation Fee associated with this course. Registration in the GC-899 will appear on the student's transcript as a no credit course with no effect on the student's GPA. Students in the Master of Science in Perfusion program are required to be continuously registered for four quarters per academic year after initiation of the master's thesis. Students in other programs are not required to be registered for the summer program.

GE-703 Simulation and Modeling **2** **2** **3**

This course covers modeling and simulation of continuous and discrete systems for engineering analysis and design. Topics include stochastic systems, Monte Carlo methods, computer applications, development of models and algorithms, iteration methods, numerical methods and curve fitting. Applications of artificial intelligence in computer modeling and simulation also are discussed. Commercial simulation software packages are used in laboratory sessions. (prereq: graduate standing, CS-182 or CS-185, MA-235, or equivalents)

	Lecture Hours Per Week	Lab Hours Per Week	Credit In Quarter Hours

GE-705 Computer Assisted Engineering 3 0 3

The purpose of this course is to make students familiar with the application of computer-based tools in the analysis and design of engineering systems. Topics covered include data acquisition, frequency domain analysis, mathematical and statistical problem solving, the use of computers in graphics and an introduction to simulation. The course emphasizes the use of commercially available software packages for problem solving. Students are taught to write small programs using high-level languages and special purpose software library packages. (prereq: graduate standing, a course in differential equations such as MA-235, computer programming such as CS-182 or CS-185, engineering undergraduate background)

GE-706 Digital Control Systems 3 0 3

The purpose of this course is to provide a sound introduction to the techniques applicable to the analysis and design of digital control systems. Topics include sampling, difference equations, z-transform analysis, signal flow diagrams, digital filters, frequency response, stability analysis, and extensions of controller design criteria from analog to digital systems. (prereq: graduate standing, Laplace transforms and a control systems course such as EE-370) Note: Either GE-706 or EE-579 may be taken for graduate credit, but not both.

GE-797 Engineering Project I 3

A six-credit project is required of all MSE students. This GE-797 course designation is used for the first three-credit registration. In consultation with a faculty adviser, each student develops an analytical study, engineering project or other suitable technical study that incorporates the concepts learned in the program. The project can draw from multiple disciplines or can focus on a technical area within the student's chosen field of study. (prereq: completion of 21 graduate quarter credits, EN-700 and consent of program director)

GE-798 Engineering Project II 3

This GE-798 course designation is used for the second three-credit registration for the engineering project. This is a continuation of GE-797. (prereq: GE-797)

GE-799 MSE Independent Study 3

Independent study allows a student with a particular interest in a topic to undertake additional work outside of the classroom format. The student works under the supervision of a faculty member and undertakes studies that typically lead to a report. (prereq: consent of program director or department chair. The maximum credits of independent study applied to an MSE degree is six. Credits may not be transferred from other institutions.)

IE-843 Statistical Process Control 3 0 3

Statistical process control stresses the application of statistical methods to the study of control, and improvement of products and processes. It includes frequency distribution analysis, variables and attributes of control charts, process capability studies, scatter diagrams, statistical tolerancing, Pareto analysis, stratification, cause and effect diagrams, etc. Additional topics include statistical sampling for attributes and variables, and bulk sampling. (prereq: graduate standing, a course in probability and statistics such as MA-262 or MA-701)

MA-611 Engineering Mathematics I 3 0 3

This course concentrates in the area of linear algebra. Topics covered include matrix algebra, determinants, linear systems, eigenvalues and eigenvectors, functions of square matrices, vector spaces and linear transformations. (prereq: graduate standing, undergraduate calculus through differential equations)

MA-612 Engineering Mathematics II 3 0 3

This course reviews the algebra and studies the calculus of complex numbers. Topics covered include analytic and harmonic functions, power series and integration by residues. (prereq: graduate standing, undergraduate calculus through differential equations)

	Lecture Hours Per Week	Lab Hours Per Week	Credit In Quarter Hours

MA-701 Probability and Statistics **3** **0** **3**

This course presents statistical methods used in engineering. Topics covered are the laws of probability, probability distributions, moments, the central limit theorem, confidence intervals, tests of hypotheses, correlation and regression, statistical quality control, and reliability and life testing. (prereq: graduate standing, undergraduate calculus)

ME-512 Transport Processes **3** **0** **3**

This course explains the behavior of incompressible fluids under static and dynamic conditions. It addresses the principles of heat transfer by conduction, radiation and conversion as applied to both steady-state and transient systems. The application of heat transfer analysis is included. (prereq: one undergraduate course in thermodynamics such as ME-311, MT-355 or equivalent)

ME-514 Thermodynamic Applications **3** **0** **3**

This course offers a study of applications of thermodynamic principles to typical devices and systems such as compressors, nozzles, turbines, steam power plants, internal combustion engines, air conditioning, refrigeration, heat pumps and gas turbines. (prereq: one undergraduate course in thermodynamics such as ME-311, MT-355 or equivalent)

ME-521 Science of Engineering Materials **3** **0** **3**

The structure and solid-state reaction in single and multiphase materials under equilibrium and nonequilibrium conditions are covered. Elastic, plastic and viso-elastic behavior of materials are analyzed. Material systems, service stability, failure of materials and the selection of materials are considered. (prereq: two undergraduate courses in physics such as PH-110 and PH-220, undergraduate course in chemistry such as CH-200, or equivalents)

ME-703 Advanced Mechanics **3** **0** **3**

This course re-examines basic strength of materials and explores how it is extended for analyses of situations having complicated geometries, loading and stress distributions. Topics include development of approximate solutions using energy methods, the concepts of finite element analysis and applications of planar theory of elasticity. (prereq: graduate standing, undergraduate calculus through differential equations and one undergraduate course in strength of materials such as ME-207)

ME-821 Corrosion and Degradation of Materials **3** **0** **3**

This course covers the principles and mechanisms of corrosion and degradation for a variety of materials. Emphasis is given to the corrosion of metals; however, the degradations of polymers and polymer matrix composites also are covered. This course is intended to aid in understanding corrosion failures, and assist in material selection, materials substitution and corrosion prevention. (prereq: ME-521 or equivalent)

ME-822 Structure and Properties of Engineering Materials **3** **0** **3**

This course provides the student with an in-depth look at various engineering alloy and material systems. The effect of microstructural features on mechanical properties is discussed. Material property comparisons are made in order to demonstrate the advantages and disadvantages of various materials for specific applications. (prereq: ME-521 or equivalent)

		Lecture Hours Per Week	*Lab Hours Per Week*	*Credit In Quarter Hours*
ME-861	**Finite Element Analysis for Mechanical Engineering**	**3**	**0**	**3**

Application of the finite element method in the areas of stress analysis, heat transfer and fluid flow is covered in this course. Theoretical background is presented, and the interpretation of the results of the analysis as applied to the design process is stressed. Stress analysis includes 2-D and 3-D applications, contact problems and nonlinear analysis. Heat transfer analysis includes steady-state and transient, conduction and convection analysis in two and three dimensions. Fluid flow analysis also includes steady-state and transient, laminar and turbulent flow in two and three dimensions. This course stresses FEA as a design tool rather than the development of finite element theory. A commercial FEA program is used to perform the analysis, and illustrate and interpret the output. (prereq: ME-460 or MT-393, ME-703)

ME-862 Advanced Mechanical System Design **3** **0** **3**

This course reviews the analysis of springs and screws when subjected to a combination of steady and alternating loads. The course investigates the design and analysis of advanced machine components. Included are topics such as belting, clutches, brakes, welds, rivets, journal bearings, cams, impact stresses and fans. (prereq: graduate standing, ME-205, ME-206, and ME-207, or equivalent)

The following three courses are from the Fluid Power Engineering Option in the MSE program. The option is offered only on a special petition basis. A group of at least eight students must petition the MSE program director requesting that the option be scheduled. The petition will be reviewed, and a decision to offer the option will be based upon ensuring that sufficient enrollment be maintained in each of the courses offered. The Fluid Power Engineering Option will only be available in Milwaukee if offered.

ME-871	**Mathematical Modeling of Fluid Power Systems**	**2**	**2**	**3**

This course examines basic circuit theorems and the methods of solution. Emphasis is placed upon the methods of development, useful mathematical models of fluid power components such as valves of all common types, actuators, power sources, interconnecting lines and cavitation phenomena. Use of the computer to solve engineering problems is stressed. (prereq: graduate standing, one year of undergraduate calculus, ME-471 or MT-372)

ME-872 Theory of Fluid Power Dynamics **2** **2** **3**

A review is made of conventional methods for solving dynamic systems, i.e., Laplace transforms, Bode analysis, Nyquist analysis, root-locus and state-space representations. Methods are presented for mathematical modeling of complete hydraulic systems along with methods of solving the equations. Simulation, synthesis and identification methods are covered and comparisons are made. Practical methods of system linearization are applied to examples. Use of the computer is stressed. (prereq: ME-871, and ME-431/432 or MT-333)

ME-873	**Design of Feedback Control for Fluid Power Systems**	**2**	**2**	**3**

In this course, an electrohydraulic design project is undertaken by the student. The scope of the project should have industrial relevance and employ electrohydraulic technology in a closed-loop control application. Simulation of the proposed system is required, with the project results being presented in written and oral form. (prereq: ME-872)

MI-11200 Introduction to Epidemiology **3** **0** **3**

This course, along with Statistics (see MI-693), provides the essential tools necessary for outcomes research and the practice of evidence-based medicine. Topics include epidemiologic concepts and models, morbidity and mortality measures, research design methodologies, risk theory, correlation and causality, and the application of these principles to the evaluation of health services and public policy.

	Lecture Hours Per Week	Lab Hours Per Week	Credit In Quarter Hours
MI-13200 Introduction to Medical Informatics I & II A & B	**3**	**0**	**6**

This course is taught over two sequential quarters (3 credits each) beginning in the fall. This course provides the foundation for graduate study in medical informatics and is a broad overview of the field. It is recommended that all students begin their program of study with this course. Topics covered include the health care environment and culture, electronic medical records, clinical information systems (hospital, outpatient, nursing, laboratory, pharmacy, radiology, etc.), decision-support systems, clinical research and health-assessment systems, technology assessment and health care business processes.

MI-13201 Ethics in Medical Informatics	**3**	**0**	**3**

This course explores the ethical and legal issues applied to information access and use in the health care environment. Topics include patient privacy and confidentiality, data security, coding and reimbursement, conflicts of interest, intellectual property rights, medical error reporting, and business/professional responsibility.

MI-13203 Health Care Decision Support	**3**	**0**	**3**

Because of the sheer complexity of health care both clinically and operationally, organizations are turning to computer applications that support the decision-making process. This course highlights both clinical and operational decision support systems (DSS) as they are currently used and explores future applications. Clinical DSS topics include electronic medical records, computerized physician order entry, disease management systems, expert systems/neural networks, automated documentation, Bayesian networks, clinical vocabularies and evidence-based medicine. Operational DSS topics include executive information systems, consumer informatics and contract modeling. This is critical content as health care institutions increasingly focus on outcomes measures for clinical and business decision making.

MI-13204 Information Systems Project Management	**3**	**0**	**3**

The design and implementation of an informatics application in the health care environment is an incredibly complex project. This course provides a basic methodology for understanding and defining the scope of the project, planning and running it, as well as post implementation assessment. As a final project, students work either individually or in groups to produce their own project management documentation.

MI-13299 Internship or Research Project A & B	**0**	**0**	**6**

The student and an adviser design this project jointly. Each project is designed to provide the maximum learning experience. In most cases, this will be an applied project within a health care environment. The project should reflect the student's area of professional interest.

MI-693 Intermediate Statistics	**3**	**0**	**3**

This course, along with Epidemiology (MI-11200), provides the essential data analysis tools necessary for data mining and evidence-based medicine. The concepts in this course are also needed to assess information system performance and decision-making. Topics include probability theory, discrete and continuous variables, hypothesis testing, and regression and correlation analysis. (Prereq: Introductory course in statistics)

MI-743 Principles of Health Care Management	**3**	**0**	**3**

This graduate level course provides students with an overall understanding of the principles of management as are practiced in today's health care environment. Emphasis will be on those fundamentals of management that impact the performance of interdisciplinary teams and the interaction that occurs between individuals, the team, the organization and beyond. Topics include organizational theory, information and control, strategic planning, leadership, motivation and employee development, change management, project management, uncertainty, conflict, ethics and social issues. Case studies illustrating the topics in health care settings are used throughout.

	Lecture Hours Per Week	Lab Hours Per Week	Credit In Quarter Hours

MI-758 Medical Informatics Business Science **3** **0** **3**

This course presents a variety of topics related to the business aspects of the field of applied medical informatics. Topics include business case development, budgeting, RFPs, working with vendors/consultants, quality and performance in health care, and process evaluation/design/reengineering.

MI-783 Database Structures and Processing **3** **0** **3**

This course provides an overview of the current database modeling techniques, technologies and design principles. Topics include entity-relationship and semantic data modeling, relational, network, and hierarchical database technologies, normalization, data dependencies, resource sharing and distributed databases. (Prereq: Introduction to Medical Informatics II)

MI-786I Medical Informatics Journal Club **0** **0** **1**

Weekly readings will be selected from contemporary literature in medical informatics. Each student will choose an article once during the quarter, and write a summary and questions for online discussion with other students. Students must enroll in this course three times for a total of 3 credit hours.

MI-787 Health Care Systems Analysis and Design **3** **0** **3**

This course covers systems development methodologies, the systems development life cycle, the concepts, tools and techniques currently used in the analysis of health care information systems, and the design of new systems and applications. You will work in project teams to develop the preliminary design of an informatics application for a fictitious organization. (Prereq: Introduction to Medical Informatics)

MI-788 Medical Informatics Case Study Seminar **3** **0** **3**

This course is an in-depth study of real world medical informatics systems. It is run in seminar format and requires considerable reading in preparation for each class discussion. Case studies based on student internship/research projects (see MI-13299 A & B) will be used to discuss how and why a system is designed and implemented. The medical, business/financial, and legal implications of automating a health care function are discussed. (Prereq: Advanced standing in the MSMI program and consent of course instructor or program director)

MI-799 Medical Informatics Independent Study **0** **0** **3**

As an elective, this course allows a student with a particular interest in a topic to undertake a course of study outside of the traditional classroom format. Goals and deliverables from the independent study must be approved by the program director. Alternatively, graduate students may take an undergraduate course for graduate credit under the independent study designation. Additional requirements will be placed on students in this situation (See catalog section entitled, “MSOE Graduate Policy on Receiving Graduate Credit for an Undergraduate Course”) (Prereq: Consent of program director)

MI-885 Computer Network Design **3** **0** **3**

This course provides an introduction to telecommunication concepts necessary for understanding network design and operation both within and between health care organizations. Topics include network designs (topology), client-server and mainframe environments, the operation of various network hardware devices (servers, routers, gateways, modems, cable types, etc.), network operating systems (NT, W2000, Unix, etc.), and other network applications. The understanding of telecommunications concepts is essential for teaming with technical professionals.

		Lecture Hours Per Week	*Lab Hours Per Week*	*Credit In Quarter Hours*

MI-887 Health Care Network Security **3** **0** **3**

This course is a highly recommended elective. The management of clinical and administrative data is changing from paper to electronic systems. Without the necessary safeguards in place (policies, organizational structures, and network software and devices), the fundamental right of the patient to maintain his or her privacy will be violated. This course is intended to provide an overview of the efforts necessary to comply with HIPAA and maintain a reasonable level of health information security from both an organizational and technical perspective.

MS-5714 Computer Network Design II **3** **0** **3**

This course is the successor to Computer Network Design. The course provides a more in-depth discussion of network design concepts. Topics include discussion and comparison of different network technologies (ie: Unix, Ethernet, Novell), considerations when networking different hardware platforms, designing a network for maximum performance and a discussion of the HL 7 standard. Emphasis will be placed on network technologies and hardware platforms commonly used in a health care environment. (prereq: MI-885)

PE-601 Analysis of Biological Systems **3** **0** **3**

This course covers topics in mathematics, fluids, and mass transfer with specific applications to medicine and the life sciences. Topics include first and second order linear differential equations compartmental analysis, Laplace transforms, models of the heart and circulation, gas transport in the lungs and electrical properties of cell membranes. MATLAB is used as the computer software tool to solve many of the problems presented in this course. (prereq: graduate standing)

PE-640 Applied Biophysical Transport **3** **0** **3**

The objective of this course is to present the principles of fluid, mass and heat transfer as they apply to equipment used in extra-corporeal perfusion. MATLAB is used to solve various problem assignments.

PE-642 Electronic Medical Instrumentation **3** **0** **3**

The objective of this course is to introduce students to medical devices that they might be in contact with in clinical practice. Following a review of basic electrical and electronic fundamentals, this survey course progresses with a broad overview of the theory and clinical applications associated with a variety of diagnostic and therapeutic medical devices. Emphasis will include the basic design and operation of these devices along with discussion of their inherent risks, failure modes and safety precautions. Laboratory and/or demonstration exercises will be integrated when possible. (prereq: graduate standing)

PE-645 Blood Compatible Materials **3** **0** **3**

The objective of this course is to present the principles for selection of materials used in cardiopulmonary bypass (CPB) medical devices. Topics include the following: concepts of biocompatibility, structure and behavior of solids, metals, polymers, ceramics, biological tissues, blood-material interactions, sterilization, biocompatibility testing, vascular grafts, extra-corporeal blood pumps, ventricular assist devices (VAD), oxygenators, heart valves, pacer leads and blood substitutes. (prereq: graduate standing)

PE-646 Medical Statistics **3** **0** **3**

This graduate course focuses on the use, interpretation and limitations associated with a variety of inferential statistical methods commonly used within medical research. Particular emphasis is given to the analysis of variance (ANOVA) as it applies to both completely randomized and repeated-measure designs, multiple regression, correlation and the analysis of covariance (ANCOVA). The nonparametric analog to these tests is also covered, namely Wilcoxon signed-rank, Kruskal-Wallis and rank-correlation methods. Commercially available statistical software is used throughout the course. (prereq: graduate standing and one undergraduate course in statistics)

	Lecture Hours Per Week	Lab Hours Per Week	Credit In Quarter Hours

PE-647 The Design of Experiments 3 0 3

As a continuation of PE-646, this graduate course addresses the broader issue of experimental design and methodology as it applies to medical research. Emphasis is given to the entire research process from defining and refining the original research question, to evaluating its feasibility, assessing the reliability and validity of dependent and independent variables and measurements, selection of the appropriate statistical design, interpretation and presentation of results. Experimental and statistical techniques for the control of error variance also are covered. (prereq: PE-646)

PE-648 Biodynamics: Circulation 3 0 3

This graduate course is a continuation of PE-640. It deals in more detail with the mechanics of circulation. The major topics include blood flow in arteries, veins, microcirculation, lungs, coronary arteries and veins and skeletal muscle. (prereq: PE-640 or consent of the instructor)

PE-650 Seminar on Clinical Medicine 2 0 2

This graduate seminar on clinical medicine includes the following topics: assessment and management of risk factors for open heart surgery, blood conservation, hemodynamic monitoring, ventilator support, dialysis/hemofiltration, IABP/pacemakers/defibrillators, ventricular support devices, transplantation and special topics in cordiopulmonary bypass. (prereq: PE-670, PE-675)

PE-651 Seminar on Medical Ethics 2 0 2

This graduate seminar entails a self-conscious consideration of the requirements of professional ethics corresponding to the emergence of perfusion as an autonomous profession. Two topics dominate the discussion: the tension between the requirement of professional autonomy and the surgeon's presumed role as the "captain of the ship," and perfusion ethics' unique combination of elements of the fields of business ethics and biomedical ethics. (coreq: PE-705 or consent of the instructor)

PE-670 Pharmacology 3 0 3

This is a graduate-level course introducing the general principles of pharmacology. The main emphasis is on the basic mechanisms of drug actions and interactions with biological systems. The basic physiology, receptors that mediate drug actions, as well as the drugs themselves, are emphasized in each of the subject areas. Although the course is taught as an overview of pharmacology, special attention is directed to drugs that affect the heart, peripheral vasculature, kidneys and other areas pertinent to cordiopulmonary bypass.

PE-673 Advanced Physiology I 3 0 3

The objective of this course is to present the anatomy and physiology of systems, with an emphasis on how they relate to the profession and practice of Perfusion. Topics covered include: cell structure and function (with an emphasis on membrane function and transporters), membrane potentials and action potentials, skeletal and smooth muscle structure and function, and cardiovascular structure, function and regulation. (prereq: graduate standing or consent of the instructor)

PE-674 Advanced Physiology II 3 0 3

The objective of this course is to continue the study of anatomy and physiology begun in PE-673. Topics covered include: fluid compartments and regulation, plasma pH balance and regulation, and respiratory, renal, liver, endocrine and nervous systems function. (prereq: PE-673)

PE-675 Pathophysiology 3 0 3

The objective of this graduate course is to present basic pathologic processes in general. In addition, the course emphasizes those pathology topics more relevant to cardiovascular perfusion. These topics include thrombosis and hemostasis, congenital and acquired heart diseases, cardiomyopathies, and lung and brain pathology. (prereq: PE-673)

	Lecture Hours Per Week	Lab Hours Per Week	Credit In Quarter Hours
PE-681 Perfusion Seminar in Applied Topics	**1**	**0**	**1**

The objective of this course is to bring to campus outside speakers who address current topics in cardiovascular surgery and/or perfusion. (prereq: graduate standing or consent of the instructor)

PE-699 Master's Thesis	**6**	**0**	**6**

Students working toward the degree of Master of Science in Perfusion must design, perform, write and defend an original research project dealing with either the theory or practice of cardiopulmonary perfusion. (prereq: consent of the MSP program director)

PE-700 Extra-Corporeal Perfusion Laboratory	**0**	**3**	**1**

The object of this laboratory is to have the students use extra-corporeal equipment to study transport phenomenon as it applies to the practice of perfusion. Further, each student is required to study and demonstrate competence in catastrophic event management. (prereq: consent of the MSP clinical program director)

PE-701 Clinical Extra-Corporeal Perfusion I	**2**	**1**	**3**

The objective of this course is to provide a general introduction to principles of extra-corporeal technology, define the scope of practice for the perfusionist, and convey a general familiarity of the equipment, personnel and practices within the cardiac operating room. Topics include the following: history of cardiac surgery and perfusion, aseptic technique, extra-corporeal equipment and circuit design, hemodynamic monitoring, principles of gas transfer and oxygenator design, blood salvage techniques, intra-aortic balloon counter-pulsation, and perfusion safety. In the operating room, students observe cardiopulmonary bypass (CPB) procedures and assist in the set up and priming of CPB equipment. The primary clinical goal for the MSP student at the conclusion of PE-701 is to be able to set up and prime the heart-lung machine consistently without the aid of the clinical instructor. During surgical cases, students are under the direct supervision of physicians and board certified clinical perfusionists. (prereq: graduate standing and consent of the instructor)

PE-702 Clinical Extra-Corporeal Perfusion II	**2**	**1**	**3**

The objective of this course is to present to the MSP student detailed concepts of perfusion technology. Topics include the following: hemodilution, hypothermia, myocardial protection/preservation, coagulation management and pathophysiology of cardiopulmonary bypass (CPB). In the operating room, the student begins to assume more responsibility. There is continued emphasis on perfecting set-up and prime techniques. Students start to perform ancillary perfusion duties during the case such as charting, blood gas/ACT draws, cardioplegia delivery, and function as the primary perfusionist during the middle portion of the case. As the course progresses, the student attempts to initiate and terminate CPB. The primary clinical goal for the MSP student at the conclusion of PE-702 is to function as the primary perfusionist for the entire case. During surgical cases, students are under the direct supervision of physicians and board certified clinical perfusionists. (prereq: PE-701)

PE-703 Clinical Extra-Corporeal Perfusion III	**2**	**4**	**6**

The objective of this course is to continue to present to the MSP student detailed concepts of perfusion technology. Topics include the following: pharmacological review with emphasis on perfusion application, further discussions about the pathophysiology of cardiopulmonary bypass (CPB), pulsatile blood flow and other clinical management techniques, and circulatory assist device applications. In the operating room, the student has assumed the responsibilities as the primary perfusionist and begins to demonstrate proficiency in the practice of extra-corporeal technology in a more independent nature, but still under the direct supervision of physicians and board certified clinical perfusionists. The cases theoretically increase in difficulty with regards to the technical complexity, and the degree of involvement and/or application of advanced techniques by the student. The student is assigned cases, as they become available, including the following: adult ECMO, cardiac transplantation, ventricular assist device implantation and total artificial heart implantation. The clinical goal of the MSP student is to continue to improve perfusion techniques and gain more experience. (prereq: PE-702)

	Lecture Hours Per Week	Lab Hours Per Week	Credit In Quarter Hours

PE-704 Pediatric Extra-Corporeal Perfusion **2** **1** **3**

The objective of this course is to provide a fundamental basis of extra-corporeal technology applications for neonatal and pediatric patients. Topics include the following: fetal, neonatal and pediatric anatomy/physiology; congenital heart defects; pediatric perfusion circuits and devices; extra-corporeal membrane oxygenation (ECMO); and other associated topics. The course lectures are divided weekly into two parts: the first is an in-depth clinical perspective on associated topics by various health care providers from Children's Hospital of Wisconsin (CHW); the second is lecture by a pediatric perfusionist on the fundamentals of neonatal/pediatric perfusion. In the operating room at CHW, the student is exposed to a variety of neonatal/pediatric patients and various extra-corporeal applications. While in surgery, students are under the direct supervision of CHW physicians and board certified clinical perfusionists. (prereq: consent of the MSP clinical program director)

PE-705 Clinical Extra-Corporeal Perfusion IV **2** **4** **6**

The objective of this course is to provide lectures in the management of special cases and unusual problems associated with the application of extra-corporeal technologies, and to prepare the student for the American Board of Cardiovascular Perfusion (ABCP) Certification Examinations. Topics include the following: catastrophic event management, liver transplantation, operative field isolation, perfusion of the pregnant patient, hemoglobinopathies, accidental hypothermia and electrophysiology. The clinical goals for the MSP student are as follows: (1) complete all clinical cases and rotations; (2) obtain clinical release from the MSP Clinical Competency Review Committee; (3) complete all catastrophic event management testing; and (4) pass the written MSP Final Clinical Examination. While in surgery, students are under the direct supervision of physicians and board certified clinical perfusionists. (prereq: consent of the MSP clinical program director)

PH-863 Electronic Materials and Devices **3** **0** **3**

Four broad areas covered in this course are the crystal structure of solids, electronic properties of solids, the principles of p-n junctions, and semiconductor device and integrated-circuit technology. Specific topics to be covered include space lattices and crystal structure, the energy band theory of solids, theory of the p-n junction, semiconductor diodes, bipolar junction transistors, junction and insulated-gate field-effect transistors, and integrated-circuit design potentials and limitations. (prereq: graduate standing, PH-110 and PH-230, or equivalent)

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