

College of Engineering, Technology, and Architecture

The College of Engineering, Technology, and Architecture (CETA) provides challenging programs that prepare graduates for stimulating, meaningful, and rewarding professional careers.

A National Science Foundation study has predicted a shortage in the engineering workforce. The complexities of today's products and processes require more education and continued retraining of engineers. Engineers currently in the workplace, as well as those who will graduate in the future, must augment their technical knowledge and skills in order to stay abreast of new developments and provide the technical leadership that will be needed.

The graduate program in engineering prepares its students for a meaningful profession that anticipates trends in engineering practice. Students are trained to think independently to solve engineering problems in a global framework.

Architecture prepares students for a variety of professional careers in the design and construction industries. The program emphasizes an integration of artistic principles, engineering fundamentals, and business understanding with the constant exploration of innovative design. For students who want to broaden their education at the graduate level, the architecture program offers several combined or dual degree programs in conjunction with other graduate programs at the University, including the M.B.A. (Barney School of Business), the M.F.A. (Hartford Art School), and the M.Engr.

Mission

The College of Engineering, Technology, and Architecture delivers a high-quality education and prepares individuals for professional careers

in engineering, technology, and architecture, or further graduate studies. Our programs prepare individuals to function as effective members of a global society. Programs promote technical excellence, reasoning ability, communication and interpersonal skills, and an understanding of ethical and moral issues. Our graduates are strongly encouraged to pursue professional registration in their chosen fields. Programs are available to both day and evening students. Practice-oriented educational experiences are offered at the graduate and undergraduate levels.

Faculty

The faculty of CETA combine impressive educational backgrounds with broad experience in business and industry. Their primary commitment is to teaching. The college's full-time faculty members are joined by a select group of architects, engineers, and researchers from local industry who serve as adjunct faculty. Their experience reflects pioneering work in their specialties.

The faculty in the Department of Architecture are practicing, registered, professional architects, who engage in consulting and design. This professional involvement brings a high degree of technical, managerial, and design experience to the classroom. The full-time faculty members are joined by a select group of architects from local firms who serve as adjunct faculty.

The faculty in the engineering departments are professional engineers who are currently engaged in consulting and research in their specialties. This professional involvement and the leadership roles that faculty play in their professional communities bring a high degree of technical and managerial ability to the classroom.

Awards received recently include grants from the National Science Foundation, NASA, the Society of Manufacturing Engineering, Hewlett-Packard, the Department of Energy, United Technologies, and Connecticut Innovations, Inc.

Students enrolled in the E²M program also benefit from the Barney School faculty's contacts and experiences with the regional, national, and international business communities.

Accreditation

All CETA graduate programs are accredited by the New England Association of Schools and Colleges and by the Board of Higher Education of the State of Connecticut.

The Master of Architecture program holds candidate status with the National Architectural Accrediting Board (NAAB) 1735 New York Avenue, NW, Washington, DC 20006; www.naab.org.

The following is a statement promulgated by the NAAB: "In the United States, most state registration boards require a degree from an accredited professional degree program as a prerequisite for licensure. The National Architectural Accrediting Board (NAAB), which is the sole agency authorized to accredit U.S. professional degree programs in architecture, recognizes two types of degrees: the Bachelor of Architecture and the Master of Architecture. A program may be granted a five-year, three-year, or two-year term of accreditation, depending on its degree of conformance with established educational standards. Master's degree programs may consist of a pre-professional undergraduate degree and a professional graduate degree, which, when earned sequentially, comprise an accredited professional education. However, the pre-professional degree is not, by itself, recognized as an accredited degree. The NAAB grants candidacy status to new programs that have developed viable plans for achieving initial accreditation. Candidacy status indicates that a program should be accredited within six years of achieving candidacy, if its plan is properly implemented."

Facilities

The extensive, modern facilities of the Integrated Science, Engineering, and Technology complex, the Harry Jack Gray Center, and the Auerbach Computer Center provide ample classroom and conference space, as well as laboratories and state-of-the-art computer hardware and software and studio facilities. CETA has more than 250 microcomputers that can be used as stand-alone systems or in an interfacing environment with the University server. The

college also operates a Local Area Network (LAN) that links faculty and student laboratory computers. The laboratories provide opportunities for research in acoustics, vibrations, heat-power, power systems, data acquisition, energy conversion, automatic controls, electronics, digital signal processing, fuzzy logic, neural nets, VLSI, FPGA/CPLD, fluid mechanics, water resources, instrumentation, materials, computer engineering and science, geotechnical engineering, geographical information systems, manufacturing, computer-aided manufacturing, design, mechatronics, biomechanics, advanced AutoCAD, advanced digital presentation, 3-D modeling, and designated architectural studio space. Specialized computer programs are also available, such as ProEngineer, Working Model, Human CAD, DFM, Mechanical Desktop, Watershed Modeling Systems (WMS), ArcGIS, Idrisi, MARC, ANSYS, Fluent, Virtual Prototyping Software (ADAMS), PSpice, Matlab, Simulink, VisSim, LabView, Neural Ware, and Xlinix. A state-of-the-art mechatronics laboratory has facilities to conduct experiments with CNC machine tools.

Engineering Applications Center

The Engineering Applications Center at the University of Hartford is managed by the College of Engineering, Technology, and Architecture with support from the Barney School of Business and the College of Arts and Sciences. It comprises the Acoustics and Vibrations Laboratory, the Advanced Manufacturing Institute, the Biomechanics Institute, the Environmental Institute, the Clean Energy Institute, the Institute for Life Support and Sustainable Living, and the Signal-Processing Institute.

The center provides local business and industry the opportunity to apply new technologies to their products and processes through application projects, demonstrations, short courses, symposia and forums in a wide range of current interest areas. In addition to providing resources to industry for interdisciplinary technology transfer, the center contributes to the quality of engineering education at the college by involving students in its projects.

Admission Requirements

Admission requirements include the following:

1. Completed application form
2. Letter of intent
3. Official transcripts (a minimum 3.0 GPA as an undergraduate*)
4. Professional letters of recommendation: two for M.Eng., three for M.Arch.
5. Architecture candidates must submit a portfolio.
6. Engineering candidates must have an appropriate baccalaureate degree in engineering from an engineering degree program accredited by the Engineering Accreditation Commission (EAC) of the Accrediting Board for Engineering and Technology (ABET).*
7. TOEFL (international students)
8. Guarantors Statement (international students)

For application and program information, contact the Center for Graduate and Adult Academic Services at 860.768.4371.

*Applicants who hold baccalaureate degrees in engineering fields not usually considered typical (electrical, mechanical, civil, aerospace, chemical, computer, or control engineering are typical engineering degrees); or who hold baccalaureate or master's degrees in non-engineering fields or in engineering technology; or those whose undergraduate GPA is below 3.0 but who have appropriate architecture or engineering experience will be considered on an individual basis. The same applies to applicants holding bachelor's degrees from institutions not accredited by EAC/ABET. Applicants in these categories may be required to complete specified undergraduate engineering courses before being admitted to the Master of Engineering program. Students should obtain at least a B grade in all such preparatory courses. Applicants may enroll for up to 6 credits on a nonmatriculated basis prior to making formal application for admission. Grades of courses taken on this basis will be considered in the review of the application.

Transfer Credit

Students who wish to receive transfer credit for courses completed while enrolled outside CETA must petition the CETA Graduate Academic Standards and Policies Committee (GASPC). Transfer credit must be recommended by a CETA department chair and may be granted only after admission to the graduate program. A maximum of 6 credits of graduate work obtained at accredited institutions other than the University of Hartford may be applied toward a master's degree, provided a grade of B or better was attained. A transfer course must also be analogous to a CETA course that the student has not taken. Course credits transfer, but grades do not. Independent study courses not taught in a lecture-style format taken at another institution

will not be accepted as transfer credits. Graduate engineering courses taken online may be transferred only if a grade of B or better is scored in an exam administered by a University of Hartford professor in the appropriate department. Course work completed more than seven years prior to admission to a CETA graduate program is generally not considered to meet contemporary standards and is not accepted. Transferred courses will appear on a student's transcript as the analogous CETA course with a transfer designation added.

Financial Assistance

Student loans are administered through banks in the home state/country of the individual students.

Graduate Assistantships

Graduate assistantships are available for eligible full-time graduate students, subject to funding constraints. Amounts of assistantship awards and required student work commitments may vary. Students interested in assistantships should contact the appropriate department.

For architecture students, partial-tuition scholarships are available for applicants to the program. The awarding of the scholarships will be determined by the Graduate Admission Committee in consultation with the department at the time of admission. Teaching assistantships will be made available to qualified candidates as determined by the Graduate Committee.

The engineering departments have a number of openings available for graduate assistantships. To qualify, a graduate student must be matriculated and carrying at least 9 credits per semester. Official Graduate Record Examination scores are also required but only for the first semester of study. The amount of an assistantship is up to \$2,500 per semester, reflecting a commitment of up to 20 work hours per week. Work assignments are determined by the department that oversees the student's technical specialty. Assistantships will be awarded on the basis of academic and work performance and financial need. Cumulative and most-recent-semester grade point averages will determine academic performance. Assistantships will be awarded on a semester basis. Consideration for continuation of an assistantship requires a minimum cumulative grade point average of 3.6. Documentation of financial need will be required. Assistantships will be determined by the GASPC at the time of application review.

International Students

English Proficiency

International students for whom English is a second language may be tested for English proficiency upon arrival. Students who need improvements will be required to complete English courses in the English Language Institute prior to beginning graduate studies. International students must submit TOEFL scores, which should be at least 550 to obtain admission into the program.

Financial Support

International students must provide a Guarantor's Statement of Financial Support with their application for admission.

Guidelines

Grading

Professors may assign the following grades:

A	4.00
A-	3.67
B+	3.33
B	3.00
B-	2.67
C+	2.33
C	2.00
C-	1.67
F	0.00
W	Withdrawal
I	Incomplete
P	Pass
NP	No Pass

Pass/No Pass Grade

Graduate students in the College of Engineering, Technology, and Architecture must take courses for letter grades. The Pass/No Pass option is available to undergraduate students only.

Withdrawals

A W (withdrawal) is assigned to a student who has attended a course for three to 10 weeks. A withdrawal before the third week removes the course from the transcript. Withdrawals are not permitted after the 10th week of classes. To withdraw, an add/drop form must be approved by the student's advisor and filed with the registrar.

Incompletes

An I (incomplete) may be assigned by an instructor to a student who has attended an entire course and, due to extenuating circumstances,

needs an extension to complete outstanding work. Incomplete work is to be submitted on a schedule agreed to between the student and the instructor.

Academic Standards

The minimum cumulative grade point average required for awarding of a master's degree in CETA is 3.0 (A=4.0). Only courses included in the student's plan of study will be considered in the evaluation of the overall GPA. All students must have their plan of study approved by their respective advisor and the chair after completion of 12 credits and before registering for future courses. Students must take 12 credits (not including transfer credits) in order to establish a cumulative GPA. If one F or two Cs (including C- and C+ grades) are received within these 12 credits, the student is subject to dismissal. Once a cumulative GPA is established, the GPA must be maintained at or above 2.8 in order for the student to make satisfactory academic progress toward the degree. A student whose average falls below this level will be reviewed by the Graduate Academic Standards and Policies Committee and is subject to being placed on probation or dismissal. Once a student is placed on probation, a subsequent semester average below 2.8 will result in dismissal. Dismissal may be appealed in writing within seven days to the Graduate Academic Standards and Policies Committee, CETA c/o the Office of Graduate Studies, United Technologies Hall, room 205. Appeals must provide a substantive basis for consideration.

Time Limit

Graduate students in CETA must complete their program within seven years. Students who require more time to complete their degree must request an extension in writing from the appropriate department chairman.

Registration

Students may register by mail or fax prior to the first class meeting. In-person registration may be done with their faculty advisor. Registration continues until classes have met once. Late registration continues until classes have met twice. Admission after the beginning of a class requires the permission of the instructor. All application materials must be submitted prior to initial registration for a class. Engineering applicants may register as nonmatriculated students for up to 6 credits.

Classes

Graduate classes in CETA are limited in size to encourage interaction among students and faculty. Classes begin in the late afternoon and run through the evening. Special arrangements make laboratory and studio facilities available on weekends.

Professional Societies

The University is a member of the American Society for Engineering Education (ASEE) and the Association of Collegiate Schools of Architecture (ACSA).

Department of Architecture

Professor Davis

Associate Professors Crosbie (Chair), Fuller, Petry

Assistant Professors Carloni, Sawruk, Warnagiris

The Master of Architecture program prepares students for a variety of professional careers in the design and construction industries.

In a collaborative, multidisciplinary setting, the Architecture program balances theoretical, technical, professional, and creative knowledge. Students are prepared for careers in architecture and a wide assortment of other design-, construction-, or business-related professions. The pedagogic approach to architecture education is centered on the studio. The studio provides the appropriate environment for the assimilation and synthesis of knowledge gained throughout the curriculum by incorporating design, aesthetic, technology, and the needs of people. The sequence of studio courses provides sequentially more challenging projects and is intended to develop the student's skills to acknowledge, analyze, articulate, and synthesize solutions pertaining to the built environment.

For those students who want to broaden their education at the graduate level, the architecture program offers several combined or dual degree programs in conjunction with other graduate programs at the University, including the M.B.A. (Barney School of Business), the M.F.A. (Hartford Art School), and the M.Engr.

To be considered for admission, applicants must have received an undergraduate pre-professional degree in architecture (such as a Bachelor of Science or Bachelor of Arts in Architecture, Architectural Engineering, or Architectural Engineering Technology) from an accredited college, university, or other institution. The student's background and preparation must be such in content and scope as to indicate the ability to complete successfully the curriculum requirements.

Master of Architecture (64 credits)

	<i>Credits</i>
First Fall Semester	
ARC 511 Architectural Studio I	6
ARC 512 Advanced Site Planning	4
ARC 513 Advanced Building Systems	3
Professional elective*	<u>3</u>
<i>Total credits</i>	<i>16</i>
First Spring Semester	
ARC 521 Architectural Studio II	6
ARC 522 Advanced Building Economics	4
ARC 523 Advanced Structural Systems	3
Professional elective*	<u>3</u>
<i>Total credits</i>	<i>16</i>
Second Fall Semester	
ARC 611 Architectural Studio III	6
ARC 612 Advanced Design Theory	4
ARC 613 Thesis Research	3
Professional elective*	<u>3</u>
<i>Total credits</i>	<i>16</i>
Second Spring Semester	
ARC 621 Master's Thesis	6
ARC 622 Advanced Urban Issues	4
ARC 623 Advanced Professional Practice	3
Professional elective*	<u>3</u>
<i>Total credits</i>	<i>16</i>

Master of Engineering

Graduate studies in engineering at the University of Hartford lead to the Master of Engineering (M.Eng.). Engineers require a broad, analytical engineering capability and an engineering management perspective. The program emphasizes applied design and stresses communication, which is very important for a successful career. The Master of Engineering program includes independent study requirements, which offer the opportunity to pursue design projects or self-directed study. Specialty concentrations are offered in civil, electrical, environmental, and mechanical engineering, with further concentrations in manufacturing and turbomachinery. The program, which offers specialty course work, applied mathematics, engineering management, and design project independent study, provides excellent preparation for an engineering career and for continued graduate study.

3+2 Program (B.S. + M.Eng. degrees)

This program allows full-time and part-time engineering students to earn their B.S. and M.Eng. degrees in five years of study. Two graduate-level courses taken in the undergraduate program may be applied to both undergraduate and graduate degree requirements. Students usually commit to the program at the start of the second semester of their junior year, and juniors who are interested should contact their department chairman. In order to be accepted into the program, students must have a 3.0 cumulative grade point average at the end of the junior year.

Excellence in Engineering and Management (E²M) Program (M.Eng. and M.B.A.)

This program allows full- and part-time engineering students in the graduate program to earn M.Eng. and M.B.A. degrees by taking a total of 63 credits. The prerequisite is a bachelor's degree in engineering, and students will have to satisfy all requirements necessary to pursue an M.Eng. degree. Students with a bachelor's degree in physical sciences, mathematics, and other fields may also apply but will have to take additional courses at the undergraduate level to remove deficiencies in the engineering major they plan to pursue. Students must also have successfully completed Basic Principles of Economics (EC 600) or equivalent course work. GMAT test scores are required of all applicants.

*Professional electives may be chosen from graduate courses in art, business, and engineering with approval.

Areas of Research Concentration

Students may select from an extensive list of research concentrations, including Energy Systems, Acoustics and Noise Control, Mechatronics, Design for Manufacturing and Disassembly, Surface-Finish Research, Computer-Integrated Manufacturing, Environmentally Conscious Manufacturing, Biomechanics, Mechanical Design, Comparison of Deterministic and Random Sampling Techniques for Quality Analysis of Integrated Circuits, Advances in Surface Roughness Measurement, Investigation of Fractal Sounds and Their Musical Implications, Applications of Data Acquisition Techniques to Electric Machinery, Carpal Tunnel Syndrome, Concurrent Product and Process Design, Cost-Effective CAD for Robust Design of Integrated Circuits Using Artificial Neural Networks, Detection Threshold Selection for Tracking Performance Optimization, Dynamic and Static Insertion Loss Measurements of In-Duct Muffler Designs, Mechatronics of Computer Interface, Multitarget Tracking: Recent Advances and Development, Multirate-PDA Tracker, Noise Control Study of QL-Type Transformers, Nuclear Pulse Processors Using Digital Filters and Wavelet Transformers, Pole Placement Algorithms for Multirate-Sampled Systems, Real-Time Fault Diagnostics of Power Transformers, Structural Model Building for Ankle-Foot Orthoses, Suppression and IMD Generation in a Hard Limiter Transponder, Personal Communications System Design, Satellite Communications Systems, DSP for Communications Systems, Sensor Array Processing, Digital Signal Processing Software and Hardware, Power Systems: Analysis and Design, Application of Remote Sensing in Environmental Engineering, Applications of GIS in Environmental Engineering, Air Quality Modeling, Aeration and Mass Transfer, and Groundwater Modeling.

Full-Time Study

Full-time students must register for a minimum of 9 credits per semester.

Summer Studies

Selected courses will be offered during the summer, subject to minimum numbers of students registering for the scheduled courses. Part-time students may want or need to take summer courses to maintain their desired schedules, and full-time students generally must carry a load of summer courses to complete the program in a one-and-one-half- to two-year period. The various independent study courses can continue during the summer, subject to satisfactory arrangements between graduate students and faculty advisors.

Comprehensive Final Project

Each specialty within the Master of Engineering program requires a comprehensive final project under the course title of Independent Studies in [Specialty]. A minimum of 6 credits is required for the ME and ECE specialties, and 3 credits are required for the environmental engineering specialty. Each of these involves independent research and the completion of a final paper and report for presentation to faculty and, in some cases, an oversight committee, which includes engineering practitioners. Students have the option of extending their independent studies by an additional 3 credits by applying their general elective to this pursuit. Independent study may not begin until the student has completed 12 credits toward the degree.

Engineering Colloquium (EM 700)

All full-time engineering graduate students are required to register each semester for the Engineering Graduate Colloquium (0 credit). Colloquia address topics of interest to all graduate engineering students and include presentations by engineering faculty and engineering research personnel from industry. Attendance at colloquia is mandatory in order to achieve a passing grade.

Department of Civil, Environmental, and Biomedical Engineering

Professor Hadad

Associate Professors Keshawarz, Mohamed,
Nowak, Pines (*Chair*)

Assistant Professors Arico, Fang, Grant,
Townsend

Requirements for Master of Engineering, Specialization in Structural Engineering: 30 credits

Core Courses (15 credits required)

CE 500 Advanced Mechanics of Materials

CE 501 Advanced Structural Design

CE 507 Finite Element Analysis

CE 530 Geotechnical Engineering II

CE 601 Structural Dynamics

Mathematics (3 credits required)

M 515 Methods of Applied Mathematics I

Engineering Management (3 credits required)

EM 601 Engineering Program Management

Independent Studies (3 credits required)

CE 600 Graduate Project in Civil Engineering
(3–9 credits)

Electives (6 credits from the following list)

CE 503 Geographic Info Systems in Practice

CE 523 Engineering Hydrology

CE 600 Graduate Project in Civil Engineering

ME 602 Continuum Mechanics

M 516 Methods of Applied Mathematics II

M 517 Applied Engineering Statistics

EM 600 Engineering and the Corporation

Any approved graduate management course

Requirements for Master of Engineering, Specialization in Environmental Engineer- ing: 30 credits

Core Courses (9 credits required)

CE 609 Advanced Air Quality Engineering

CE 610 Hazardous Waste Management

CE 612 Advanced Water Quality Engineering

Chemistry Courses (3 credits required)

CH 519 Applied Environmental Chemistry

Mathematics (3 credits required)

M 517 Applied Engineering Statistics

or MBA 610 Quantitative Decision Making

Engineering Management (3 credits required)
EM 601 Engineering Program Management

Independent Study (3 credits required, up to
6 additional credits as electives, if elective
credits are available)

CE 600 Graduate Project in Civil Engineering
(3–9 credits)

Elective Courses (9 credits required)

CE 502 Groundwater Hydrology

CE 503 Geographic Information Systems in
Practice

CE 504 Conn. Env. Regulations and Policy

CE 507 Finite Element Analysis

CE 509 Pollution Prevention

CE 523 Engineering Hydrology

CE 524 Solid Waste Management

CE 608 Analysis of Environmental Impact

CH 539 Organic Chemistry for Environmental
Engineers

M 515 Methods of Applied Mathematics I

EM 600 Engineering and the Corporation

Any approved graduate course

Requirements for Master of Engineering, Specialization in Transportation Engineering: 30 credits

Core Courses (9 credits required)

CE 510 Simulation and Modeling of
Transportation Systems

CE 512 Traffic Flow Theory and Analysis

CE 514 Urban Transportation Planning

Mathematics (3 credits required)

M 515 Methods of Applied Mathematics I

Engineering Management (3 credits required)

EM 601 Engineering Program Management

Independent Studies (6 credits required)

CE 600 Independent Study

Electives (9 credits from the following list)

CE 591 ST Railroad and Transit Engineering

M 517 Applied Engineering Statistics

CE 501 Advanced Structural Design

CE 503 Geographic Information Systems (GIS)

CE 504 Connecticut Environmental Regulations
and Policy

CE 523 Engineering Hydrology

CE 530 Geotechnical Engineering II

Department of Electrical and Computer Engineering

Professors Ilumoka-Nwabuzor, Shertukde
Associate Professors Alnajjar, Eppes (*Chair*),
Hill, Nagurney

Assistant Professors Abu-aisheh, Britt, Eppes,
Mellodge, Moslehpour, Shuman, Yu

Requirements for Master of Engineering, Electrical Engineering: 30 credits

Core Courses (15 credits required)

ECE 521 Communications Theory
ECE 532 Embedded Microprocessors
ECE 534 VHDL and Applications
ECE 540 DSP Hardware
ECE 543 Digital Control Systems
ECE 544 State Variable Control Systems
ECE 551 Neuralnet Applications
ECE 565 Digital VLSI Design I
ECE 567 Analog VLSI Design
ECE 572 Power Systems Analysis
ECE 573 Power Electronics
ECE 5XX System Design and Implementation
ECE 641 Digital Signal Processing
ECE 642 Advanced Linear Discrete and
Continuous Control Systems
ECE 643 Advanced Digital Control Systems
ECE 644 Estimation and Filtering Theory
ECE 671 Transformers: Theory and Practice
ECE 672 Protective Relaying
ECE 675 Surge Processes in Power
Engineering

Mathematics (3 credits required)

M 515 Methods of Applied Mathematics I

Engineering Management (3 credits required)

EM 601 Engineering Program Management

Independent Studies (6 credits required)

ECE 600 Graduate Project in Electrical

Engineering (up to 9 credits)

Elective Course (3 credits required)

A professional elective may be selected from
the following categories:

1. Any other ECE graduate course listed above
under core courses
2. ECE 600 Graduate Project in Electrical
Engineering may be increased to 9 credits.
3. M 517 Applied Engineering Statistics
EM 600 Engineering and the Corporation
4. An additional graduate management course
5. An approved engineering graduate course in
another department

Students may concentrate their studies by
selecting appropriate courses in

- electrical power
- controls
- computer
- microelectronics
- communications and/or signal processing
- embedded applications

Department of Mechanical Engineering

Professors Celmer, Sahay, Shetty

Associate Professors Adrezin, Canistraro,
Filburn, Milanovic (*Chair*)

Assistant Professors Ghosh, Vigeant, Yavuzturk

Instructor Norwood

Requirements for Master of Engineering, Mechanical Engineering: 30 credits

Core Courses (15 credits required)

Five courses selected from mechanical engineering 500- or 600-level graduate courses

Mathematics (3 credits required)

M 515 Methods of Applied Mathematics I

Engineering Management (3 credits required)

EM 601 Engineering Program Management

Independent Studies (6 credits required)

ME 607 Graduate Project in Mechanical
Engineering (3–9 credits)

Elective Course (3 credits required)

A professional elective may be selected from the following categories:

1. Any ME graduate course not selected to fulfill core course requirements
2. ME 607 Graduate Project in Mechanical Engineering may be increased to 9 credits.
3. M 517 Applied Engineering Statistics
4. EM 600 Engineering and the Corporation
5. An additional graduate management course
6. An approved engineering graduate course in another department

Requirements for Master of Engineering, Specialization in Manufacturing Engineering: 30 credits

Mathematics (3 credits required)

M 515 Methods of Applied Mathematics I

Engineering Management (3 credits required)

EM 601 Engineering Program Management

Manufacturing Engineering Core Courses
(9 credits required)

ME 607 Graduate Project in Mechanical
Engineering (minimum 6 credits)

ME 680 Design for Manufacturing (3 credits)

Balance of Program (15 credits required)

ME 501 Kinematic Linkage Design

ME 504 Dynamics of Machines

ME 505 Mechatronics System Design

ME 507 Finite Element Analysis

ME 510 Advanced Mechanics of Materials

ME 511 Advanced Materials

ME 580 Quality Tools in Product Design

ME 582 Reliability Engineering

ME 512 Precision Engineering

ME 519 Six Sigma Principles and Applications

ME 600 Computer-Aided Geometric Modeling

ME 601 Machine Vision and Robotics

ME 681 Seminar on Modern Issues in
Manufacturing Engineering

ME 682 Advanced Manufacturing Processes

Requirements for Master of Engineering, Specialization in Turbomachinery Engineering: 30 credits

Mathematics Course (3 credits required)

M 517 Applied Engineering Statistics [3]

Engineering Management (3 credits required)

EM 601 Engineering Program Management [3]

Engineering Core Courses (18 credits
required)

ME 530 Gasdynamics [3]

ME 531 Gas Turbine Analysis [3]

ME 632 Aerodynamic Design of Turbines and
Compressors [3]

ME 640 Turbomachinery Dynamics and
Control [3]

ME 672 Strength, Design, and Materials in
Turbomachinery [3]

ME 607 Graduate Project in Mechanical
Engineering [3]

Elective Courses (6 credits required)

A second semester of ME 607 may be chosen.

ME 506 Principles of Combustion [3]

ME 606 Turbomachinery Noise Control [3]

ME 609 High-Speed Aerodynamics [3]

ME 676 Manufacturing Issues in
Turbomachinery [3]

M 515 Methods of Applied Mathematics I [3]

E²M (M.Eng. and M.B.A. Dual Degree in Engineering and Business)

The E²M program is the first dual-degree program in Connecticut in engineering and management, enabling full- and part-time engineering graduate students to earn both a Master of Engineering (M.Eng.) and a Master of Business Administration (M.B.A.) by taking a total of 63 credits. This is 18 fewer credits than if the degrees were pursued separately. With four different engineering specialties from which to choose, the E²M program is as flexible as it is efficient.

E²M is a unique, three-way partnership: between the Barney School of Business and the College of Engineering, Technology, and Architecture, and extending to a third party—business and industry in Greater Hartford. Course work at the Barney School includes applied projects, for which students formulate marketing and business plans for area companies. The Engineering Applications Center assists local businesses and industries in applying new techniques, and students become involved through application projects, symposia, and forums.

Program Outline

Mathematics Courses

M 515 Methods of Applied Mathematics

Core Courses

Waiver or transfer possible based on prior course work.

MBA 610 Quantitative Decision Making

MBA 612 Accounting Concepts

MBA 614 Economic Analysis for Managers

MBA 616 Corporation Finance

MBA 618 Marketing Management

MBA 620 Operations Management

Breadth I

Core courses will be taken before these courses (no waivers).

MBA 710 Leadership and Management

MBA 720 Managing Technology and Innovation

MBA 730 Managing Customer Relationships and Experience

MBA 740 Business Law and Society

MBA 750 Performance Analysis

MBA 760 The Global Business Environment

Capstone

Completion of Core and Breadth I required. Transfer credit will not be accepted for this course.

MBA 810 Organizational Strategy and Policy

Breadth II

Electives related to specialty in engineering as follows:

Six courses from engineering specialty (see detailed listing of engineering specialties on previous pages)

One graduate project in the engineering specialty

Engineering Specialties

Civil Engineering

Electrical Engineering

Electrical Power Engineering

Environmental Engineering

Manufacturing Engineering

Mechanical Engineering

Turbomachinery

Course Descriptions

Architecture

ARC 511 Architectural Studio I [6] Problem-oriented studio offered to first-semester, fifth-year students. Problems are intended to broaden and deepen individual understanding of the process, theories, and systems that influence the design of the built environment. Emphasis is on the thorough examination of all aspects of building. Field trips and design project work are required. Prerequisites: AET 352 and AET 367, or equivalent.

ARC 512 Advanced Site Planning [4] Emphasizing the nature of landscape as a built environment, course work ranges in scale from the national landscape to the specific site. Study includes a broad investigation of the built landscape, from physical landform and technical issues to the case studies of typological and prototypical examples of site design. Case studies, field trips, and system design project work are required. Prerequisites: AET 244, AET 352, and AET 367; or equivalent.

ARC 513 Advanced Building Systems [3] Design analysis and performance characteristics of building environmental systems, emphasizing heating, cooling, ventilation, and lighting systems. In addition, building electrical systems, acoustics, water, waste, and drainage systems are covered in terms of fundamental theory, designs, and calculations. Case studies, field trips, and system design project work are required. Prerequisite: AET 241 or equivalent.

ARC 514 Advanced Digital Presentations [4]

This course is offered as an advanced design course concerned with the integration of computer modeling, animations, and multimedia technologies into the design methods of the architectural profession. It stresses the need to integrate critical thinking about computer technology and focused learning of software tools and methods. Software used may vary per instructor and requires no previous knowledge of these specific tools; however, students should have a fundamental knowledge of and comfort with computer and operating systems. Prerequisite: AET 358 or equivalent.

ARC 521 Architectural Studio II [6] Elective problem-oriented studio offered to second-semester, fifth-year students. Introspective problems are intended to broaden and deepen individual understanding of the process, theories, and systems that influence the design of the built environment. Emphasis is on the thorough examination of all aspects of building. This studio consists of a single comprehensive design project. As such, the individual program and design solution must be recorded in a bound format similar to that required for the thesis. Field trips and design project work are required. Prerequisite: ARC 511 or equivalent.

ARC 522 Advanced Building Economics [4] Individual and team analyses of architectural development proposals addressing relevant economic topics and trends. Proposals are analyzed for development, construction, and finance. Economic and social factors having an impact on real estate values are examined. The economics of architectural development in general is the basis for further analysis of individual project types, including education, research/technology, commercial, and healthcare. Micro- and macro-level developments are explored, and their relative economic impacts are investigated. Prerequisites: ARC 511, ARC 512, and ARC 513; or equivalent; or permission of instructor.

ARC 523 Advanced Structural Systems [3]

The development of an advanced working knowledge of building systems primarily comprising composites, including reinforced, high-strength, and precast concrete; reinforced masonry; and emerging composites. Arches, shells, and plates are analyzed. Advanced computer applications assist the student in developing an

understanding of the relationships between concept, material, form, and structural implication. Case studies, field trips, and system design project work are required. Prerequisites: AET 355, AET 364, and AET 474; or equivalent.

ARC 585 Seminar on Architectural Topics [3]

The purpose of this course is to introduce a way of thinking and communicating about architecture. The course introduces the mechanics and conventions of writing about architecture, and develops and clarifies an architectural point of view. Focusing on the generation of a personal architectural viewpoint, the course serves as a basis from which to critique the built environment. Prerequisites: AET 155 and 156, or equivalent.

ARC 586 Architectural Monuments [3]

This is a study-abroad course that focuses on a sampling of the most significant structures in the history of architecture. The course is designed for students who wish to study examples of architectural history in direct contact with the historic structures. Students are required to sketch, diagram, photograph, and understand these structures while documenting their work with an architectural portfolio project and a research paper. Students travel to and tour these historic structures with the instructor. Prerequisites: AET 155, AET 156, and permission of instructor.

ARC 611 Architectural Studio III [6]

Problem-oriented studio offered to first-semester, sixth-year students. Problems are intended to broaden and deepen individual understanding of the process, theories, and systems that influence the design of the built environment. Emphasis is on the thorough examination of all aspects of building. Field trips and design project work are required. Prerequisites: ARC 511 and ARC 521, or equivalent.

ARC 612 Advanced Design Theory [4]

A course that presents deeper, often implicit and hidden motivations that influence architecture. Basic human values and beliefs leading to classical philosophies and aesthetics are explored. Major historical and contemporary propositions on architecture are surveyed. Typical topics range from the study of specific historical periods or schools of thought regarding design to the diverse trends in current architectural thinking. Prerequisites: AET 155 and AET 156, or equivalent.

ARC 613 Thesis Research [3] Research for a singular design or design-related project as selected by the individual student. The course consists of independent research done at a sufficient depth to display a mastery of the process of defining an architectural problem, including the investigation and discussion of the procedural, physical, and intellectual limits of the problem. The course culminates with the publication of an architectural program, a theoretical statement, as well as the generation of all contextual information and design strategies necessary as the base for ARC 621 Master's Thesis. Prerequisites: AET 470, ARC 511, ARC 521, and ARC 611; or equivalent; or permission of the chair.

ARC 621 Master's Thesis [6] Execution of a singular design or design-related project as selected by the individual student. The project is based on independent research and preliminary design work produced in ARC 613, and is of sufficient depth and breadth to display a mastery of design skills and comprehensive understanding of architectural issues related to form, process, judgment, representation, and communication. The work is done under the guidance of a thesis advisor chosen by the student. Prerequisites: ARC 511, ARC 521, ARC 611, and ARC 613; or equivalent; or permission of the chair.

ARC 622 Advanced Urban Issues [4] Recognizing that contemporary patterns of urbanization around the world challenge traditional notions of urbanity and public space, this course exposes students to seminal European and American texts of urban theory that have shaped and continue to shape how architects and planners conceive of urban culture and understand the meaning of cities. Prerequisites: AET 155 and AET 156, or equivalent.

ARC 623 Advanced Professional Practice [3] An examination of contemporary architectural practice, developing awareness and understanding of the profession, including the relationship of the profession to society, as well as organization, management, and documentation of the process of providing professional services. The study of codes and fire protection emphasizing the review of existing codes, code philosophy, code provisions, and the code-writing process. Prerequisite: AET 481 or equivalent.

Engineering

CE 500/ME 510 Advanced Mechanics of Materials [3] Relationships between stress and strain at a point; introduction to theory of elasticity; yield and fatigue failure theories; stress concentrations; unsymmetrical bending; shear center; torsion of hollow, thin-walled sections; introduction to finite elements. Prerequisites: ES 212 and M 242, or equivalents.

CE 501 Advanced Structural Design [3] Design of prestressed concrete structural members. Plate girder design. Plastic design of steel beams and frames using the Load and Resistance Factor design method. Computer applications. Prerequisites: CE 312 or equivalent, and senior or graduate standing. Laboratory fee.

CE 502 Groundwater Hydrology [3] An applied course dealing with groundwater hydrology and its interrelation with surface water; well hydraulics, pumping tests, and safe yield of aquifers; and some modeling of groundwater flow. Prerequisites: ES 320 or ME 340 or equivalent, and senior or graduate standing. Laboratory fee.

CE 503 Geographic Information Systems in Practice [3] (ENV) Fundamentals of the ArcView GIS system, spatial data acquisition and manipulation, database creation and management, raster versus vector GIS, Integration of the Global Positioning System (GPS) technology into GIS practices, network analysis, GIS applied to solve engineering problems. Prerequisite: Senior or graduate standing, or permission of the instructor. Laboratory fee.

CE 504 Connecticut Environmental Regulations and Policy [3] (ENV) Examination of federal and Connecticut state laws, state policies, and state statutes that industry must observe to be in compliance with the DEP's permitting and enforcement programs. The Clean Water Act, Clean Air Act, and the Resource Conservation and Recovery Act are examined and assessed for their strengths and weaknesses, as well as Connecticut state statute 22a-454. Prerequisite: Senior or graduate standing in engineering, or permission of the instructor.

CE 507/ME 507 Finite Element Analysis [3] Principles and applications of finite element method. The principle of virtual work is used to develop finite element equations for the representation and analysis of engineering structures. Hand calculations and computer modeling are used to analyze two- and three-dimensional constructs. Prerequisite: Senior or graduate standing, or permission of instructor. Laboratory fee.

CE 509/ME 509 Pollution Prevention [3] (ENV) Assessment of pollution prevention technologies and lean manufacturing techniques used in industry to reduce waste generation. Understanding of how to implement pollution prevention into daily operations and analysis of capital investments to minimize waste. Prerequisite: Senior or graduate standing in engineering, or permission of instructor.

CE 510 Simulation and Modeling of Transportation Systems [3] Principles of simulation. Use of traffic simulation models for the planning, design, and operations of transportation systems. Simulation model development, calibration and validation. Traffic signal control and optimization strategies. Statistical design and analysis of simulation experiments. Performance measures analysis. Group project, written and oral presentation of the project. Prerequisites: Graduate or senior standing with CE 452. Laboratory fee.

CE 512 Traffic Flow Theory and Analysis [3] Fundamentals of traffic flow theory are developed. Topics are the characteristics of macroscopic and microscopic traffic flow, the statistical distribution of traffic flow parameters, traffic stream models, car-following and continuum-flow models, shock wave analysis, queuing analysis, and traffic signal control and optimization. May be taken as a professional elective for senior civil engineering undergraduates. Prerequisites: Graduate or senior standing with CE 452, or permission of the instructor.

CE 514 Urban Transportation Planning [3] Methodologies for planning multimodal transportation systems, trip generation, trip distribution, mode choice, traffic assignment, travel-demand and network modeling, interrelationship of transportation and urban environment, data sources and collection, transport legislation and financing. Prerequisites: Graduate or senior standing with CE 452. Laboratory fee.

CE 523 Engineering Hydrology [3] (ENV) The hydrologic cycle, Reynolds Transport Theorem, precipitation, streamflow, introduction to groundwater, hydraulic and hydrologic routing, data collection and analysis, statistical considerations. Primary emphasis is on surface water. Prerequisite: ME 340 or equivalent. Laboratory fee.

CE 524 Solid Waste Management [3] (ENV) Systems approach to solid waste management: re-use, recycling, resource recovery, transportation, storage, and disposal of solid waste. Prerequisite: Graduate standing in engineering or permission of instructor.

CE 530 Geotechnical Engineering II [3] The application of the principles of soil mechanics to the design of footings, retaining walls, pile foundations, caissons, and sheet piles; foundations on difficult soils and problems dealing with foundation settlement will be investigated. Prerequisites: CE 330 and senior or graduate standing in engineering, or permission of instructor.

CE 600 Graduate Project in Civil Engineering [3–9] Independent study of an appropriate civil engineering topic selected by the student in consultation with a faculty advisor. Requirements vary according to whether 3, 6, or 9 credits are selected. Independent study topics related to students' employment activities may be proposed. The usual schedule is one semester for each 3-credit increment, but accelerated schedules are possible with advisor approval. A written paper and an oral presentation are required. Prerequisites: Completion of at least 12 credits toward the M.Eng. degree in the civil engineering specialty and permission of faculty advisor.

CE 601 Structural Dynamics [3] Behavior of structures and structural components exposed to time-dependent loadings. The study of lumped-mass multi-degree-of-freedom systems and their applications to structures. Introduction to earthquake analysis and design. Computer analysis of classical problems. Prerequisite: Graduate standing.

CE 608 Analysis of Environmental Impact [3] National Environmental Policy Act, the need for environmental assessment, government environmental agencies, the air environment, the water environment, the noise environment, ecology and the biological environment, the cultural and socioeconomic environments, methods of analysis. Prerequisite: Graduate standing.

CE 609 Advanced Air Quality Engineering

[3] Air pollution meteorology; atmospheric dispersion modeling; historical air pollution incidents and problems; sources and properties of pollutants; process and equipment design for control, modification, or removal; legal considerations. Prerequisite: Graduate standing or permission of instructor.

CE 610 Hazardous Waste Management

[3] Prevention control, storage, transportation, containment, and treatment of hazardous waste; sources and properties of hazardous waste; relationship with other environmental concerns; legal and administrative issues. Prerequisite: Graduate standing or permission of instructor.

CE 611 Advanced Solid Waste Management

[3] Systems approach to solid waste management; reuse, recycling, resource recovery, transportation, storage, and disposal of solid waste; interaction with other environmental concerns, such as air and water pollution. Prerequisite: Graduate standing.

CE 612 Advanced Water Quality Engineering

[3] Physical, chemical, and biological water and waste water treatment from a unit operations or unit process approach. Design of system components to achieve desired water quality characteristics. Prerequisites: CE 420 and graduate standing, or permission of instructor.

CE 591, 592, 691, 692 Special Topics in Civil/Environmental Engineering

[1–6] Selected topics in civil/environmental engineering at the graduate level. Significant topics in the field will be chosen on the basis of student and faculty needs and interests. Prerequisite: Graduate standing or permission of instructor.

ECE 521 Communications Theory

[3] Review of signals and networks. Fourier series and transforms, probability, random variables and random processes, base pulse and digital signaling, bandpass signaling techniques and components, performance of communication systems corrupted by noise, signal-space methods in digital data transmission. Prerequisite: ECE 420 or equivalent.

ECE 532 Embedded Microprocessors

[3] This course involves topics related to embedded, real-time microprocessor systems. It is project oriented, giving students the further opportunity to investigate topics discussed in the course. Projects will use a microcontroller. Students will be expected to be familiar already with the Motorola 68HC11 assembly language as well as

C-language programming. Prerequisites: Senior or graduate standing, or permission of instructor; C language; and familiarity with assembly language. Laboratory fee.

ECE 534 VHDL and Applications

[3] This class utilizes VHDL for design, synthesis, simulation, and modeling. Students will learn how to write VHDL models that can be automatically synthesized into integrated circuits, such as FPGA. The use of software and hardware is an essential part of the course. Prerequisite: ECE 231. Laboratory fee.

ECE 540 Digital Signal Processing (DSP)

Hardware [3] Architecture and programming of digital signal processing chips. Application of DSP chips to sampling, digital filters, FFTs, etc. Prerequisites: ECE 440-441 or equivalents. Laboratory fee.

ECE 543 Digital Control Systems

[3] The modeling, analysis, and design of linear discrete control systems; z- and modified z-transforms; sampling and data reconstruction; open- and closed-loop transfer function and state-space models; steady-state and transient response analysis; root locus; frequency response plots; digital controller design using Bode plots; microcomputer implementation of digital controllers. Prerequisites: ECE 442 (minimum grade of C-) and ECE 332.

ECE 544 State Variable Control Systems

[3] State-space models for continuous and discrete control systems; controllability and observability; canonical forms; pole placement, observers, reduced-order observers, observers in the loop, and optimal controllers for SISO continuous and discrete control systems; lyapunov stability and bang-bang controllers. Prerequisite: ECE 543 or equivalent.

ECE 551 Engineering System Design Using

Neural Networks [3] Fundamentals of neural systems, neural network paradigms, network properties, and learning concepts. Neural architectures, supervised learning, error backpropagation. Unsupervised learning and feature extraction. Engineering-system design applications—function approximation, classification, clustering, forecasting, control, optimization, pattern recognition. Hardware implementation of neural nets using nanoscale-integrated circuit technology. Engineering-design case studies from transportation, laser drilling, fingerprint identification, signal processing, and integrated circuit optimization. Lab projects, literature-search critical review. Prerequisite: Senior or graduate standing. Laboratory fee.

ECE 565 Digital VLSI Design I [3] Techniques for CMOS digital integrated circuit design at circuit, subsystem, and system levels. CAD tools for design from schematic capture to physical layout. Design methodologies—programmable logic, standard cell, full custom CMOS fabrication technology; design issues—speed, power, reliability, testability; CMOS-design case studies. Laboratory project. Prerequisites: ECE 231, ECE 232, ECE 362, ECE 364 (minimum grade of C– in all four courses) and senior or graduate standing. Laboratory fee.

ECE 567 Analog VLSI Design [3] Techniques for CMOS analog integrated circuit design at circuit, subsystem, and system levels. Analog circuit building blocks, CAD tools for design from schematic capture to physical layout. Design case studies, structured laboratories, and laboratory project. Design economics, quality and reliability issues. VLSI performance optimization: objectives, constraints, designable parameters, algorithms. Introduction to neural networks for modeling and optimization. Prerequisites: ECE 565 and senior or graduate standing. Laboratory fee.

ECE 572 Power Systems Analysis [3] Introduction to circuit modeling of electrical power systems and their components. Topics include symmetrical components, per-unit analysis, three-phase and DC transmission lines, transient analysis, lightning effects, corona, short-circuit fault analysis, power system protection devices and relaying schemes. Prerequisite: ECE 471 or equivalent.

ECE 573 Power Electronics [3] Theory and operation of power diodes, power transistors, silicon-controlled rectifiers, diacs, triacs, and unijunction transistors. Design of phase-controlled rectifiers, and DC-DC converters and inverters. Prerequisite: ECE 362 or equivalent.

ECE 600 Graduate Project in Electrical Engineering [up to 9] Independent study of an appropriate electrical engineering topic selected by the student in consultation with a faculty advisor. Requirements vary according to whether 3, 6, or 9 credits are selected. Independent study topics related to students' employment activities may be proposed. The usual schedule is one semester for each 3-credit increment, but accelerated schedules are possible with advisor approval. A written paper and an oral presentation are required. Prerequisites: Completion of at least 12 credits toward the M.Eng. degree in the electrical engineering specialty and permission of faculty advisor.

ECE 641 Digital Signal Processing [3] Sampling and Analog/Digital (A/D) conversion properties of discrete linear systems, digital filter design, implementation of digital filters, algorithms for discrete Fourier transform analysis. Prerequisite: ECE 341 or equivalent.

ECE 642 Advanced Linear Discrete and Continuous Control Systems [3] Time and frequency-domain analysis and synthesis of linear discrete and continuous systems with emphasis on state-space methods based on modern control theory. Prerequisites: ECE 543 and M 515, or equivalents.

ECE 643 Advanced Digital Control Systems [3] Pole placement design, state estimation using full and reduced-order digital observers, optimal control methods, multivariable digital control systems, multirate digital control systems, implementation issues. Prerequisites: ECE 543 and M 515, or equivalents.

ECE 644 Estimation and Filtering Theory [3] Bayesian estimation theory; maximum likelihood estimation; linear minimum variance estimation; discrete and continuous Kalman filters; colored noise, smoothing, and prediction; first-order nonlinear Kalman filter; applications to communication and control. Prerequisites: ECE 521, ECE 642, M 515, and M 517; or equivalents.

ECE 662 Solid-State Electronic Devices [3] An introduction to the physical bases of semiconductor device operation. Quantum and statistical mechanics as applied to semiconductors. Fundamentals of diode and transistor operation. Prerequisite: ECE 362 or equivalent.

ECE 671 Transformers—Theory and Practice [3] The transformer as an electrical device: its uses and applications; winding insulation; magnetic circuit; losses; mechanical forces and strengths; transformer temperature; loading, rating, and life; maintenance, protection, and detection of faults; transformer connections; transformer testing; design and application; shipping considerations. Prerequisite: ECE 471 (minimum grade of B) or equivalent.

ECE 672 Protective Relaying [3] Introduction. Review of related fundamentals: per-unit and percent values, phasors and polarity, symmetrical components; sources of input to relays; fundamentals of protecting a power system; power system grounding principles; system protection: generator protection, transformer, reactor and shunt capacitor protection, bus protection, motor protection, line protection; pilot protection;

stability implications. Prerequisites: ECE 572 and ECE 671, or equivalents.

ECE 675 Surge Processes in Power Engineering [3] Transient analysis of lumped power circuits, transients in distributed parameter circuits, computation of traveling waves, lightning surges, switching surges, surges in coils and windings, insulation coordination. Prerequisites: ECE 471 and ECE 572, or equivalents.

ECE 591, 592, 691, 692 Special Topics in Electrical Engineering [1–6] Selected topics in electrical engineering at the graduate level. Significant topics in the field will be chosen on the basis of student and faculty needs and interests. Prerequisite: Graduate standing or permission of instructor.

EM 600 Engineering and the Corporation [3] A detailed review of engineering and the corporation. Organizational theory as applied to the engineering function in corporate organizations; engineers as corporate and professional citizens; management of technology; innovation, products, and entrepreneurship; and special problems of the corporate engineer—conflict issues, ethics, proprietary dealings, career opportunities, career security, and continuing education. Prerequisite: Baccalaureate degree in engineering or admission to the M.Eng. program.

EM 601 Engineering Program Management [3] An examination of the nature, theory, and practice of engineering program management, with particular attention to the technical program. Emphasis is on management problems and solutions in technical program operations in the industrial/commercial business setting and the skills necessary for program management performance. Topics include proposals and program planning, competitive bidding and contracts, budgets and schedules, engineering and high-tech factors and entrepreneurship, group dynamics, conflict resolution, program productivity, and program evaluation. Prerequisite: Baccalaureate degree in engineering or admission to the M.Eng. program.

ES 591 Special Topics in Engineering Science [1–6] Selected topics in engineering sciences at the graduate level. Significant topics in the field will be chosen on the basis of student and faculty needs and interests. Prerequisite: Graduate standing or permission of instructor.

ME 500 Convective Heat and Momentum Transfer I [3] Incompressible flow and convective heat transfer theory applied to internal and external laminar flows; conservation principles;

analytical and numerical laminar flow calculations; laminar boundary layer analysis; effects of boundary layer suction and blowing. Prerequisite: ME 341 or equivalent.

ME 501 Kinematic Linkage Design [3] Theory and practice in the selection of kinematic linkages for the generation of desired functions, paths, and motions. Recent developments and current research are reviewed. Prerequisites: ES 211 and M 240, or equivalents. Laboratory fee.

ME 502 Noise Control Design [3] Problems in control of noise in industry or in community; application of federal, state, and local laws; interrelation with air pollution control; emphasis on design of noise control structures or devices. Special design project requiring written term paper and an oral presentation. Prerequisite: ME 460 (minimum grade of C–). Laboratory fee.

ME 503 Vibrations II [3] Vibration analysis of multimass systems and distributed systems; generalized coordinates and Lagrange's equation, influence coefficients and Dunkerley's equation, experimental investigations, matrix and computer solutions. Prerequisite: ME 350 (minimum grade of C–). Laboratory fee.

ME 504 Dynamics of Machines [3] Static and dynamic force, moment analysis of planar and space mechanisms, dynamics of a rigid body, balancing of machines, cam dynamics. Prerequisite: ME 350. Laboratory fee.

ME 505 Mechatronics System Design [3] Principles of transducers and sensors and how to interface them with a process in a computer environment. Discussion topics about types of transducers and different sensors include operating principles, modeling, design considerations, and applications. Computer interfacing work includes signal conversion, interface components, and real-time application of microcomputer systems to problems in manufacturing. Component integration and design considerations are addressed by case histories presented by the instructor. Student design projects involve problems from industry that require computer interfacing and experimental techniques. Topics include principles of transducers and sensors, signal processing, data acquisition, and computer interfacing using case studies. Prerequisites: ECE 360 (minimum grade of C–) and senior or graduate standing, or permission of instructor. Laboratory fee.

ME 506 Principles of Combustion [3] Introduction to the mathematical modeling of combustion phenomena. Topics include symmetrical components; review of chemical equilibrium, adiabatic flame temperature, chemical kinetics, detonation, and flammability limits. Prerequisites: ME 337 and ME 341, or equivalents.

ME 507/CE 507 Finite Element Analysis [3] Principles and applications of finite element method. The principle of virtual work is used to develop finite element equations for the representation and analysis of engineering structures. Hand calculations and computer modeling are used to analyze two- and three-dimensional constructs. Prerequisite: Senior or graduate standing or permission of instructor. Laboratory fee.

ME 509/CE 509 Pollution Prevention [3] Assessment of pollution prevention technologies and lean manufacturing techniques used in industry to reduce waste generation. Understanding of how to implement pollution prevention into daily operations and analysis of capital investments to minimize waste. Prerequisite: Senior or graduate standing in engineering, or permission of instructor.

ME 510/CE 500 Advanced Mechanics of Materials [3] Relationships between stress and strain at a point; introduction to theory of elasticity; yield and fatigue failure theories; stress concentrations; unsymmetrical bending; shear center; torsion of hollow, thin-walled sections; introduction to finite elements. Prerequisites: ES 212 and M 242, or equivalents.

ME 511 Advanced Materials [3] Introduction to properties and processes of production of high strength and/or high modulus of elasticity fibers, ceramics, polymers, and elastomers; survey of design, analysis, fabrication, and testing. Professional elective. Prerequisite: CH 111.

ME 512 Precision Engineering [3] This course provides a substantial understanding of the tools and techniques used in precision engineering and their application in manufacturing processes. Dimensional metrology, precision design principles, design of machine tools, materials and material removal processes, controls, optics, and nanotechnology. Prerequisite: B.S. in engineering or permission of instructor.

ME 519 Six Sigma Principles and Applications [3] Principles of Six Sigma. Implementing the design for quality philosophy and methodology. Process-flow diagrams, cause-and-effect diagram, failure mode effects analysis, gage

R&R, capability studies, design of experiments, strategy for organizing quality techniques in industry. Prerequisite: B.S. in engineering or permission of instructor.

ME 530 Gasdynamics [3] The dynamics and thermodynamics of compressible fluid flow. Equations of motion for inviscid gas flows, one-dimensional gas flows, oblique shock and expansion waves, quasi-one-dimensional flows, nozzle and diffuser operation, flows with friction, flows with heating and cooling, two-dimensional flows, introduction to numerical methods in gasdynamics. Prerequisites: ME 337 and ME 340, or equivalents.

ME 531 Gas Turbine Analysis [3] The performance analysis of stationary gas turbine systems and aircraft gas turbine engines. Ideal shaft power gas turbine cycles; cycle losses; the ideal ramjet, turbojet, and turbofan engines; aircraft engine losses; diffusers and nozzles; centrifugal and axial flow compressors; axial flow turbines. Prerequisite: ME 530.

ME 580: Quality Tools in Product Design [3] New Product Development System connecting voice of customer with new product design, development, manufacturing process, and quality control. Introduction to the state-of-the-art tools used in new product development. Strategy planning, policy deployment, quality function deployment, design concept methodology, design for Six Sigma quality, failure mode and effect analysis, reliability analysis, and problem solving. Process capabilities and control and just-in-time manufacturing. Prerequisite: B.S. in engineering or permission of instructor/department.

ME 582 Reliability Engineering [3] Concepts of probability and statistics are applied to the field of reliability engineering. Among the topics are redundancy, reliability prediction, designing for reliability, mortality distribution models, failure categories, theory of maintenance, environmental effects, life testing, effectiveness and cost of reliability, factor of safety, and structural reliability. Prerequisites: ES 212 and M 240.

ME 600 Computer-Aided Geometrical Modeling in Design and Manufacturing [3] Representation of solids, constructive solid geometry and the CSG tree, OCTREE representations and applications, boundary representation, analysis of geometrical algorithms and associated data structures, geometrical modeling applications in manufacturing. Prerequisite: Knowledge of PASCAL, C, and FORTRAN. Laboratory fee.

ME 601 Machine Vision and Robotics [3] Basic concepts, techniques, and limitations of machine intelligence systems; machine learning algorithms, interpretation of line drawings; exploration of machine vision and manipulation; intelligent interaction of machines with the environment; hierarchical, goal-directed behavior with applications in vision and robotics. Student project required. Prerequisites: ES 211 or equivalent, and knowledge of advanced programming.

ME 602 Continuum Mechanics [3] A course that unifies elasticity and fluid mechanics. Topics include application of vector and tensor analysis, stress and strain constitutive laws, basic laws of continua. Prerequisites: ES 212, ME 340, and M 344; or equivalents.

ME 603 Convective Heat and Momentum Transfer II [3] Turbulent boundary layer analysis. Turbulence models and corresponding solutions, transpiration cooling and wall roughness effects, heat transfer at high velocities. Prerequisite: ME 500 or equivalent.

ME 606 Turbomachinery Noise Control [3] Theoretical and applied principles of acoustics, including the wave equation in 3-space; wave propagation in fluid media, including Lighthill's theory of aerodynamic noise; application of passive and active noise-control techniques to compressor, fan, pump, and turbine noise; as well as integrated system design. Prerequisites: ME 460 and M 344, or equivalents.

ME 607 Graduate Project in Mechanical Engineering [3–9] Independent study of an appropriate mechanical engineering topic selected by the student in consultation with a faculty advisor. Requirements vary according to whether 3, 6, or 9 credits are selected. Independent study topics related to students' employment activities may be proposed. The usual schedule is one semester for each 3-credit increment, but accelerated schedules are possible with advisor approval. A written paper and an oral presentation are required. Prerequisites: Completion of at least 12 credits toward the M.Eng. degree program in the mechanical engineering specialty and permission of faculty advisor.

ME 609 High-Speed Aerodynamics [3] Aerothermodynamics of high-speed aerodynamics. One-dimensional, high-speed flow. Prandtl-Meyer expansion waves, normal shock waves, and oblique shock waves. Shock-expansion theory of supersonic airfoils. Linearized theory of compressible high-speed flow over airfoils,

Prandtl-Glauert equations, and supersonic flow over airfoils. Supersonic wing lift and pressure drag calculations. Prerequisites: ES 395 and M 344, or equivalents.

ME 632 Aerodynamic Design of Turbines and Compressors [3] Thermodynamic and aerodynamic theory applied to the design of turbomachinery. Gas turbine system analysis, centrifugal compressors, axial flow compressors, axial and radial flow turbines, compressor and turbine matching. Prerequisite: ME 531. ME 640 Turbomachinery Dynamics and Control [3] Transition from classical dynamics to modern high-power turbomachinery. Modes of vibration; rotor dynamics; effects of flow-induced forces; elements of aeroelasticity; modeling of dynamic/rotating, continuous-time systems. Analysis and control of turbomachines. Feedback control systems; open- and closed-loop control for dynamics; stability of dynamic/rotating systems, control systems design, modeling, compensation, passive/active control, digital control. Prerequisites: ME 350 and ES 440, or equivalents.

ME 672 Strength, Design, and Materials in Turbomachinery [3] Stresses in rotating systems-rotors, discs, shafts, seals, blades, and bearings; heat- and flow-induced stresses; basic turbomachine design requirements and material characteristics; turbomachine structural optimization; micro-mechanical and macro-constitutive materials models; basic failure theories; applications to single-crystal and polycrystalline materials; ceramics; thermal barrier and hard coatings; high-temperature lubricants and fundamentals of tribology; components models and system configuration design of gas turbine engines. Prerequisites: ES 212, ME 213, and ME 370; or equivalents.

ME 676 Manufacturing Issues in Turbomachinery [3] Design and material requirements for turbomachines. Elastic-plastic behavior of materials; thermal properties; anisotropy in materials; coatings; material manufacturing processes; single-crystal blade manufacturing; basic machine-tool elements; numerical modeling; manufacturing systems; quality, reliability, and control; process cost estimations. Prerequisite: ME 672.

ME 680 Design for Manufacturing [3] Principles of design for manufacturing. Integrating product and process design. Part geometry and its effect on assembly. Design for assembly principles. Several tools and methods, including customer-driven engineering, product rating for

assembly based on geometry or assembly motions, reverse engineering, and the use of the process capability for setting the quality and tolerance limits for new parts. Product design review. Manufacturability evaluation methods. Strategy for organizing design for manufacturing techniques in an industry. Prerequisite: Permission of instructor. Laboratory fee.

ME 681 Seminar on Modern Issues in Manufacturing Engineering [3] Exploration of special topics in concurrent engineering, such as intelligent design and manufacturing. Detailed examination of feature-based design and roles of qualitative reasoning, flexible fixturing systems, knowledge-based process planning for mechanical and electronic components, control of manufacturing systems, tools for building expert systems, neural networks to solve manufacturing problems. Prerequisite: Graduate standing.

ME 682 Advanced Manufacturing Processes [3] A decision-making framework of manufacturing systems. Mechanics and thermal models of machining, machining economics and optimization, characteristics of primary forming processes, modeling machining vibration for stability analysis. Process planning and the operation of manufacturing systems. Design and operation of computer-controlled machining centers. New issues in gauging and inspection. Prerequisite: Graduate standing.

ME 591, 592, 691, 692 Special Topics in Mechanical Engineering [1–6] Selected topics in mechanical engineering at the graduate level. Significant topics in the field will be chosen on the basis of student and faculty needs and interests. Prerequisite: Graduate standing or permission of instructor.

Other Related Courses

Chemistry Courses for Environmental Engineering

CH 519 Applied Environmental Chemistry [3] A study of chemical phenomena in the environment emphasizing problems of pollution management. Applications of kinetics, thermodynamics, and chemical reactivity theory to the amelioration of environmental pollution problems. Prerequisites: CH 539 or CH 231, and CH 347 or ME 236; or equivalents.

CH 539 Organic Chemistry for Environmental Engineers [3] A survey of the chemistry of carbon compounds. Emphasis on the effect of structure on chemical and physical properties. Other topics include the detection, characterization, toxicology, and mechanisms of degradation of organic compounds. Prerequisite: CH 111 or equivalent.

Management

MBA 610 Quantitative Decision Making [3] This course provides the student with necessary skills and understanding of the role of quantitative methods in decision making. It deals with many quantitative procedures involving a variety of computer applications and how they assist the manager in decision making and interpretation. Topics include a review of data analysis, regression analysis, time series analysis, forecasting, linear programming, and their applications. Laboratory fee. (Fa/Sp/Su)

Mathematics

M 515 Methods of Applied Mathematics I [3] Matrix algebra, simultaneous linear equations and numerical methods for their solution, inverses, and determinants. Eigenvalues and eigenvectors, canonical forms, matrix norms, algebraic variational methods, functions of matrices. Matrix methods for linear systems of ordinary differential equations (ODE), including the state-transition matrix. Quadratic forms and positive definite matrices; singular value decomposition. Introduction to nonlinear analysis. Prerequisites: Undergraduate calculus and differential equations.

M 517 Applied Engineering Statistics [3] Data collection, display, and interpretation. Discrete probability. General distributions and expectation values. Special discrete and continuous distributions. Sampling distributions and the Central Limit Theorem. Point and interval estimation, including confidence, prediction, and tolerance intervals. Parametric and non-parametric methods of hypothesis testing. Analysis of variance and the design of experiments, including blocking, etc. Simple and multivariate regression analysis, correlation, residual plots, diagnostics, and outlier detection. Introduction to statistical process control. Prerequisite: Undergraduate calculus.