Francis College of Engineering

Engineering is a profession that is concerned with the application of scientific knowledge and technology in service to society. It is involved with the identification of societal needs and creative technological solutions which address these needs in ways which are sensitive to societal, environmental and economic concerns and constraints.

The James B. Francis College of Engineering recognizes that the engineering needs of society are as complex and varied as the diverse interests, motivations, competencies, and backgrounds of its students. Therefore, it has developed a broad spectrum of programs to serve the needs of the student society and the high technology sector of the Massachusetts economy. The emphasis within each engineering program is on technical rigor, utilizing the latest advances in technology for the solution of engineering problems. At the same time, each program is characterized by a curriculum that is broad enough to produce engineers who are qualified to meet contemporary demands.

The College has active chapters of professional engineering and engineering honor societies in all major engineering disciplines, as well as the National Society of Black Engineers, Society of Women Engineers, Society of Hispanic Professional Engineers, and Tau Beta Pi - the national engineering honor society. In addition, Student Advisory Councils in each Department provide direct feedback to each Department Chair, and the College’s Engineering Student Council helps foster a sense of community in the students by planning and directing social functions and advising. Student participation in these societies and groups is strongly encouraged.

For more information, visit the College of Engineering website.

Joseph Hartman, Dean of Engineering

- Policies
- Programs

Departments

- Chemical Engineering
- Civil & Environmental Engineering
- Electrical & Computer Engineering
- Mechanical Engineering
- Plastics Engineering

Mission of the Francis College of Engineering

Policy

- Change of Program
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Programs

- BS/MS Engineering Degree
- Business Administration Minor for Engineering Majors
- Graduate Programs in Engineering
- Engineering College-Wide Courses
- Undergraduate Degree Programs in Engineering

Objectives of the Francis College of Engineering

The Francis College of Engineering seeks to prepare men and women to be successful in engineering or their chosen profession.

The faculty and staff of the Francis College of Engineering are strongly committed to providing our students with a high quality education relevant to the needs of society and industry. We will do this in a cooperative atmosphere that facilitates learning and cares about the needs of our students.

Programs are available in several engineering disciplines to accommodate varied interests. In addition, within each discipline students may prepare for various careers such as research, development, design, production, construction, teaching, and management. A faculty advisor is assigned to each student to provide experienced guidance in selecting programs and courses and in career planning.

Each student is encouraged to develop his or her full potential as an engineer with a high degree of awareness of the technological
needs of society, the nation, and particularly those of Massachusetts industry, government, and educational institutions.

The College stresses professional needs by continuously updating courses and options in the standard engineering and selected specialty programs. The departments use all available resources to advance the level of excellence of their programs. All undergraduate engineering programs are accredited by the Engineering Accreditation Commission of ABET, http://www.abet.org. Departments adhere to the standards of the National Society of Professional Engineers. The college also follows the careers of successful graduates, and solicits their views on making programs more relevant and effective.

In each discipline, the College of Engineering offers graduate research programs that not only serve as a source of updating the undergraduate course offerings, but also ensure that faculty are on the cutting edge of their particular disciplines. These programs advance the general level of information and knowledge that is so essential in fast-moving technological fields, while providing the highly specialized research required by industry. By functioning as an educational resource to the engineering profession and industry of the Commonwealth through instruction, consulting services, and research, the College of Engineering at the University of Massachusetts Lowell provides its students with an ever-current view of the working world for which they must prepare.

The College also offers associate and baccalaureate degree programs in Engineering Technology in the evenings through Online & Continuing Education.

**General College of Engineering Requirements**

Each candidate for the undergraduate degree must satisfy the general requirements of the University of Massachusetts Lowell in order to graduate. The student must also meet the specific academic requirements of the College of Engineering as indicated in this section, as well as complete all credits and courses required by the department in which the student majors. The number of credits required for the completion of each College of Engineering program is established by the department offering the program.

Courses taken by freshmen entering any engineering discipline are for the most part similar and include calculus, physics, chemistry, college writing, and engineering design.

Introduction to Engineering I (25.107) introduces first-year students to the engineering design process for solving open-ended problems. Introduction to Engineering II (25.108) is department-specific and continues with computer tools and applications to department-specific problems.

Students who have completed their freshman programs with a grade-point average of 2.50 or better automatically qualify for admission to the sophomore program of their choice. Students who fail to achieve that required average will be admitted to the sophomore year of engineering programs only upon the recommendation of appropriate departmental committees.

Please refer to the University grade-point average policy for satisfying retention and graduation requirements.

Individuals who are not granted continued matriculation in the College of Engineering but who satisfy University retention requirements may file for intercollegiate transfer within the University. Students who are dismissed from the College of Engineering and who are ineligible to file for intercollegiate transfer, or who are denied admission to another college following application for intercollegiate transfer, are dismissed from the University.

**Change of Program**

Students who wish to change their declarations of program within the College of Engineering are required to follow the procedure stipulated under University Academic Policies: Change of Major within College of Enrollment. It should be noted that College of Engineering students who change their programs within the College of Engineering after the first semester of the sophomore year should expect to have to take semester credits beyond the minimum degree requirement, and thus extend the normal four-year period of study.

Students who wish to change from engineering to a major that is offered by another college within the University of Massachusetts Lowell must apply for an intercollegiate transfer. These procedures are described under University Academic Policies: Change of Major with Intercollegiate Transfer.

Qualified students from other colleges in the University of Massachusetts Lowell may transfer into degree programs of the College of Engineering using the same procedure. However, these students may expect to extend their period of study beyond the normal four-year period, particularly if they transfer after the first semester of the sophomore year.

**Declaration of a Second Major**

Candidates for degrees in the College of Engineering may be permitted to elect additional majors offered in other colleges of the University, provided that all curriculum requirements in engineering are satisfied.

Engineering students who wish to take on a second major that is offered by the College of Engineering or by another college must formalize this intent by the start of the junior year. At that time the student is also required to submit for approval his or her intended program of study to the advisor in the department offering the second major. It should be noted that in most cases, the election of an additional major will extend the normal four-year period of undergraduate study. Students who elect to take a second academic major in another college are candidates for one degree in the College of Engineering only. A student who pursues an academic major in the College of Engineering and another college or two majors in the College of Engineering is subject to all degree requirements of the
Transfer Policies of the College of Engineering

General Policies

It is the policy of the College of Engineering to accept transfer students from other institutions as well as from other colleges within the University of Massachusetts Lowell. Such students may expect recognition of previously completed courses if these are equivalent to those that are specified by the curricula of the College of Engineering. Transfer students are required to have at least a 2.5 grade-point average in order to be admitted to the College of Engineering.

Transfer from Other Institutions

UMass Lowell participates in the Joint Admissions Program of the Massachusetts Community Colleges and the University of Massachusetts. According to this program, a student from one of these community colleges is guaranteed admission to UMass Lowell provided the student is enrolled in a designated transfer program and earns an associate degree with a 2.5 or higher cumulative grade point average.

Courses that are transferred from other institutions are initially evaluated by the Office of Admissions in terms of general University of Massachusetts Lowell requirements. Professional courses are subsequently evaluated by the departments in which the student has been accepted. Credit is given for completed courses where the grade is C (2.000 on a 4.000 scale) or better.

The University of Massachusetts Lowell also subscribes to the Commonwealth Transfer Compact. Under this compact, the holder of an associate degree from a compact institution receives up to 66 credits for this work toward a Bachelor of Science in engineering or technology. Courses which are transferred to the University of Massachusetts Lowell under the provisions of the Commonwealth Transfer Compact, but which do not meet the credit requirements of the College of Engineering, or which are not acceptable as unrestricted elective courses, will be listed on the student’s transcript, but will not apply to the minimum degree requirements.

In the event that a student has first transferred to some other college in the University of Massachusetts Lowell under the Commonwealth Transfer Compact and subsequently makes a transfer to the College of Engineering, all previously completed courses, including transferred courses from other compact institutions, will be re-evaluated in terms of their applicability toward degree requirements of the College of Engineering.

The policies of each of the colleges in the University determine the applicability of grades received in transfer to the grade-point average of the student’s major at the University of Massachusetts Lowell. It is the policy of the College of Engineering not to count such grades for the purpose of determining the student’s grade-point average in his or her professional area.

2 + 2 and 2 + 3 Transfer Programs

The College of Engineering has been a leader in the development and implementation of 2 + 2 and 2 + 3 Programs in the Commonwealth of Massachusetts. More and more students who are interested in earning a Bachelor of Science degree in one of the engineering disciplines pursue their first two years of the curriculum at selected community and state colleges and complete the degree requirements during two to three final years at the University of Massachusetts Lowell. The program is ideal from the standpoint of the student who is not ready to enter a four-year college, allowing the participant to ease into college life while still remaining close to home and within the environment of a smaller college.

The contractual agreements among participating schools require an on-going review of coursework normally offered in the first two years. Curricula and other requirements are carefully established and examined by faculty at both institutions.

Transfer agreements vary with each institution participating in the 2 + 2 or 2 + 3 programs. Some participating colleges offer programs that prepare students for transfer to mechanical and electrical engineering; programs in other schools lead to entry into chemical, civil or plastics engineering. High school students who are considering this program should consult the office of admissions at the University of Massachusetts Lowell for information about available programs in participating institutions.

Repetition of Transferred Courses

A student who has been granted transfer credit from another institution, and on this basis has been assigned to advanced courses for which the transferred course is a prerequisite, may be subsequently advised to repeat such transferred work at the University of Massachusetts Lowell. Such cases arise when preparation of the student is demonstrably inadequate to allow successful performance.

To repeat a transferred course a student must file an academic petition with the Dean of the College. Since credit may not be granted
more than once for the completion of any course, a condition for filing such a petition is the simultaneous filing of a “request to revoke recognition” statement to dispose of the previously transferred course credit.

Intercollegiate Transfer to the College of Engineering

Students wishing to transfer to the College of Engineering from another college within the University of Massachusetts Lowell, or from a baccalaureate (degree granting) Division of Continuing Education program, must file a form for change of major together with a transcript, with the Dean of the College of Engineering and with the appropriate engineering department head. Petitions for transfer must be filed no later than November 1 in order to transfer in the spring semester, and no later than April 1 in order to transfer in the fall semester.

Any student who wishes to transfer from another college in the University to the College of Engineering must have a minimum grade-point average of 2.500. Irrespective of the grade received, all courses that may not be applied to the College of Engineering program requirements will be deleted from the student’s cumulative grade-point average.

For further procedural details about the University’s policies concerning intercollegiate transfers, students are referred to University Academic Policies: Change of Major with Intercollegiate Transfer.

Undergraduate Degree Programs in Engineering

The College of Engineering offers four-year undergraduate programs leading to the degree of Bachelor of Science in Engineering; programs leading to Associate and Bachelor of Science in Engineering Technology (in evening part-time programs through Continuing Education), five-year dual-degree programs with the College of Arts and Sciences leading to a Bachelor of Science degree in Engineering and a Bachelor of Arts, and five-year programs leading to both Bachelor of Science in Engineering and Master of Science in Engineering.

The degree of Bachelor of Science in Engineering is offered in the following fields: Chemical Engineering, Civil Engineering, Electrical Engineering, Mechanical Engineering, Plastics Engineering and a new program in Computer Engineering. Course requirements for engineering degrees have been determined by specific professional objectives and are subject to the recommendations of the Engineering Accreditation Commission and the Accreditation Board for Engineering and Technology (ABET). All undergraduate engineering programs are accredited by the Engineering Accreditation Commission of ABET, http://www.abet.org.

The degree of Bachelor of Science in Engineering Technology is awarded in the areas of Civil Engineering Technology, Electronic Engineering Technology, and Mechanical Engineering Technology, offered in the evenings through the Division of Corporate Studies and Continuing Education. The Electronic and Mechanical Engineering Technology bachelor's degree programs are currently accredited by the Technology Accreditation Commission of ABET, http://www.abet.org.

Courses of study in engineering and engineering technology provide a basic general education, scientific-technological preparation in the sciences, and a comprehensive introduction to an engineering or technology field. Students must select a single major field of study. However, candidates for degrees in the College of Engineering may be permitted to elect additional majors in other colleges of the University, provided that all curriculum requirements for their degree program in the College of Engineering are satisfied.

Minor in Business Administration for Engineers

The minor in business administration for engineers is offered by the College of Management (CoM) in conjunction with the College of Engineering.

Courses in the Minor in Business Administration for Engineers

Required courses:

- 49.201 Economics I (may count as Gen Ed course)
- 60.201 Accounting/Financial
- 61.301 Business Finance
- 62.201 Marketing Principles
- 66.301 Organizational Behavior

Elective courses:

Two courses from a selected list which is approved by the Engineering department and College of Management or 63.301 Management information Systems plus one additional course from a selected list which is approved by the Engineering department and CoM.

For Civil & Environmental Engineering, these two additional courses are:

- 14.372 Civil Engineering Systems (already core in CEE)
- And one from the following list:
  - 14.475 Construction Management (*)
  - 22.576 Engineering Project Management (*)

Courses marked with * and 66.301 Organizational Behavior may be used as Technical Electives in CEE.

For Plastics Engineering, these two additional courses are:

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- 26.537 Business Law for Engineers (†)
  And one from the following list:
  - 26.507 Plastics Industry Organization (*)
  - 26.540 Commercial Development of Polymeric Systems (*)
  - 26.590 Survey of Intellectual Property (*)
  - 22.576 Engineering Project Management (*)

† Course 26.542 counts as a Design elective, and courses marked with * count as a Technical Elective in Plastics. In addition, Plastics students not taking 22.576 are encouraged to take 60.202 Accounting/Managerial or 14.470 Engineering Economics or 10.409 Economics & Process Analysis.

For Chemical Engineering, these two additional courses are:

- 10.409 Economics and Process Analysis
  and one from the following list:
  - 14.372 Civil Engineering Systems (*)
  - 63.210 Operations Analysis Techniques
  - 22.576 Engineering Project Management (*)
  - 26.542 Business Law for Engineers (*)
  - 26.590 Survey of Intellectual Property (*)

Courses marked with * may count as a Technical Elective in ChE.

For Mechanical Engineering, these two additional courses are:

- 22.576 Engineering Project Management (*)
- 22.575 Industrial Design of Experiments (*)
- 14.372 Civil Engineering Systems or 63.210 Operations Analysis Techniques
- 14.470 Engineering Economics (*) or 10.409 Economics & Process Analysis (*)
- 26.542 Business Law for Engineers (*)

Courses marked with * may count as a Technical Elective in ME.

For Electrical and Computer Engineering, these two additional courses may be:

- 14.372 Civil Engineering Systems or 63.210 Operations Analysis Techniques
- 14.470 Engineering Economics or 10.409 Economics and Process Analysis
- 22.576 Engineering Project Management
- 26.542 Business Law for Engineers
- 26.590 Survey of Intellectual Property

Additional courses may be added by each Engineering Department to their list of elective courses, with the approval of the College of Management.

Five-Year Bachelor of Science/Master of Science in Engineering Degrees Program

The purpose of this program is to offer qualified undergraduate students an accelerated program of study leading to a Master of Science in Engineering at the end of five years of study. Students benefit from the efficiency of a continuous, coordinated sequence of subjects and reduced credit hour requirements. Students can receive the Bachelor of Science in Engineering at the end of the fourth year and the Master of Science in Engineering at the end of the fifth year if all requirements are met.

To be considered academically eligible for this program, a student should have a cumulative GPA of 3.0 or greater by the end of their junior year. The student must file a formal Graduate School application prior to graduation (noting "BS/MS" on the application). Academically eligible applicants are not required to take the Graduate Record Examination and the application fee is waived. Upon recommendation of the student’s advisor, the approval of the department graduate admissions committee, and the Dean of the Graduate School, the student may be admitted as a provisional graduate student.

Applicants who satisfy the Graduate School and Engineering Department admission requirements for the five year program are assigned to a graduate faculty member who acts as their program advisor. Depending on the Department, the M.S.E degree requires the successful completion of a minimum of 30 -33 credit hours that include at least 24-27 hours in class and seminar study, almost all of which must be at the 500 level or higher. Courses at the 400 level are designed for seniors, but may be taken by graduate students for graduate credit if written approval is given by the student’s advisor.

Once admitted to the program, the student may double-count up to two graduate courses (6 credits) taken as senior electives, after consulting with a departmental Faculty Advisor. This effectively reduces the requirements for the Masters degree program by 2 courses, allowing the BS/MS student to complete the graduate coursework requirements in the final, fifth year.

A student in this program may be eligible for financial assistance, i.e., fellowships and research and teaching assistantships, during the fifth year of study. Acceptance of this assistance and the attendant responsibilities may delay the completion of the program beyond the five years.
Graduate Programs in Engineering

The education of engineers in state-of-the-art areas of advanced technology and the University’s commitment to national and regional economic development are the major premises upon which the graduate programs in the College of Engineering are based. These programs are intended to produce engineers whose education not only develops expertise in the design, development and production of products, but also an understanding of the management involved in the creation of new products, companies, and service organizations. Thus, the graduate programs in engineering are intended to educate engineers capable of keeping abreast with the rapidly changing technology that characterizes the high technology economy of the Northeast. The programs lead to degrees of Master of Science in Engineering, Master of Science, Doctor of Science, Doctor of Philosophy, and Doctor of Engineering.

Minor in Business Administration for Engineers

The minor in business administration for engineers is offered by the College of Management (CoM) in conjunction with the College of Engineering.

Courses in the Minor in Business Administration for Engineers

Required courses:
- 49.201 Economics I (may count as Gen Ed course)
- 60.201 Accounting/Financial
- 61.301 Business Finance
- 62.201 Marketing Principles
- 66.301 Organizational Behavior

Elective courses:
Two courses from a selected list which is approved by the Engineering department and College of Management or 63.301 Management information Systems plus one additional course from a selected list which is approved by the Engineering department and CoM.

For Civil & Environmental Engineering, these two additional courses are:
- 14.372 Civil Engineering Systems (already core in CEE)
- 14.475 Construction Management (*)
- 22.576 Engineering Project Management (*)

Courses marked with * and 66.301 Organizational Behavior may be used as Technical Electives in CEE.

For Plastics Engineering, these two additional courses are:
- 26.537 Business Law for Engineers (†)
- 26.507 Plastics Industry Organization (*)
- 26.540 Commercial Development of Polymeric Systems (*)
- 26.590 Survey of Intellectual Property (*)
- 22.576 Engineering Project Management (*)

† Course 26.542 counts as a Design elective, and courses marked with * count as a Technical Elective in Plastics. In addition, Plastics students not taking 22.576 are encouraged to take 60.202 Accounting/Managerial or 14.470 Engineering Economics or 10.409 Economics & Process Analysis.

For Chemical Engineering, these two additional courses are:
- 10.409 Economics and Process Analysis
- 14.372 Civil Engineering Systems (*)
- 63.210 Operations Analysis Techniques
- 22.576 Engineering Project Management (*)
- 26.542 Business Law for Engineers (*)
- 26.590 Survey of Intellectual Property (*)

Courses marked with * may count as a Technical Elective in ChE.

For Mechanical Engineering, these two additional courses are:
- 22.576 Engineering Project Management (*)
- 22.573 Manufacturing Systems (*)
- 14.372 Civil Engineering Systems or 63.210 Operations Analysis Techniques
- 14.470 Engineering Economics (*) or 10.409 Economics & Process Analysis (*)
- 26.542 Business Law for Engineers (*)
Courses marked with * may count as a Technical Elective in ME.

For Electrical and Computer Engineering, these two additional courses may be:

- 14.372 Civil Engineering Systems or 63.210 Operations Analysis Techniques
- 14.470 Engineering Economics or 10.409 Economics and Process Analysis
- 22.576 Engineering Project Management
- 26.542 Business Law for Engineers
- 26.590 Survey of Intellectual Property

Additional courses may be added by each Engineering Department to their list of elective courses, with the approval of the College of Management.

Policies

Please review the following policies:

- Change of Program
- College of Engineering Faculty (pdf)
- Declaration of Second Major
- Degree Requirements
- Transfer Policies

10.101 Technology and Human Built World

Course ID: 30309
Course Details:
Max Credits: 3
Min Credits: 3

10.201 Material Balances

Course ID: 30311
Course Details: Introduction to the field of chemical engineering and solution of problems involving units and dimensions, mass balances, flow sheets and gas relationships.
Max Credits: 3
Min Credits: 3

10.202 Energy Balance & Introduction to Thermodynamics

Course ID: 30312
Course Details: Continuation of Chemical Engineering Calculations I including real gas relationships, humidity, energy balances, and the combined mass-energy balance systems. Introduction to the first law of thermodynamics.
Max Credits: 3
Min Credits: 3

10.205 Fundamentals of Electricity

Course ID: 30313
Course Details: An introduction to direct current and alternating current of electric circuits with emphasis on practical application.
Max Credits: 3
Min Credits: 3

10.303 Fluid Mechanics

Course ID: 32001
Course Details: This course introduces the student to several fundamental concepts and applications of fluid mechanics. It overviews the
basic properties of fluids, the study of fluid statics and fluid flow systems, and the development and application of the appropriate mass, momentum, and energy balance relationships needed to solve a variety of practical problems, with a particular focus on the macroscopic view. Emphasis is on the ability to apply the basic principles to the design and analysis of engineering systems involving applications in hydrostatics, internal, open-channel, and external flows, pump selection, flow measurement, etc. The course also focuses on proper problem solving strategy and on the correct use of units in engineering analysis.

Max Credits: 3
Min Credits: 3

**10.304 Heat Transfer**

Course ID: 33342

Course Details: Fundamental principles of heat transmission by conduction, convection, radiation and evaporation. Applications of these principles to the solution of industrial heat transfer problems and to the design calculations for heat exchange situations.

Max Credits: 3
Min Credits: 3

**10.308 Introduction to Material Science and Engineering**

Course ID: 2866

Course Details: A general overview of solid materials which are likely to be considered for engineering applications in, or be produced by the chemical process industries. They will be discussed from the viewpoints of their units structures, appropriate phase diagrams, their chemical and physical attributes, and the association of these to end use applications. Discussion of metals, ceramics, polymers, and to a limited degree, composites.

Max Credits: 3
Min Credits: 3

**10.310 Separation Processes with Mass Transfer**

Course ID: 2867

Course Details: Introduction to equilibrium staged and other separations, including distillation, adsorption, absorption, membrane and chromatographic based separations. Unifying fundamental relations and concepts are emphasized.

Max Credits: 3
Min Credits: 3

**10.311 Chemical Engineering Thermodynamics**

Course ID: 2868

Course Details: The first and second laws of thermodynamics, P-V-T relations, mathematics of property changes, generalized correlation's of thermodynamic properties, application of thermodynamics to problems of phase and chemical equilibria.

Max Credits: 3
Min Credits: 3

**10.315 Unit Operations Laboratory**

Course ID: 2869

Course Details: Students perform laboratory base experimental analyses in fluid flow and heat transfer and fluid flow and heat transfer unit operations processes common in Chemical Engineering practice. The course is team based and students are expected to develop and improve in their ability to work and interact in a group environment. Written and oral reports are required. Safety in both lab and industrial practice are emphasized.

Max Credits: 3
Min Credits: 3

**10.316 Unit Operations Laboratory II**
Course ID: 2870

Course Details: Experimental projects treat heat and mass transfer, including staged operations, in a unit operations format. Process measurement and calibration emphasised. Written reports required.

Max Credits: 2
Min Credits: 2

10.317 Applied Mathematics with Matlab

Course ID: 2871

Course Details: The focus of this course will be to develop the students' problem solving skills for a broad range of technical applications. Matlab will be used as the programming environment. The course will be applications oriented with the appropriate level of mathematics and theory to support the use of the software to formulate, solve, and analyze technical problems. Applied numerical methods will be introduced as a means for solving a wide variety of problems.

Max Credits: 3
Min Credits: 3

10.331 Introduction to Nuclear Engineering I

Course ID: 1263

Course Details: Review of relevant nuclear physics topics including nuclear stability, various forms of radiation, radioactive decay, and the interaction of radiation with matter (including health effects). Emphasis placed on neutron reactions in various core and structure materials, neutron cross sections, and the development and analysis of the neutron balance equation for various reactor types. Key aspects of nuclear reactor core physics and shielding design (criticality, power generation, reactor kinetics, reactivity control, fuel depletion, fission product poisoning, etc.) are treated. (10.331 and 24.331 are the same)

Max Credits: 3
Min Credits: 3

10.347 Elements of Thermodynamics and Heat Transfer

Course ID: 2874


Max Credits: 3
Min Credits: 3

10.403 Chemical Reaction Engineering

Course ID: 2876

Course Details: Review of principles underlying rates of transformation of matter and energy; effect of temperature and catalysis on chemical reactions. Introduction to the basic ideas underlying chemical reaction engineering. May be taken for graduate credit.

Max Credits: 3
Min Credits: 3

10.405 Design Of Papers

Course ID: 2877

Course Details: Fundamentals of the mechanical and optical testing of paper and allied products. Discussion of engineering mechanics involved in various testing procedures. Statistical analysis of test data. Structure of materials revealed by physical tests. Laboratory projects designed to illustrate problems in development of paper products and associated required processes.

Max Credits: 3
Min Credits: 3
10.409 Engineering Economics and Process Analysis

Course ID: 2879

Course Details: This course brings together all the Chemical Engineering core principles applied to the development of economic process designs. Economic evaluations of manufacturing operations and projects including essential concepts in accounting, depreciation, time value of money, and the evaluation of investment alternatives are applied for process analysis and design objectives. The impact of management and production costs, product markets, regulatory, environmental and safe production practices, the analysis of corporate annual reports including balance sheets and income statements, and capital and operating costs are all considered in regard to efficient and economic processes. In addition to lecture materials students are required to complete comprehensive projects.

Max Credits: 3
Min Credits: 3

10.410 Chemical Plant Design

Course ID: 2880

Course Details: This course is the logical continuation of 10.409. The principles of technical and economic evaluation are applied to a chemical engineering problem. A group of students is given a statement of the problem. They are required to find information on raw materials, products, thermodynamic parameters and plant practices in order to develop the assumptions required to carry out an examination of technical and economic feasibility. Each group generates a final report for the problem. Homework is also assigned to assist the student in the specifics of the problems.

Max Credits: 3
Min Credits: 3

10.413 Process Dynamics & Control

Course ID: 2881

Course Details: An introduction to chemical process control. Description of processes and equipment by differential equations and the Laplace transform. Development of block diagrams. System stability is studied by both root locus and frequency response methods. May be taken for graduate credit.

Max Credits: 3
Min Credits: 3

10.415 Processes and Controls Laboratory

Course ID: 33359

Course Details: Experimental projects dealing with heat and mass transfer, separations and process control. Written and oral reports required.

Max Credits: 2
Min Credits: 2

10.420 Special Senior Projects

Course ID: 2884

Course Details: Original research projects primarily in the chemical engineering field and supervised by a staff member of the department. Written reports required.

Max Credits: 3
Min Credits: 3

10.434 Introduction to Nuclear Engineering II

Course ID: 36717

Course Details: A continuation of 10.331/24.331 with further discussion of basic nuclear reactor theory and reactor operations. The 2nd half of the semester focuses on heat removal and energy conversion in pressurized and boiling water reactors, including heat transfer in
fuel elements and shields and the heat transfer characteristics of boiling and non-boiling liquids. Engineered safety and overall reactor
core and plant design considerations are also discussed. (10.434 and 24.434 are the same)

Max Credits: 3
Min Credits: 3

10.450 Nanoscale Transport Phenomena for Manufacturing Nanodevices

Course ID: 36698

Course Details: An interdisciplinary course taught by faculty from the Chemical, Mechanical and Plastics Engineering Departments, who
have special knowledge in nanoscale fluid mechanics and heat transfer. The course on nanoscale transport phenomena constitutes a
bridge between existing fluid and heat transfer courses in multiple disciplines and emerging nanoscale science and engineering
concepts to reflect the forefront of nanomanufacturing. The course is designed to incorporate recent advances in manufacturing polymer
based nanodevices. Key issues of the implementation and maintenance costs for fabrication will be addressed. Hands-on laboratory
experiments will be performed to complement the lectures with the ultimate goal of designing and building a complete nanodevice at the
end of the course. The course will prepare graduates for employment focused on designing and manufacturing nano/microfluidic
systems, lab on ship devices, electronic devices, medical devices and other emerging technologies.

Max Credits: 3
Min Credits: 3

10.490 Industrial Experience

Course ID: 35482

Course Details: This zero credit course is used for students in Chemical Engineering who receive special permission.

Max Credits: 0
Min Credits: 0

10.491 Industrial Experience I

Course ID: 2891

Course Details: Projects performed by students in the Cooperative Education Program at their place of employment and supervised by
the employer and advisor from the department. Reports required upon completion of the project.

Max Credits: 12
Min Credits: 0

10.492 Industrial Experience II

Course ID: 2892

Course Details: Projects performed by students in the Cooperative Education Program at their place of employment and supervised by
the employer and advisor from the department. Reports required upon completion of the project.

Max Credits: 9
Min Credits: 1

10.493 Industrial Experience III

Course ID: 2893

Course Details: Projects performed by students in the Cooperative Education Program at their place of employment and supervised by
the employer and advisor from the department. Reports required upon completion of the project.

Max Credits: 9
Min Credits: 1

10.494 Select Topics: Paper Engineering

Course ID: 2894
Course Details: Topics in paper engineering. Content may vary from year to year to reflect contemporary applications of paper engineering.

Max Credits: 3
Min Credits: 3

10.496 Selected Topics: Paper Engineering

Course ID: 2895

Course Details: Topics in paper engineering. Content may vary from year to year to reflect contemporary applications of paper engineering.

Max Credits: 3
Min Credits: 3

14.203 Statics (alternate 22.211)

Course ID: 2964

Course Details: Discusses vector concepts of forces and moments of forces. Static equilibrium of particles, rigid bodies and simple structures. Static friction forces. Geometric properties of sections.

Max Credits: 3
Min Credits: 3

14.204 Strength of Materials (alternate 22.212)

Course ID: 2965

Course Details: Introduces the concept of stress and strain at a point, stress-temperature relationships, force and deformation analyses of bodies under axial, shearing, flexural, torsional and combined loadings, shear and bending moment diagrams, and Euler Columns.

Max Credits: 3
Min Credits: 3

14.205 Dynamics (alternate 22.213)

Course ID: 2966

Course Details: Vector development of kinematics of particles and rigid bodies with respect to fixed and moving coordinate systems of one, two, and three dimensions. The dynamics of particles, systems of particles, and rigid bodies. Angular momentum and the inertial properties of rigid bodies. Energy, impulse and momentum methods.

Max Credits: 3
Min Credits: 3

14.225 Surveying I

Course ID: 2970

Course Details: A presentation of the basic instruments used in survey processes including distance, angle and level measurements. Analysis and adjustment of random errors. Principles of closed and open traverses. Fieldwork practice in instrument use and office-type projects in contour mapping and the application of contoured topography to highway and water-control projects.

Max Credits: 3
Min Credits: 3

14.226 Geomatics

Course ID: 2971

Course Details: Principles and practice of route surveys and designs. Topics include simple and compound circular curves, intersections of straight and curved baselines, vertical alignment principles including parabolic easement curves, earthwork operations and determination of volumes. Includes office-type projects illustrative of the application of surveying information to Civil Engineering.
projects such as water resources, sanitary sewers and property subdivision. Fieldwork instruction in basic traverse surveys, gathering of topographic information, and the staking-out of buildings and circular curves.

Max Credits: 3
Min Credits: 3

14.286 Probability and Statistics for Engineers

Course ID: 2972
Course Details: Probability, statistics, reliability and decision with applications in engineering. Probability of events, discrete and continuous random variables, probability density functions and distributions, estimation, regression and correlation techniques, risk and reliability concepts.

Max Credits: 3
Min Credits: 3

14.301 Fluid Mechanics

Course ID: 2973
Course Details: Fluid properties, fluid statics, fluid dynamics including continuity, impulse-momentum and energy equations. Pipe flow, turbomachinery, similitude and modeling, laminar and turbulent flow, boundary layer and closed conduct design.

Max Credits: 3
Min Credits: 3

14.310 Engineering Materials

Course ID: 2975
Course Details: A treatment of the properties of engineering materials that influence the design, construction and maintenance of Civil Engineering works. Included are such materials as ferrous and non-ferrous metals, timber, asphalt, and cementitious materials. Supplemented by laboratory testing of various engineering materials.

Max Credits: 3
Min Credits: 3

14.311 Engineering Materials Laboratory

Course ID: 2976
Course Details: Experiments and written reports. Testing and measurement techniques and material standards illustrating behavior of materials, including metals, wood, and Portland cement concrete.

Max Credits: 1
Min Credits: 1

14.330 Soil Mechanics

Course ID: 2977
Course Details: Development of the fundamental principles of soil mechanics as utilized in soil and foundation engineering. Topics include: classification, index properties, strength and stress-strain behavior, effective stress principle, permeability, flow and consolidation. Introduction to basic soil mechanics laboratory practice.

Max Credits: 3
Min Credits: 3

14.332 Environmental Engineering Laboratory

Course ID: 2979
Course Details: Laboratory experiments to illustrate analysis of environmental samples and experimental techniques, normally used in support of water and wastewater treatment facilities. Course emphasizes data acquisition and analysis, and engineering report writing.
Max Credits: 1
Min Credits: 1

14.333 Geotechnical Laboratory

Course ID: 2980

Course Details: Laboratory experience that illustrates soil mechanics and fluid flow theory. Experiments are conducted in the soils and hydraulics laboratories. Course emphasizes data acquisition and analysis and writing engineering reports.

Max Credits: 1
Min Credits: 1

14.340 Transportation Engineering

Course ID: 2981

Course Details: Development of the basic principles pertaining to the movement of people and goods by modern transportation systems. Techno-economic characteristics of the various transportation modes. Aspects of planning, design and operation of land, air and water transportation facilities. Development, structure and function of the U.S. transportation system.

Max Credits: 3
Min Credits: 3

14.341 Transportation Engineering Laboratory

Course ID: 2982

Course Details: Practice techniques of data collection, analysis and presentation that are commonly used in the planning, design and operation of transportation facilities with primary emphasis on highway systems.

Max Credits: 1
Min Credits: 1

14.350 Structural Analysis I

Course ID: 2983

Course Details: Principles of structural analysis applied to typical civil engineering structures as the initial step in the total design concept. Emphasis on the classical methods of analysis of statically determinate and indeterminate structures. The personal computer as an analytical tool.

Max Credits: 3
Min Credits: 3

14.352 Reinforced Concrete

Course ID: 2984

Course Details: Ultimate strength and elastic behavior of reinforced concrete structural members, continuity in building frames, deflections, shear reinforcement, development length and bar cutoffs, columns and footings.

Max Credits: 3
Min Credits: 3

14.362 Environmental Engineering

Course ID: 2985

Course Details: Physical, chemical and biological principles of the treatment of water and wastewater are considered along with their application to treatment systems. The system components of wastewater and water treatment plants are studied to provide a basic design capability. Hazardous waste site remediation is also discussed.

Max Credits: 3
14.372 Civil Engineering Systems

Course ID: 2986

Course Details: Introduction to methods of operations research, management science and economic analysis used in the design, planning and managing of engineering systems. Main topics covered: systems modeling, optimization concepts, network analysis, mathematical programming, critical path analysis, decision analysis, economic consideration.

Max Credits: 3
Min Credits: 3

14.409 Environment Engineering Geology

Course ID: 2988

Course Details:

Max Credits: 3
Min Credits: 3

14.431 Foundation and Soil Engineering

Course ID: 2990

Course Details: The application of soil mechanics to the design and analysis of foundations and soil structures. Topics include: soil origin and deposition, subsurface exploration, bearing capacity and settlement analyses, design of shallow foundations, earth pressures, retaining structures, and slope stability.

Max Credits: 3
Min Credits: 3

14.452 Steel Design

Course ID: 2993

Course Details: An introduction to structural steel design with emphasis on use and interpretation of the AISC Manual and LRFD Specifications. Subjects include design of tension, compression, beams, and beam-column members, plus bolted and welded connections. Other topics may include composite beams, plate girders, building connections and plastic analysis and design.

Max Credits: 3
Min Credits: 3

14.460 Water Resources Engineering

Course ID: 2995

Course Details: This course is a continuation and extension of Fluid Mechanics, with a focus on engineering applications of hydraulic and hydrologic engineering. This course covers fundamental concepts of open-channel flow, hydraulic structures, design of open channels, surface-water hydrology, and groundwater hydrology.

Max Credits: 3
Min Credits: 3

14.466 Introduction to LEED

Course ID: 37656

Course Details: This course examines the principles of sustainability and how they are applied to engineering and the built environment. Areas covered include energy, water, materials, transportation, and green building principles. Issues of evaluation of sustainability, including life cycle analysis and rating systems, are also discussed. This course fulfills the educational requirements for eligibility to take the LEED (Leadership in Energy and Environmental Design) Green Associate exam.

Max Credits: 3
Min Credits: 3

14.470 Engineering Economics

Course ID: 2999

Course Details: Presentation of mathematical principles of economic analysis, with emphasis on defining alternatives and predicting consequences of proposed investments. Emphasis is placed on the economic, social and environmental impacts of proposed Civil Engineering projects. The attractiveness of investments is judged by present worth, annual worth, rate of return, and benefit-cost ratio techniques. Sensitivity analysis, depreciation and tax impacts in economic studies are also discussed.

Max Credits: 3

14.475 Construction Management I

Course ID: 3000

Course Details: Development of management skills and techniques to plan, schedule, supervise, and control construction projects. Project estimating; labor costs and productivity; construction plans, specifications and contracts; labor relations; time, cost and quality control; construction equipment and project decision making and financing.

Max Credits: 3

14.480 Special Topics in Civil Engineering

Course ID: 3002

Course Details: Contemporary topics in selected areas of study within civil engineering. Course content is chosen by the instructor to meet the interests of the students.

Max Credits: 3

14.481 Special Topics

Course ID: 3003

Course Details: Contemporary topics in selected areas of study within civil engineering. Course content is chosen by the instructor to meet the interests of the students.

Max Credits: 3

14.483 Spec Topics: Civil Engineering

Course ID: 3004

Course Details: Contemporary topics in selected areas of study within civil engineering. Course content is chosen by the instructor to meet the interests of the students.

Max Credits: 3

14.485 Capstone Design

Course ID: 3005

Course Details: Introduction to the essentials of engineering design and a forum for practicing the design process. Integrates many elements of the curriculum through a comprehensive design project to professional standards. Projects includes the use of open-ended problems, feasibility analysis, complete design process, consideration of alternative solutions, and cost estimation. Students practice team effort, development of a system perspective, communication skills, reporting, and presentations.

Max Credits: 3
14.491 Industrial Experience I

Course ID: 3007

Course Details: The new Cooperative Education program for undergraduates combines academic studies with work experience in appropriate positions in the public or private sectors. It permits students to participate in the flexible schedule of study and work that is related to their academic fields of study and to receive academic credit for the work experience. Requires 500 hours of cooperative education engineering experiences, on a full-time or part-time basis, during any academic semester or summer. All co-op work must be pre-approved by the Co-op Coordinator. (Effective with Class of 2001-02, students in CEE are able to earn three credits after the successful completion of both Industrial Experience I and II).

Max Credits: 12
Min Credits: 3

14.492 Industrial Experience II

Course ID: 3008

Course Details: The new Cooperative Education program for undergraduates combines academic studies with work experience in appropriate positions in the public or private sectors. It permits students to participate in the flexible schedule of study and work that is related to their academic fields of study and to receive academic credit for the work experience. Requires 500 hours of cooperative education engineering experiences, on a full-time or part-time basis, during any academic semester or summer. All co-op work must be pre-approved by the Co-op Coordinator. (Effective with Class of 2001-02, students in CEE are able to earn three credits after the successful completion of both Industrial Experience I and II).

Max Credits: 3
Min Credits: 0

14.493 Industrial Experience III

Course ID: 3009

Course Details:

Max Credits: 3
Min Credits: 3

15.113 Computer-Aided Design and Drafting

Course ID: 3096

Course Details: Demonstrates CAD concepts using both class discussion and laboratory work. Using interactive computer graphics workstations, students will create several civil/architectural drawings that involve the processes of inserting and modifying lines, arcs, text, dimensions, and other geometric entities. AutoCAD is used in this course.

Max Credits: 2
Min Credits: 2

15.123 Surveying I

Course ID: 3098

Course Details: Basic principles of surveying: use, care, and adjustments of tape, engineers transit, engineers level, theodolite and electronic distance measuring devices; introduction to surveying processes by means of traverse computations, development of topographic information, introduction to global positioning systems, elementary photogrammetry, the Internet, and the use of the electronic computer in land surveying. Problems are used to illustrate basic principles.

Max Credits: 4
Min Credits: 4

15.124 Surveying II

Course ID: 3099
Course Details: Basic principles of route designing and surveying. An introduction to the preparation of calculations and plans for the construction of all routes of transportation. Class topics include route geometry determination, curve geometry, economic analysis using cost to benefit rationale. Determination of earthwork quantities and the use of the electronic computer in route surveying. Problems are used to illustrate basic principles.

Max Credits: 4
Min Credits: 4

15.131 Environmental Chemistry I

Course ID: 3100

Course Details: Emphasizes basic chemical theory. Reactions and equations are presented, along with an introduction to the structure and character of water, its impurities, and the chemical treatment schemes that have been devised to deal with them.

Max Credits: 3
Min Credits: 3

15.152 Water Biology

Course ID: 3102

Course Details: Covers the following topics: uses of biology lab tools; microscope basic chemistry; water molecules; physical properties; biochemistry; life functions; features of life and the cell; classification; viruses and monerans; simple water animals; simple water plants; protists and fungi; methods of transport, osmosis, diffusion, etc.; photosynthesis, respiration, ecosystems, and biomes.

Max Credits: 3
Min Credits: 3

15.242 Steel Design I

Course ID: 3110

Course Details: Provides an introduction to the analysis and design of structural steel elements based on AISC LRFD code requirements. Structural elements covered include tension members, columns, beams, and beam columns. Types of structures considered include simple and continuous spans, and braced and unbraced frames. Strength, serviceability, design economy and good design practice principles are discussed. Use of computer software to perform routine analysis and design tasks is reviewed and examples provided.

Max Credits: 3
Min Credits: 3

15.246 Hydraulics

Course ID: 3111

Course Details: Presents the properties of fluids, principles of hydrostatic pressure, fluid flow with applications to orifices, tubes, wires, and pipes. Two demonstration laboratory sessions will be held during the semester.

Max Credits: 3
Min Credits: 3

15.263 Wastewater Operations Laboratory I

Course ID: 3121

Course Details: In this lab, fundamental principles of biological wastewater treatment are explained. Students perform basic wet chemistry tests for monitoring and operating a biological wastewater treatment system.

Max Credits: 1
Min Credits: 1

15.274 Water Works Operations Lab I
Course ID: 3123

Course Details: Introduces the students to fundamental laboratory equipment as applied to the operation of water treatment facilities. The following determinations will be conducted: odor, color, turbidity, jar tests, pH, chlorine residual, acidity, alkalinity, hardness, chlorine, iron, manganese, phosphate, aluminum, nitrogen, cycle, coliform, microscopic analysis, heavy metals, and organics. Pre-Requisite: 15.131.

Max Credits: 1
Min Credits: 1

15.280 Industrial Waste Treatment

Course ID: 3124

Course Details: This course examines the state and federal regulations for industrial wastewater treatment. Basic chemistry is covered and physical-chemical treatment for neutralization, oxidation-reduction, metals removal, and cyanide destruction is reviewed in detail along with numerous sample problems. Common industrial waste treatment processes such as filtration, ion exchange, activated carbon, ultra filtration reverse osmosis and other membrane filtration techniques are presented. Chemical feed systems, polymer feed systems, chemical dosage calculations, jar testing, sludge handling, and dewatering methods and sludge calculations are also discussed.

Max Credits: 3
Min Credits: 3

15.315 Land Development Desktop

Course ID: 30318

Course Details:

Max Credits: 3
Min Credits: 3

15.353 Forensic Engineering

Course ID: 32150

Course Details: This course is a survey of forensic engineering with particular emphasis on using engineering science and technology to investigate and reconstruct failures of engineered systems. Topics include qualifications of the forensic engineer, the scientific method, failure hypotheses, levels of confidence, physical evidence, field investigation techniques, examination and testing, codes and standards, and personnel safety. Other topics include ethics, the hired gun, junk science, the legal process, introduction to expert witness testimony, trial exhibits, Frye and Daubert decisions, bias, forensic engineering practice, and engineering reports.

Max Credits: 3
Min Credits: 3

15.486 Transportation Elements

Course ID: 3151

Course Details: Transportation Elements is the study of a variety of issues associated with the planning, project evaluation, vehicle/driver/traffic characteristics, roadway capacity and social/economic/environmental impacts of transportation projects. Students will develop and retain a basic understanding of the environmental process and alternatives analysis as well as design considerations. Practical, real-world examples will be used to model the topics of each lecture. The concepts presented in this course directly relate to numerous other civil engineering fields.

Max Credits: 3
Min Credits: 3

16.100 Introduction to Electrical and Computer Engineering

Course ID: 3154

Course Details: This introductory course is designed to expose students to many of the new developments in Electrical Engineering, especially those on-going in the Department. It will also provide information about co-op opportunities and career planning, while also allowing faculty in the Department to describe their courses and answer questions.
16.201 Circuit Theory I

Course ID: 3159


Max Credits: 3
Min Credits: 3

16.202 Circuit Theory II

Course ID: 3160

Course Details: Discusses the sinusoidal forcing function, complex numbers, phasors, sinusoidal steady-state conditions, impedance, average real power, reactive power and rms values, exponential forcing function, poles and zeros in the s-plane, concept of the system function and its use in determining the forced response and resonance, reactance cancellation and concept of s-plane vectors. The course also covers Thevenin's and Norton's theorems, superposition, reciprocity, and maximum power in the frequency domain, impedance and admittance. Introduction to matrices and their use in circuit analysis, magnetic coupling, mutual inductance, and ideal transformer. Engineering Science (100%).

Max Credits: 3
Min Credits: 3

16.207 Basic Electrical Engineering Laboratory I

Course ID: 3161

Course Details: Experimental work designed to verify theory and to acquaint students with electrical measurement techniques: experiments on meters, bridges, and oscilloscopes. Experiments are correlated with course 16.201 and concern: resistive measurements, Kirchhoff's laws, network theorems, conservation of power and maximum power transfer, inductance and capacitance, and first and second-order transients, operational amplifiers.

Max Credits: 2
Min Credits: 2

16.208 Basic Electrical Engineering Lab II

Course ID: 3162

Course Details: Presents experimental work designed to emphasize electrical measurement techniques of linear systems with time-varying signals. Waveform measurements with dc and ac meters as well as advanced use of the oscilloscope are also discussed. Experiments are integrated with course 16.202. Experiments cover: Kirchhoff's laws for phasors, bode plots, magnitude and phase measurements of impedance, network theorems, frequency response, resonance, inductance, maximum power transfer, and MATLAB techniques. Engineering Science (50%); Engineering Design (50%).

Max Credits: 2
Min Credits: 2

16.211 Fundamentals of Electricity I

Course ID: 1269

Course Details: Serves as an introduction to direct current and alternating current analysis of electric circuits, with emphasis on energy and power. Covers design and use of multi-range voltmeters, ammeters, and ohmmeters, the use of bridges and oscilloscopes, phasor analysis of AC circuits, Trigonometric Fourier series, BODE plots, transformers, relays, solenoids, mechanical analogs and magnetic analogs with the application of Fourier and BODE techniques. Students will also be introduced to DC and AC motors and generators,
residential circuits, equipment protection, and introduction to digital logic including minimization techniques. Availability and cost of instruments and components is stressed throughout this course. Not for EE majors. Engineering Science (100%).

Max Credits: 3
Min Credits: 3

16.212 Fundamentals of Electricity Laboratory

Course ID: 3163
Max Credits: 1
Min Credits: 1

16.213 Fundamentals of Electricity I

Course ID: 1269
Course Details: Serves as an introduction to direct current and alternating current analysis of electric circuits, with emphasis on energy and power. Covers design and use of multi-range voltmeters, ammeters, and ohmmeters, the use of bridges and oscilloscopes, phasor analysis of AC circuits, Trigonometric Fourier series, BODE plots, transformers, relays, solenoids, mechanical analogs and magnetic analogs with the application of Fourier and BODE techniques. Students will also be introduced to DC and AC motors and generators, residential circuits, equipment protection, and introduction to digital logic including minimization techniques. Availability and cost of instruments and components is stressed throughout this course. Not for EE majors. Engineering Science (100%).
Max Credits: 3
Min Credits: 3

16.214 Fundamentals of Sound Recording

Course ID: 3164
Course Details: Similar to 16.211 but tailored for Sound Recording Technology students only
Max Credits: 3
Min Credits: 3

16.216 ECE Application Programming

Course ID: 3165
Course Details: Introduces C programming for engineers. Covers fundamentals of procedural programming with applications in electrical and Computer engineering and embedded systems. Topics include variables, expressions and statements, console input/output, modularization and functions, arrays, pointers and strings algorithms, structures, and file input/output. Introduces working with C at the bit manipulation level. Laboratories include designing and programming engineering applications.
Max Credits: 3
Min Credits: 3

16.233 History of Radio

Course ID: 3171
Course Details: Intended primarily for students majoring in the liberal arts. The course develops the theory of electricity from an historical perspective. Sufficient background in circuit theory, resonance, field theory and radio waves is given to provide an understanding of the principles of radio from its antecedents in the nineteenth century through the invention of the transistor in the mid twentieth century. The fundamental contributions of, for example Volta, Oersted, Morse, Maxwell, Faraday, Hertz, Lodge, and Marconi are considered. In the present century the technical advances of such figures as de Forest, Fleming, Fessenden, Armstrong and Shockley are studied. The growth, regulation and culture of American broadcasting are also central to the course. Laboratory work is required and students may use this course toward fulfilling the General Education (science/experimental component) requirement of the University. Not open to students in the College of Engineering.
Max Credits: 3
Min Credits: 3
16.265 Logic Design

Course ID: 3172


Max Credits: 3
Min Credits: 3

16.311 Electronics I Lab

Course ID: 3175


Max Credits: 2
Min Credits: 2

16.312 Electronics II Laboratory

Course ID: 3176


Max Credits: 2
Min Credits: 2

16.317 Microprocessors Systems Design I

Course ID: 3178

Course Details: Introduction to microprocessors, Uses assembly language to develop a foundation on the hardware which executes a program. Memory and I/O interface design and programming. Design and operation of computer systems. Study of microprocessor and its basic support components, including detailed schematics, timing and functional analysis of their interactions. Laboratories directly related to microprocessor functions and its interfaces (e.g. memory subsystem, I/O devices and coprocessors).

Max Credits: 3
Min Credits: 3

16.322 Data Structures

Course ID: 3179

Course Details: Covers algorithms and their performance analysis, data structures, abstraction, and encapsulation. Introduces structures and their physical storage representation. Studies stacks, queues, linked lists, trees, graphs, heaps, priority queues, and hashing. Discusses efficient sorting (quicksort and heapsort) and introduces experimental analysis of algorithms as applied to engineering applications. Examines several design issues, including selection of structures based on what operations need to be optimized (insertion, deletion, traversal, searching, sorting, evaluation), encapsulation of algorithms using class and template techniques, and how and when to use recursion (versus explicit stack-based techniques). Laboratories include programming of data structures in C++ and Java applied to Engineering.

Max Credits: 3
Min Credits: 3

16.333 Chemistry and Engineering of Electronic Materials
Course ID: 3180

Course Details: The production and processing of materials into finished products constitute a large part of the present economy. To prepare students for the use of a variety of traditional and new materials, this course will cover: atomic structure and chemical bonding, crystal geometry and defects, mechanical properties and phase diagrams of metals and alloys, electrical and optical properties of semiconductors, ceramics, and polymers; brief description of electronic, quantum electronic and photonic devices; benefits and difficulties of materials design with decreasing dimensions from millimeters to micrometers and to nanometers.

Max Credits: 3
Min Credits: 3

16.355 Electromechanics

Course ID: 3183

Course Details: Alternating current circuits, three phase circuits, basics of electromagnetic field theory, magnetic circuits, inductance, electromagnetic energy conversion. Ideal transformer, iron-core transformer, voltage regulation, efficiency equivalent circuits, and three phase transformers. Induction machine construction, equivalent circuit, torque speed characteristics, and single phase motors. Synchronous machine construction, equivalent circuits, power relationships phasor diagrams, and synchronous motors. Direct current machines construction, types, efficiency, power flow diagram, and external characteristics.

Max Credits: 3
Min Credits: 3

16.360 Engineering Electromagnetics I

Course ID: 3184

Course Details: Waves and Phasors, Transmission lines as Distributed Circuits, Smith Chart Calculations, Impedance Matching, Transients on Transmission Lines, Vector Analysis, Electrostatics and Capacitance, Steady current flow in conductors and Resistance, Magnetostatics and Inductance.

Max Credits: 3
Min Credits: 3

16.362 Signals and Systems I

Course ID: 3185

Course Details: A study of various continuous voltage/current time functions and their applications to linear time-invariant electrical systems. Review of pertinent topics from 16.202, such as system functions, S-plane concepts and complete responses. Step, ramp and impulse responses of linear circuits. Sifting integrals. Types of analog filter responses. Designs for Butterworth and Chebyshev filters. Fourier Analysis, Fourier Transforms, Convolution, Laplace Transforms, Parseval's Theorem. A large portion (30-40%) is devoted to teaching the students communication skills and the use of MATLAB for solving homework problems. A MATLAB based text is assigned to the course.

Max Credits: 3
Min Credits: 3

16.363 Introduction to Probability and Random Processes

Course ID: 3186

Course Details: This course employing probabilistic methods of signal and system analysis (an extension of 16.362) considers the random nature of the world faced by electrical engineers. The course addresses the issues of the nature and characterization of random events, especially noise and its effect on systems. The course is divided into three parts, 1) Introduction to discrete and continuous probability 2) Introduction to statistical methods and 3) random signals and noise and the response of linear systems to random signals. There will be frequent use of Monte-Carlo simulation techniques on the computer to allow students to verify theory and to learn the important technique of simulation. Applications of theory to manufacturing and reliability, noise analysis, spectral analysis, data communication, data collection, and system design will be presented. Prerequisite: 16.362

Max Credits: 3
Min Credits: 3

16.364 Engineering Mathematics
Course ID: 3187

Course Details: Complex number, Argand plane, derivatives of complex numbers, limits and continuity, derivative and Cauchy Riemann conditions, analytic functions, integration in the complex plane, Cauchy's integral formula, infinite series for complex variables. Taylor series, Laurent series, residue theory, evaluation of integrals around indented contours. Linear vector spaces, matrices and determinants, eigenvalues and eigenvectors.

Max Credits: 3
Min Credits: 3

16.365 Electronics I

Course ID: 3188

Course Details: A brief introduction to solid-state physics, leading to discussion of physical characteristics of p-n junction diodes, bipolar junction transistors, and field-effect transistors: active, saturated, and cutoff models of bipolar transistors and triode, constant current, and cutoff models of MOSFETs. Circuit models for diodes, and diode applications. Circuit models for transistors, and transistor applications in bipolar and MOS digital circuits and low-frequency amplifier circuits. Analysis of digital circuits and linear circuits based on application of circuit models of devices and circuit theory.

Max Credits: 3
Min Credits: 3

16.366 Electronics II

Course ID: 3189

Course Details: A continuation of 16.365 with discussion of differential amplifiers, operation amplifiers and op amp applications, transistor amplifiers at very high frequencies; direct-coupled and band pass amplifiers; small and large signal amplifiers; feedback amplifiers and oscillators. Active filters, wave form generation circuits including Schmitt trigger, multiplexers, and A/D and D/A converters. Circuit design employing integrated circuit operational amplifiers and discrete devices. Circuit analysis using SPICE. An electronic design project constitutes a major part of the course.

Max Credits: 3
Min Credits: 3

16.399 Capstone Proposal

Course ID: 3195

Course Details: This course discusses and presents the non-technical tools and procedures for bringing a potential product from the idea or basic concept stage through final design and to market. Fundamentals of market research, product safety and liability concerns, necessary technical communication skills. Economic concerns, patent, application procedures, design procedures and people skills necessary to be part of an engineering team.

Max Credits: 3
Min Credits: 3

16.400 Engineering Topics

Course ID: 3196

Course Details: This course introduces to the seniors developing the capstone proposal important concepts such as economics, environmental, sustainability, manufacturability, ethical, health, safety, social and political constraints and how these are related to the overall engineering processes. These will be used as an integral part of their capstone projects.

Max Credits: 1
Min Credits: 1

16.403 Microwave Engineering

Course ID: 3198

Course Details: An introductory course in the analysis and design of passive microwave circuits beginning with a review of time-varying electromagnetic field concepts and transmission lines. Smith Chart problems; single and double stub matching; impedance transformer
design; maximally flat and Chebyshev transformers; microstrip transmission lines, slot lines, coplanar lines; rectangular and circular waveguides; waveguide windows and their use in impedance matching; design of directional couplers; features of weak and strong couplings; microwave filter design; characteristics of low-pass, high-pass, band-pass, band-stop filter designs; two-port network representation of junctions; Z and Y parameters, ABCD parameters, scattering matrix; microwave measurements; measurement of VSWR, complex impedance, dielectric constant, attenuation, and power. A design project constitutes a major part of the course.

Max Credits: 3
Min Credits: 3

16.409 Directed Studies

Course ID: 3199

Course Details: Provides an opportunity for qualified Electrical Engineering students to investigate specific areas of interest. The actual project undertaken may be software or hardware oriented. The most important characteristics of the projects are that the end results represent independent study, that they are research and development oriented, and that they are accomplished in an engineering environment. Design reviews and progress reports are expected for each project. A final formal report to be permanently filed in the EE Department is required for each project. Engineering Design (100%).

Max Credits: 3
Min Credits: 3

16.410 Directed Studies

Course ID: 3200

Course Details: The purpose of this course is to provide an opportunity for qualified Electrical Engineering students to investigate specific areas of interest. The actual project undertaken may be software or hardware oriented. The most important characteristics of the projects are that the end results represent independent study and that they are research and development oriented, and that they are accomplished in an engineering environment. Design reviews and progress reports are expected for each project. A final formal report to be permanently filed in the EE Department is required for each project.

Max Credits: 3
Min Credits: 3

16.411 Medical Diagnostic Imaging

Course ID: 3201

Course Details: This course covers the physics and electrical engineering aspects of how signals are acquired from which images will be formed, and the principal methods by which the signals are processed to form useful medical diagnostic images. Modalities studied include: x-rays, ultra-sound, computed tomography, and magnetic resonance imaging. The principles of signal processing via Fourier transform will be reviewed. Noise and other artifacts that degrade the medical diagnostic of images are considered.

Max Credits: 3
Min Credits: 3

16.412 Directed Studies

Course ID: 3202

Course Details: The purpose of this course is to provide an opportunity for qualified Electrical Engineering students to investigate specific areas of interest. The actual project undertaken may be software or hardware oriented. The most important characteristics of the projects are that the end results represent independent study and that they are research and development oriented, and that they are accomplished in an engineering environment. Design reviews and progress reports are expected for each project. A final formal report to be permanently filed in the EE Department is required for each project.

Max Credits: 3
Min Credits: 3

16.413 Linear Feedback System

Course ID: 3203

Course Details: Concepts of feedback; open loop and closed loop systems. Feedback in electrical and mechanical systems. Mathematical models of systems and linear approximations. Transfer functions of linear systems, block diagrams and signal flow

Max Credits: 3
Min Credits: 3

16.414 Integrated Power Systems

Course ID: 3227

Course Details: Power System Operations and Electricity Markets provide a comprehensive overview to understand and meet the challenges of the new competitive highly deregulated power industry. The course presents new methods for power systems operations in a unified integrated framework combining the business and technical aspects of the restructured power industry. An outlook on power policy models, regulation, reliability, and economics is attentively reviewed. The course lay the groundwork for the coming era of unbundling, open access, power marketing, self-generation, and regional transmission operations.

Max Credits: 3
Min Credits: 3

16.418 Wireless Communication

Course ID: 3206

Course Details: Cellular systems and design principles, co-channel and adjacent channel interference, mobile radio propagation and determination of large scale path loss, propagation mechanisms like reflection, diffraction and scattering, outdoor propagation models, Okumura and Hata models, small scale fading and multipath, Doppler shift and effects, statistical models for multipath, digital modulation techniques QPSK, DPSK, GMSK, multiple access techniques, TDMA, FDMA, CDMA, spread spectrum techniques, frequency hopped systems, wireless systems and worldwide standards.

Max Credits: 3
Min Credits: 3

16.421 Real Time Digital Signal Processing

Course ID: 3209

Course Details: This course provides an introduction to real-time digital signal processing techniques using the TMS320C3x floating point and TMS320C5x fixed point processors. The architecture, instruction set and software development tools for these processors will be studied via a series of C and assembly language computer projects where real-time adaptive filters, modems, digital control systems and speech recognition systems are implemented.

Max Credits: 3
Min Credits: 3

16.423 Introduction to Solid State Electronics

Course ID: 3211


Max Credits: 3
Min Credits: 3

16.424 Computational Methods for Power System Analysis

Course ID: 3278

Course Details: The course explores some of the mathematical and simulation tools used for the design, analysis and operation of electric power systems. Computational methods based on linear and nonlinear optimization algorithms are used to solve load flow problems, to analyze and characterize system faults and contingencies, and to complete economic dispatch of electric power systems.
Real case studies and theoretical projects are assigned to implement the techniques learned and to propose recommendations. Different software applications will be used concurrently including ATP, PowerWorld Simulator, Aspen, MatLab with Simulink and Power System Toolbox, PSCAD, etc.

Max Credits: 3
Min Credits: 3

16.426 Power Systems Stability and Control

Course ID: 3213


Max Credits: 3
Min Credits: 3

16.427 Advanced VLSI Design Techniques

Course ID: 33544

Course Details: This course builds on the previous experience with Cadence design tools and covers advanced VLSI design techniques for low power circuits. Topics covered include aspects of the design of low voltage and low power circuits including process technology, device modeling, CMOS circuit design, memory circuits and subsystem design. This will be a research-oriented course based on team projects.

Max Credits: 3
Min Credits: 3

16.428 Alternative Energy Sources

Course ID: 3214

Course Details: PV conversion, cell efficiency, cell response, systems and applications. Wind Energy conversion systems: Wind and its characteristics; aerodynamic theory of windmills; wind turbines and generators; wind farms; siting of windmills. Other alternative energy sources: Tidal energy, wave energy, ocean thermal energy conversion, geothermal energy, solar thermal power, satellite power, biofuels. Energy storage: Batteries, fuel cells, hydro pump storage, flywheels, compressed air.

Max Credits: 3
Min Credits: 3

16.429 Electric Vehicle Technology

Course ID: 3215

Course Details: Electric vehicle VS internal combustion engine vehicle. Electric vehicle (EV) saves the environment. EV design, EV motors, EV batteries, EV battery chargers and charging algorithms, EV instrumentation and EV wiring diagram. Hybrid electric vehicles. Fuel cells. Fuel cell electric vehicles. The course includes independent work.

Max Credits: 3
Min Credits: 3

16.431 R F Design

Course ID: 3217

Course Details: Two-port network parameters, Smith chart applications for impedance matching, transmission line structures like stripline, microstrip line and coaxial line, filter designs for low-pass, high-pass and band-pass characteristics, amplifier design based on s-parameters, bias network designs, one port and two port oscillator circuits, noise in RF systems.

Max Credits: 3
Min Credits: 3
16.435 Computational Electromagnetics

Course ID: 3219


Max Credits: 3
Min Credits: 3

16.441 Introduction to Biosensors

Course ID: 33545

Course Details: This course introduces the theory and design of biosensors and their applications for pathology, pharmacogenetics, public health, food safety civil defense, and environmental monitoring. Optical, electrochemical and mechanical sensing techniques will be discussed.

Max Credits: 3
Min Credits: 3

16.444 Power Distribution System

Course ID: 3228

Course Details: An intermediate course in analysis and operation of electrical power distribution systems using applied calculus and matrix algebra. Topics include electrical loads characteristics, modeling, metering, customer billing, voltage regulation, voltage levels, and power factor correction. The design and operation of the power distribution system components will be introduced: distribution transformers, distribution substation, distribution networks, and distribution equipment. Prerequisite: 16.355

Max Credits: 3
Min Credits: 3

16.445 Analog Devices and Techniques

Course ID: 1266

Course Details: A survey of analog devices and techniques, concentrating on operational amplifier design and applications. Operational amplifier design is studied to reveal the limitations of real opamps, and to develop a basis for interpreting their specifications. Representative applications are covered, including: simple amplifiers, differential and instrumentation amplifiers, summers, integrators, active filters, nonlinear circuits, and waveform generation circuits. A design project is required.

Max Credits: 3
Min Credits: 3

16.450 Advanced Digital System Design

Course ID: 30319

Course Details:

Max Credits: 3
Min Credits: 3

16.453 Software Engineering

Course ID: 3230

Course Details: Introduces software life cycle models, and engineering methods for software design and development. Design and implementation, testing, and maintenance of large software packages in a dynamic environment, and systematic approach to software design with emphasis on portability and ease of modification. Laboratories include a project where some of the software engineering methods (from modeling to testing) are applied in an engineering example.

Max Credits: 3
16.459 Introduction to Nanoelectronics

Course Details: This course introduces the use of nanomaterials for electronic devices such as sensors and transistors. Synthesis methods for nanoparticles, nanotubes, nanowires, and 2-D materials such as graphene will be covered. The challenges in incorporating nanomaterials into devices will also be discussed. These methods will be compared to techniques used in the semiconductor industry and what challenges, technically and financially, exist for their widespread adoption will be addressed. Finally, examples of devices that use nanomaterials will be reviewed. The course will have some hands on demonstrations.

Max Credits: 3
Min Credits: 3

16.460 Biomedical Instrumentation

Course Details: Analysis and design of Biomedical Instrumentation systems that acquire and process biophysical signals. Properties of Biopotential signals and electrodes; Biopotential Amplifiers and Signal Processing; Basic Sensors and Principles; Medical Imaging Systems; Electrical Safety.

Max Credits: 3
Min Credits: 3

16.461 Engineering Electromagnetics II

Course Details: Continuation of Magnetostatics, Maxwell's Equations for Time-varying Fields, plane waves: time-harmonic fields, polarization, current flow in good conductors and skin effect, power density and Poynting vector, wave reflection and transmission; Snell's Law, fiber optics, Brewster angle, radiation and simple antennas, electromagnetic concepts involved in a topical technology in development.

Max Credits: 3
Min Credits: 3

16.462 Antenna Theory and Design


Max Credits: 3
Min Credits: 3

16.467 Special Topics

Course Details:

Max Credits: 3
Min Credits: 3

16.468 Electro-optics & Integrated Optics

Course Details: An introduction to physical optics, electro-optics and integrated optics. Topics include: Waves and polarization, optical
resonators, optical waveguides, coupling between waveguides, electro-optical properties of crystals, electro-optic modulators, Micro-
Optical-Electro-Mechanical (MEMS) Devices and photonic and microwave wireless systems.

Max Credits: 3
Min Credits: 3

16.469 VLSI Design

Course ID: 1268

Course Details: Introduction to CMOS circuits including transmission gate, inverter, NAND, NOR gates, MUXEs, latches and registers.
MOS transistor theory including threshold voltage and design equations. CMOS inverter's DC and AC characteristics along with noise
margins. Circuit characterization and performance estimation including resistance, capacitance, routing capacitance, multiple conductor
capacitance, distributed RC capacitance, multiple conductor capacitance, distributed RC capacitance, switching characteristics
incorporating analytic delay models, transistor sizing and power dissipation. CMOS circuit and logic design including fan-in, fan-out,
gate delays, logic gate layout incorporating standard cell design, gate array layout, and single as well as two-phase clocking. CMOS test
methodologies including stuck-at-0, stuck-at-1, fault models, fault coverage, ATPG, fault grading and simulation including scan-based
and self test techniques with signature analysis. A project of modest complexity would be designed to be fabricated at MOSIS.

Max Credits: 3
Min Credits: 3

16.470 VLSI Fabrication

Course ID: 3239

Course Details: Fabrication of resistors, capacitors, p-n junction and Schottky barrier diodes, BJT's and MOS devices and integrated
circuits. Topics include: silicon structure, wafer preparation, sequential techniques in microelectronic processing, testing and packaging,
yield and clean room environments. MOS structures, crystal defects, Fick's laws of diffusion; oxidation of silicon, photolithography
including photoresist, development and stripping. Metallization for conductors, Ion implantation for depletion mode and CMOS
transistors for better yield speed, low power dissipation and reliability. Students will fabricate circuits using the DSPL Laboratory.

Max Credits: 3
Min Credits: 3

16.472 Embedded Real Time Systems

Course ID: 3241

Course Details: Designing embedded real-time computer systems. Types of real-time systems, including foreground/background, non-
preemptive multitasking, and priority-based pre-emptive multitasking systems. Soft vs. hard real time systems. Task scheduling
algorithms and deterministic behavior. Ask synchronization: semaphores, mailboxes and message queues. Robust memory
management schemes. Application and design of a real-time kernel. A project is required.

Max Credits: 3
Min Credits: 3

16.473 Power Electronics

Course ID: 1267

Course Details: A one-semester course with emphasis on the engineering design and performance analysis of power electronics
converters. Topics include: power electronics devices (power MOSFETs, power transistors, diodes, silicon controlled rectifiers SCRs,
TRIACs, DIACs and Power Darlington Transistors), rectifiers, inverters, ac voltage controllers, dc choppers, cycloconverters, and power
supplies. The course includes a project, which requires that the student design and build one of the power electronics converters. A
 demonstrative laboratory to expose the students to all kinds of projects is part of the course.

Max Credits: 3
Min Credits: 3

16.474 Principles Of Solid State Devices

Course ID: 3242

Course Details: Principles of Solid State Devices: Crystal properties and growth of semi-conductors, atoms and electrons, Bohr's
model, quantum mechanics, bonding forces and energy bands in solids, charge carriers in semiconductors, drift of carriers in electric
and magnetic fields, carrier lifetime and photoconductivity, junctions, forward and reverse bias, reverse bias breakdown (Zener effect),
tunnel diodes, photodiodes, LED, bipolar junction transistors, field effect transistors. A design project is included in the course.

Max Credits: 3
Min Credits: 3

16.480 Microprocessor Systems II & Embedded Systems

Course ID: 31985

Course Details: Continuation of 16.317. CPU architecture, memory interfaces and management, coprocessor interfaces, bus concepts,
bus arbitration techniques, serial I/O devices, DMA, interrupt control devices. Including Design, construction, and testing of dedicated
microprocessor systems (static and real-time). Hardware limitations of the single-chip system. Includes micro-controllers, programming
for small systems, interfacing, communications, validating hardware and software, microprogramming of controller chips, design
methods and testing of embedded systems.

Max Credits: 3
Min Credits: 3

16.481 Operating Systems

Course ID: 3246

Course Details: Covers the components, design, implementation, and internal operations of computer operating systems. Topics
include basic structure of operating systems, Kernel, user interface, I/O device management, device drivers, process environment,
concurrent processes and synchronization, inter-process communication, process scheduling, memory management, deadlock
management and resolution, and file system structures. laboratories include examples of components design of a real operating
systems.

Max Credits: 3
Min Credits: 3

16.482 Computer Architecture and Design

Course ID: 3247

Course Details: Structure of computers, past and present: first, second, third and fourth generation. Combinatorial and sequential
circuits. Programmable logic arrays. Processor design: information formats, instruction formats, arithmetic operations and parallel
processing. Hardwired and microprogrammed control units. Virtual, sequential and cache memories. Input-output systems,
communication and bus control. Multiple CPU systems.

Max Credits: 3
Min Credits: 3

16.483 Network Design: Principles, Protocols & Applications

Course ID: 3248

Course Details: Covers design and implementation of network software that transforms raw hardware into a richly functional
communication system. Real networks (such as the Internet, ATM, Ethernet, Token Ring) will be used as examples. Presents the
different harmonizing functions needed for the interconnection of many heterogeneous computer networks. Internet protocols, such as
UDP, TCP, IP, ARP, BGP and IGMP, are used as examples to demonstrate how internetworking is realized. Applications such as
electronic mail and the WWW are studied.

Max Credits: 3
Min Credits: 3

16.484 Computer Vision and Digital Image Processing

Course ID: 3249

Course Details: Introduces the principles and the fundamental techniques for Image Processing and Computer Vision. Topics include
programming aspects of vision, image formation and representation, multi-scale analysis, boundary detection, texture analysis, shape
from shading, object modeling, stereo-vision, motion and optical flow, shape description and objects recognition (classification), and
hardware design of video cards. AI techniques for Computer Vision are also covered. Laboratories include real applications from
industry and the latest research areas.
Max Credits: 3  
Min Credits: 3

16.485 Computer Aided Engineering I Lab  
Course ID: 3250  
Course Details:  
Max Credits: 3  
Min Credits: 3

16.490 Fiber Optic Communication  
Course ID: 3252  
Course Details: Optical fiber; waveguide modes, multimode vs single mode; bandwidth and data rates; fiber losses; splices, couplers, connectors, taps and gratings; optical transmitters; optical receivers; high speed optoelectronic devices; optical link design; broadband switching; single wavelength systems (FDDI, SONET, ATM); coherent transmission; wavelength division multiplexing and CDMA; fiber amplifiers.  
Max Credits: 3  
Min Credits: 3

16.491 Industrial Experience  
Course ID: 3253  
Course Details: This three credit course is for co-op or industrial experience. It may be taken three times and the co-op internship should be for at least 500 hours in order to be eligible for credit. Only 3 credits may be used toward the BSEng in CpE or EE degree. Registration for this course is conditional on the approval of the Department Co-op coordinator. A grade of Satisfactory or Unsatisfactory is given.  
Max Credits: 12  
Min Credits: 0

16.492 Industrial Experience II  
Course ID: 3254  
Course Details: Industrial work experience by permission of coordinator only.  
Max Credits: 3  
Min Credits: 3

16.493 Industrial Experience III  
Course ID: 3255  
Course Details: This three credit course is for co-op or industrial experience. It may be taken three times and the co-op internship should be for at least 500 hours in order to be eligible for credit. Only 3 credits may be used toward the BSEng in CpE or EE degree. Registration for this course is conditional on the approval of the Department Co-op coordinator. A grade of Satisfactory or Unsatisfactory is given. Prerequisite: Permission of Instructor  
Max Credits: 3  
Min Credits: 3

16.499 Capstone Project  
Course ID: 3256  
Course Details: The purpose of the Capstone Project is to provide the student with a design experience which resembles entry level engineering assignments. It is expected that the project encompass a minimum of three technical areas within the CpE or EE discipline, and include some aspects of each step in the development of a marketable product i.e. Research, Design & Development, Manufactur
Marketing & Service. A formal technical report must be submitted prior to the submission of a course grade. Prerequisite 16.399 and 16.400

Max Credits: 3
Min Credits: 3

17.130 Electrical Basics and Laboratory

Course ID: 3412

Course Details: This course introduces the basic principles of electrical engineering, including the concepts of voltage, current, resistance, inductance and capacitance. Ohm's Law, Kirchhoff's Laws, superposition, Thevenin's theorem, and Norton's theorem will be covered. Alternating current concepts, frequency response and filters are discussed. The use of laboratory power supplies and measuring instruments such as oscilloscopes, voltmeters, ammeters and ohmmeters are demonstrated. Written reports are required.

Max Credits: 2
Min Credits: 2

17.213 Electric Circuits I

Course ID: 3420

Course Details: Discusses: electrical circuits; voltage, current and resistance; energy, power and charge; Ohm's Law, Kirchhoff's Current Law and Kirchhoff's Voltage Law; simplification and conversion techniques for networks containing sources and/or resistance; Thevenin's and Norton's theorems; fundamentals of magnetism and magnetic circuits; properties of capacitance and inductance and associated transient behavior of circuits.

Max Credits: 3
Min Credits: 3

17.322 Signals and Systems I

Course ID: 38851

Course Details: Introduction to signals and systems. Signal classification, Normalized energy and power. Signal families, time-domain representation by differential equations, linear time invariance, classical solution to various signal families, frequency domain representation, total solution of system with initial conditions. Impulse and pulse response of LTI systems. Convolution methods, Fourier series analysis, Fourier transforms, properties and use, inversion by partial fractions, residues with s-plane vectors, application to LTI systems with initial conditions and sources. Introductions to digital elements and equations.

Max Credits: 3
Min Credits: 3

17.354 PSpice Simulation

Course ID: 3438

Course Details: OrCAD's Capture is used as the schematic entry tool to generate circuits that will be simulated using PSpice. AC and DC independent and dependant sources and device models will be used in these circuits that will then be evaluated by various simulation methods using voltage, current and frequency sweeping as well as temperature and time sweeps. The graphical analysis tool, Probe, will be used to display the results of the simulations and Probe's mathematical functions will be used to further analyze the simulation results. All of these functions will be presented in a combination of lecture, homework, and hands-on PC lab environment. Applications learned in class will be reinforced by homework problems which will then be applied in the PC lab. Pre-Requisite: 17.355

Max Credits: 3
Min Credits: 3

17.361 Project Laboratory A

Course ID: 3444

Course Details: The project lab runs for 14 weeks with design, fabrication, and testing of the project during the weeks one through twelve, and the last two weeks for presentation of the projects to the class. It is expected that all projects be presented operational and meeting the design performance requirements. There are exceptions to this. In the case of non-working projects the progress and final report will be heavily relied on for grading.
17.383 Microprocessors A

Course ID: 3453

Course Details: Introduces the microprocessor and microprocessor programming through an integrated set of experiments and related lectures. Topics include: binary, decimal, and hexadecimal numbers; the microprocessor; memory devices; structure of microprocessor-based systems; programming and instruction sets; addressing modes; arithmetic, logical, and shift instructions; branch conditions and instructions; indexed addressing; the stack; subroutines; assembly language; floating-point routines; and software development techniques. Approximately one-half of the course time will be an associated laboratory, culminating with a programming project. Pre-Requisite: 17.341

Max Credits: 2
Min Credits: 2

17.384 Microprocessors B

Course ID: 3454

Course Details: Extends the skills developed in 17.393 to interfacing the microprocessor to the outside world through an integrated set of experiments and related lectures. Topics include: architecture of microprocessor-based systems; microcontrollers; parallel I/O ports; interrupts; A/D and D/A converters; programmable timers; handshaking; and serial communications. The course will contain a three-week project applying the functions learned to a real world design. Approximately one-half of the course time will be an associated laboratory.

Max Credits: 2
Min Credits: 2

17.391 Project Laboratory B

Course ID: 3455

Course Details: The project lab runs for 14 weeks with design, fabrication, and testing of the project during the weeks one through twelve, and the last two weeks for presentation of the projects to the class. It is expected that all projects be presented operational and meeting the design performance requirements. There are exceptions to this. In the case of non-working projects the progress and final report will be heavily relied on for grading. May do project at work (all requirements of reports, presentation, etc. still required). Pre-Requisites: 17.361, or 17.353 and 17.358 and 17.365

Max Credits: 2
Min Credits: 2

17.392 Project Laboratory C

Course ID: 3456

Course Details: The project lab runs for 14 weeks with design, fabrication, and testing of the project during the weeks one through twelve, and the last two weeks for presentation of the projects to the class. It is expected that all projects be presented operational and meeting the design performance requirements. There are exceptions to this. In the case of non-working projects the progress and final report will be heavily relied on for grading. May do project at work (all requirements of reports, presentation, etc. still required).

Max Credits: 2
Min Credits: 2

17.410 System Engineering and Analysis

Course ID: 37880

Course Details: This course describes the entire development of complex systems from needs and requirements analysis through the life cycle design process. Phases of system design form conceptual to detailed design are described. Program management and control techniques, including risk management and configuration management, are discussed Analysis of alternatives and decision making under risk and uncertainty are covered. Mathematical tools for quantitative analysis are described. Costing issues are discussed and the “ilities” (i.e., reliability, maintainability, supportability, etc.) are introduced.

Max Credits: 3
17.485 Fundamentals of Communication Systems

Course ID: 3481

Course Details: The course will provide an overview of various techniques and technologies used in communication systems. Signal analysis and linear system analysis will be discussed along with various nonlinear techniques. Various modulation techniques to be discussed will include linear modulation (AM), angle modulation (FM), and several types of digital modulation. Issues related to wireless systems as well as computer communication will be addressed.

Max Credits: 3
Min Credits: 3

20.314 Manufacturing Production

Course ID: 3717

Course Details:
Max Credits: 3
Min Credits: 3

20.402 Manufacturing Operations

Course ID: 3726

Course Details:
Max Credits: 3
Min Credits: 1

20.499 Industrial Technology Capstone Project

Course ID: 3751

Course Details:
Max Credits: 3
Min Credits: 3

22.200 Mechanical Engineering Project I

Course ID: 32997

Course Details: Students work on engineering design/build/test (DBT) projects under the supervision of a mechanical engineering faculty member. Projects can include student club based DBT projects.

Max Credits: 1
Min Credits: 1

22.201 Mechanical Design Laboratory I

Course ID: 3796

Course Details: Course emphasis is on introducing the use of computer aided design tools in the engineering problem solving process. Assigned design projects require the use of both wire frame and solid modeling tools. Lecture and lab activities are used to support project requirements, and to provide more in-depth understanding of computer aided engineering design and drawing.

Max Credits: 2
Min Credits: 2

22.202 Mechanical Design Laboratory II
Course ID: 3797

Course Details: This is an introductory course in manufacturing processes covering the basic machine tool practices utilized in the manufacturing of a product. The objective of the course is to develop a broad understanding of manufacturing operations and their relationship to engineering product design. Students manufacture, fabricate and measure the accuracy of a mechanical assembly from design drawings, using lathes, milling machines, drill presses and other conventional processes.

Max Credits: 2
Min Credits: 2

22.211 Statics

Course ID: 3798

Course Details: The application of Newton's Laws to engineering problems in statics. The free-body diagram method is emphasized. Topics include vector algebra, force, moment of force, couples, static equilibrium of rigid bodies, trusses, friction, properties of areas, shear and moment diagrams, flexible cables, screws, bearings, and belts.

Max Credits: 3
Min Credits: 3

22.212 Strength of Materials

Course ID: 3799

Course Details: Stress and deformation analysis of bodies subjected to uniaxial loading, thermal strain, torsion of circular cross-sections, shear flow in thin-walled sections, bending of beams, and combined loading. Application of equilibrium, compatibility and load-deformation relations to solve statically determinate and indeterminate systems.

Max Credits: 3
Min Credits: 3

22.213 Dynamics (alternate 14.205)

Course ID: 3800

Course Details: Calculus based vector development of the dynamics of points, particles, systems of particles, and rigid bodies in planar motion; kinematics of points in rotating and non-rotating frames of reference in one, two, and three dimensions; conservation of momentum, and angular momentum; principle of work and energy.

Max Credits: 3
Min Credits: 3

22.242 Thermodynamics

Course ID: 3803

Course Details: The first and second laws of thermodynamics are introduced and applied to the analysis of thermodynamic systems in terms of work, heat, energy transformation, and system efficiency. The use of tables, graphs, and equations of state is introduced to obtain various properties of pure substances. The concepts of work, heat and energy, as well as their relationships, are studied. The theory and application of reversible and irreversible thermodynamic process, Carnot cycles, and entropy are studied in relation to the energy analysis of engineering systems. Energy balances and ideal efficiencies of steady flow engineering systems are analyzed.

Max Credits: 3
Min Credits: 3

22.296 Mechanical Behavior of Materials

Course ID: 3810

Course Details: Properties and characterization of engineering materials. The behavior of engineering materials is studied experimentally to develop an understanding of properties important in materials selection and engineering design. Structure-property-processing relationships are discussed. Topics include stress, strain, strength, stiffness, thermal expansion, hardness, tensile and bending tests, strain gages, corrosion, microstructure of metals, polymers, ceramics and composites.

Max Credits: 3
Min Credits: 3

**22.300 Mechanical Engineering Project II**

Course ID: 32998

Course Details: Students work on engineering design/build/test (DBT) projects under the supervision of a mechanical engineering faculty member. Projects can include student club based DBT projects.

Max Credits: 1

Min Credits: 1

22.302 Mechanical Engineering Laboratory I: Instrrumentation

Course ID: 3811

Course Details: Students set up and conduct specific experiments designed to study: 1) fundamental ME instrumentation systems; 2) fundamental experimental techniques and 3) basic physical principles of mechanical systems. Experiments are divided into two areas; solid-mechanical and thermo-fluids. Students develop models for use in validating and comparing with experimental results. Written communication techniques are emphasized.

Max Credits: 3

Min Credits: 3

**22.311 Applied Strength of Materials**

Course ID: 3812

Course Details: Strength of materials principles are applied to the stress analysis of machine components and structures. The effects of buckling and combined bending, torsion, and axial loadings are studied together with the effects of stress risers due to geometrical complexities. Topics include: 3D stress transformations; principal stresses; Mohr's circle; failure criteria; stress concentration factors; equilibrium and energy methods; plates; global, local and inelastic buckling; finite elements; fracture and fatigue.

Max Credits: 3

Min Credits: 3

**22.321 Mechanical Design I**

Course ID: 3814

Course Details: Design and kinematic analysis of linkages. Course topics include linkage synthesis and motion analysis (position, velocity and acceleration) and technical writing. These topics are integrated in a semester-long design-build-test project utilizing commercial CAD and simulation software. This project involves project management, teamwork, design, creation of shop-quality drawings, manufacturing and assembly as well as performance testing of a three-position double-dwell linkage. Schedules (Gantt charts), progress reports and final reports are submitted.

Max Credits: 3

Min Credits: 3

**22.322 Mechanical Design II**

Course ID: 3815

Course Details: Design of cams and gear trains and control of mechanical devices. Course topics include: cam sizing and manufacture, cam and gear train kinematics, dynamic force analysis, machine balancing, introduction to the control of mechanical systems. The major project involves the design, analysis, manufacture, and dynamic testing of a cam having specified performance requirements; computer aided design (CAD) and computer numerically controlled (CNC) milling machines are applied. Dynamic simulation (MATLAB) is used throughout the course.

Max Credits: 3

Min Credits: 3

**22.341 Conduction & Radiation Heat Transfer**

Course ID: 3817
Course Details: The theory of steady state and transient heat conduction in solids is developed and applied. The concepts of Biot and Fourier numbers are covered and their applications are studied. The principals of thermal radiation with application to heat exchange between black and non-black body surfaces are studied. The use of radiation networks (electrical network analogy) is examined. Surface radiation properties are extensively covered. Design projects are integrated into the course.

Max Credits: 3
Min Credits: 3

22.342 Convective Processes

Course ID: 3818

Course Details: Internal and external flows with friction, Reynold's number, laminar and turbulent flows. Mathematical development of the hydrodynamic boundary layer. Boundary layer separation and fluid dynamic drag. Flow in pipes. Forced and free convective heat transfer, the thermal boundary layer, Reynolds' analogy, Prandtl and Grashof numbers. Empirical engineering convection relations. Students engage in a design project throughout the term.

Max Credits: 3
Min Credits: 3

22.361 Mathematical Methods for Mechanical Engineers

Course ID: 3823


Max Credits: 3
Min Credits: 3

22.381 Fluid Mechanics

Course ID: 3824

Course Details: A calculus-based engineering course which deals with the development of basic fluid mechanic relations. Emphasis is placed on the control-volume approach for solving problems. Topics includes fluid behavior and fluid properties: hydrostatic pressure and forces; buoyancy and stability; continuity, momentum, and Bernoulli equations; similarity and dimensional analysis; scale analysis and modeling; internal and external flows with friction; Reynold's number; laminar and turbulent flows; mathematical development of the hydrodynamic boundary layer; boundary layer separation and fluid dynamic drag; fluid flow in pipes and ducts.; friction and minor losses.

Max Credits: 3
Min Credits: 3

22.382 Heat Transfer

Course ID: 38230

Course Details: A calculus-based engineering course providing treatment of the fundamental modes of heat transfer. Topics include: steady-state and transient heat conduction in solids; forced and natural convection; the concept of thermal boundary layer; scale analysis and dimensionless number such as Reynolds, Prandtl, and Grashof numbers; Reynold's analogy; empirical engineering convection relations; thermal radiation involving heat exchange between black and non-black body surfaces.

Max Credits: 3
Min Credits: 3

22.400 Mechanical Engineering Project III

Course ID: 32999

Course Details: Students work on engineering design/build/test (DBT) projects under the supervision of a mechanical engineering faculty member. Projects can include student club based DBT projects. Completion of 22.400, 22.300, and 22.200 can count as a mechanical engineering technical elective (academic petition required).
Max Credits: 1
Min Credits: 1

**22.403 Mechanical Engineering Lab II: Measurement Engineering**

Course ID: 3825

Course Details: Continuation of Mechanical Engineering Lab I. Focuses on digital data acquisition systems used on mechanical engineering equipment. Students design measurement systems composed of various transducers, their associated signal conditioners and digital data acquisition and recording devices. Statistical methods are emphasized. Experiments require the students to provide calibration and to select appropriate sampling rates and test durations. Systems under test range from simple multisensor laboratory apparatus to actual operating mechanical systems.

Max Credits: 3
Min Credits: 3

**22.423 Capstone Design**

Course ID: 3835

Course Details: Students perform independent design work and participate in team efforts to develop conceptual designs from functional requirements. Perform design analysis and synthesis, modeling, fabrication, testing, cost estimating, and documenting the essential elements of the system design.

Max Credits: 3
Min Credits: 3

**22.425 Design of Machine Elements**

Course ID: 3837

Course Details: The principles of mechanics and commonly used failure theories are applied to the design and analysis of machine elements subjected to static and dynamic (fatigue) load conditions. Elements studied include power screws, bolts, springs, bearings, gears, lubrication, shafts, brakes, clutches, and belts.

Max Credits: 3
Min Credits: 3

**22.426 Grean Energy Engineering**

Course ID: 36920

Course Details: Introduces a comprehensive range of green energy sources, and the tools and techniques to use that energy. A strong emphasis is given to residential applications, particularly those that are cost effective. Topics include solar energy, photovoltaic, water power, wind power, geothermal heating, and bio- fuel production and use. Course will also investigate architectural considerations essential to effective implementation of green energy. Course is open to Seniors in engineering and science and those with a solid knowledge of vector notations and college algebra. Familiarity with the MATLAB computing environment would be useful.

Max Credits: 3
Min Credits: 3

**22.441 Analysis of Thermo-Fluid Processes**

Course ID: 3841

Course Details: Topics covered include: heat exchanger analysis and design; thermodynamic analysis of : gas power cycles, steam and combined cycles, and refrigeration cycles; mixtures of ideal gases; air-vapor mixtures and psychometric charts with application to air conditioning systems; flow of a compressible fluid through a variable area passage: Mach number, choking conditions, and normal shock.

Max Credits: 3
Min Credits: 3

**22.442 Design of Thermofluid Systems**
Course Details: This is a comprehensive design course accompanied by periodic supplementary lectures, and builds on the concepts learned in Thermodynamics, Fluid Mechanics, Heat Transfer, and Analysis of Thermo/Fluid Processes. The course consists entirely of design projects on such topics as heat exchangers, pumps and blowers, piping systems, air conditioning and refrigeration systems, power plant cycles, and solar and wind energy systems. In addition to the appropriate technical aspects of the design, the projects will also consider such aspects as ergonomics, cost, environmental impact.

Max Credits: 3
Min Credits: 3

22.446 Computational Thermal Fluids

Course ID: 33584

Course Details: Derivation of the partial differential equations of thermal fluids (heat conduction, Navier-Stokes, continuity, and thermal convection/diffusion equation). Introduction to the finite-difference, finite-volume, and finite-element techniques as applied to numerical solution of these equations. Use of a commercial CFD package to analyze common fluid flow and heat transfer configurations. Course also offered at the graduate level as 22.546.

Max Credits: 3
Min Credits: 3

22.450 Nanoscale Transport Phenomena for Manufacturing Nanodevices

Course ID: 36698

Course Details: An interdisciplinary course taught by faculty from the Chemical, Mechanical and Plastics Engineering Departments, who have special knowledge in nanoscale fluid mechanics and heat transfer. The course on nanoscale transport phenomena constitutes a bridge between existing fluid and heat transfer courses in multiple disciplines and emerging nanoscale science and engineering concepts to reflect the forefront of nanomanufacturing. The course is designed to incorporate recent advances in manufacturing polymer based nanodevices. Key issues of the implementation and maintenance costs for fabrication will be addressed. Hands-on laboratory experiments will be performed to complement the lectures with the ultimate goal of designing and building a complete nanodevice at the end of the course. The course will prepare graduates for employment focused on designing and manufacturing nano/microfluidic systems, lab on chip devices, electronic devices, medical devices and other emerging technologies.

Max Credits: 3
Min Credits: 3

22.451 Dynamic Systems Analysis

Course ID: 3844

Course Details: Dynamic modeling of mechanical, electrical, electro-mechanical, hydraulic and thermal components. Application of ordinary differential equations, Laplace transforms, and numerical simulation for the response of these systems; response due to initial conditions and to transient and sinusoidal inputs using both time and frequency domain approaches considered. Use of block diagrams and numerical simulation using MATLAB and Simulink for linear time invariant systems is emphasized. Project work includes model identification and synthesis from measured data for first and second order systems.

Max Credits: 3
Min Credits: 3

22.453 Mechatronics

Course ID: 3845

Course Details: Devices and methods to monitor and control mechanical systems, with particular emphasis on the use of embedded microprocessors.

Max Credits: 3
Min Credits: 3

22.457 Vibrations

Course ID: 3847
Course Details: Fundamentals of vibration analysis of 1, 2 and multi DOF mechanical systems including the effects of damping; free response, forced response to transient and steady state harmonic and periodic excitations; the significance of natural modes, resonance frequency, mode shape, and orthogonality; vibration control, vibration isolators and absorbers; introduction to vibration measurement. Computer problems include the design of vibration control devices. A measurement project involves the use of an accelerometer, signal conditioning and analysis instrumentation.

Max Credits: 3
Min Credits: 3

22.473 Design Theory and Constraints

Course ID: 3851

Course Details: Concepts of world class design and manufacturing of modern products, including the issues of Design for Quality (DFQ), cost and the customer will be studied. Tools and techniques to be studied include Total Quality Management (TQM), statistical process control, process capability studies, six sigma quality, design efficiency ratings, design for cost, design of experiments, Analysis of Variance (ANOVA) of the mean and signal-to-noise ratio, and quality function deployment. Industrial case studies are used and student project work is required.

Max Credits: 3
Min Credits: 3

22.483 Aerodynamics and Flight Mechanics

Course ID: 3856


Max Credits: 3
Min Credits: 3

22.486 Ocean Engineering

Course ID: 3859


Max Credits: 3
Min Credits: 3

22.491 Industrial Experience I

Course ID: 3860

Course Details:
Max Credits: 3
Min Credits: 3

22.492 Industrial Experience II

Course ID: 3861

Course Details:
Max Credits: 3
Min Credits: 3

22.493 Industrial Experience III

Course ID: 3862
Course Details:

Max Credits: 9
Min Credits: 3

22.499 Directed Studies in Mechanical Engineering

Course ID: 3865

Course Details: This course provides seniors in Mechanical Engineering with the opportunity to pursue the study of a technical topic or project, individually under the supervision of a faculty member and, if desired, a responsible project engineer from industry. The course is to result in a term paper or technical report.

Max Credits: 3
Min Credits: 3

23.101 Engineering Graphics

Course ID: 3974

Course Details: This course presents material in both class and laboratory format. Topics covered include: geometric constructions; multi-view sketching and projection; sectional views; isometric and oblique drawing; and dimensioning.

Max Credits: 2
Min Credits: 2

23.102 Engineering Design and Graphics

Course ID: 3975

Course Details: This course presents material in both class and laboratory format. Topics covered include: dimensioning, print reading, auxiliary views, graphs, screw threads, gears, and the design process. Working in teams, a major design project with written and oral reports is required.

Max Credits: 3
Min Credits: 3

23.200 Computer Aided Drafting (CADrf)

Course ID: 3979

Course Details: This course introduces the student to the use of CAD for construction of basic shapes and multi view drawings. It is a project oriented course introducing the student to graphic design using AutoCAD. AutoCAD, as it is applied in 23.200, is a two dimensional CAD program used to produce computer design models. Course stresses hands-on work with AutoCAD. Course is a fundamentals approach and requires no experience with other CAD programs. Pre-Requisite: 23.101

Max Credits: 3
Min Credits: 3

23.211 LABVIEW(TM) Programming with Engineering Applications

Course ID: 30827

Course Details: LabVIEW(TM) software is a graphical programming language "G" that is widely used in industrial setting by engineers and scientists alike. Materials covered in the course will be basic to programming structures. As an example the course will cover For Loops, While Loops, Case Structures, and Boolean Logic. Control, data acquisition, data reduction, and analysis tools associated with the software program will be covered, and used. A comprehensive semester project will be assigned to teams of students to solidify the basic programming topics covered, teach the Virtual Instrument (VI) hierarchy, and to emphasize the importance of teamwork. Special Notes: Can be used as an MET elective or as a substitute for 90.211 (Introduction to Programming with C-Part I) in the MET Program.

Max Credits: 3
Min Credits: 3

23.221 Statics
Course ID: 3981

Course Details: Statics is the study of objects in equilibrium and the forces acting on that object. Students will develop mathematical models to predict and analyze forces and their distributions with the use of the free body diagram. The concepts presented in this course directly relate to other mechanical and civil engineering fields. Students must have a basic understanding of trigonometry, geometry, physics and calculus. This course is in a combined section with CET.

Max Credits: 3
Min Credits: 3

23.222 Dynamics

Course ID: 3982

Course Details: This course introduces the student to the kinematics and kinetics of particles, systems of particles, and rigid bodies. This course covers the basic methods of analysis including Newton's 2nd Law (force, mass, acceleration), Work and Energy, and Impulse and Momentum. This course is in a combined section with CET.

Max Credits: 3
Min Credits: 3

23.223 Mechanics of Materials

Course ID: 3983

Course Details: This course discusses the principles of strength of materials and the relationships between externally applied forces and internally induced stresses in various types of structural and machine members and components. Included are axial, torsional, and flexural loadings, stress-strain relationships, deformation of materials, elastic deformation, principal stresses, temperature effects, Mohr's circle, shear and bending moment diagrams, the design of beams, and the deflection of beams.

Max Credits: 3
Min Credits: 3

23.241 Elements of Thermodynamics I

Course ID: 3984

Course Details: This course presents a thorough treatment of the concepts and laws of thermodynamics. The first law (energy) and the second law (entropy), properties of liquids and gases, and common power cycles (Rankine and Otto) are covered. Included is an overview of the global energy problem and power generation technologies, both established and novel

Max Credits: 3
Min Credits: 3

23.242 Applied Fluid Mechanics

Course ID: 3985

Course Details: This course addresses the Properties of Fluids and basic concepts of Continuity, Momentum, Hydrostatics, and Fluid Flow Kinematics. Analysis of flow of real fluids in pipes, ducts and open channels is conducted. The study of compressible flows, fluid couplings as well as flow measurement techniques will also be discussed

Max Credits: 3
Min Credits: 3

23.243 Elements of Thermodynamics II

Course ID: 3986

Course Details: This course is a continuation of Thermodynamics I analyzing in more detail various real world, practical power generation cycles, such as Rankine, reheat, regenerative, Otto, and Diesel. Also covered are refrigeration cycles, the basics of psychrometry, and the thermodynamics of combustion.

Max Credits: 3
23.262 Engineering Data Analysis

Course ID: 3987

Course Details: This course introduces students to basic statistical techniques, probability, risk analysis, and predictive modeling, and how they impact engineering and manufacturing activities in both analytical and forward looking activities. Topics covered basic statistics, probability, combinations, permutations, regression, correlation, and predictive model development with the objective of building working statistical models for a technical environment. Pre-Requisites: 92.126, Proficiency in MS Excel or equivalent.

Max Credits: 3
Min Credits: 3

23.295 Materials Science

Course ID: 3988

Course Details: Properties of materials, selection of materials and processing of materials for appropriate applications are the focus of this course. Case studies are utilized to demonstrate failures which need not have occurred. Materials which are considered include metals and alloys, ceramics, polymers, and composites.

Max Credits: 3
Min Credits: 3

23.301 Manufacturing Technology Laboratory

Course ID: 3989

Course Details: Students will develop an understanding of precision metrology and the machine tools, related equipment, and systems used in manufacturing. Students will learn the inter-relationships between machine tools, various machining methods, engineering design considerations, and manufacturing techniques studied in the MET program. Lecture, case studies, and laboratory work are supported by a comprehensive text with supplemental materials provided by the instructor to enhance student learning. Students will work with lathes, drill presses, vertical milling machines, and abrasive finishing methods during laboratory sessions to manufacture several precision finished parts from engineering drawings. Course grades will be determined from student performance on examinations and laboratory projects.

Max Credits: 2
Min Credits: 2

23.314 Manufacturing Productivity

Course ID: 3994

Course Details: The course will focus upon three primary categories of manufacturing improvement: theory of constraints/workflow, work definition and design, and quality improvement. Each students should understand and be conversant in the principles of productivity and able to lead a productivity improvement project upon successful completion of the course. Case studies will be used to illustrate the proper implementation of productivity improvement principles.

Max Credits: 3
Min Credits: 3

23.353 Forensic Engineering

Course ID: 32150

Course Details: This course is a survey of forensic engineering with particular emphasis on using engineering science and technology to investigate and reconstruct failures of engineered systems. Topics include qualifications of the forensic engineer, the scientific method, failure hypotheses, levels of confidence, physical evidence, field investigation techniques, examination and testing, codes and standards, and personnel safety. Other topics include ethics, the hired gun, junk science, the legal process, introduction to expert witness testimony, trial exhibits, Frye and Daubert decisions, bias, forensic engineering practice, and engineering reports.

Max Credits: 3
Min Credits: 3
23.414 Engineering Economics

Course ID: 4004

Course Details: This course introduces students to accounting and finance operations and principles, and how they impact engineering and manufacturing activities in both analytical and forward looking planning activities. Topics covered include financial statements, costing, depreciation, time value of money, cash flows, capital budgeting, and capital recovery with the objective of building working financial models for a technical environment. Pre-Requisites: 49.201 Economics I or instructor permission. Proficiency in MS Excel or equivalent.

Max Credits: 3
Min Credits: 3

23.444 Mechanical Vibrations

Course ID: 38761

Course Details: The course will teach students methods to analyze single and two degree of freedom systems considering free vibration, harmonically excited motion, and transient vibration. Concepts of two degree of freedom systems generalized to multi-degree of freedom systems will be introduced. Various analytical approaches to vibration analysis will be taught. Solutions for continuous systems will be solved by the finite difference, finite element, and mode summation methods. Dynamic systems excited by random forces of displacements (random vibrations) will be covered. Additional mathematical content beyond Calculus C will be introduced within this course as required.

Max Credits: 3
Min Credits: 3

23.475 Heat Transfer

Course ID: 4021

Course Details: This course focuses on the study of the fundamentals of heat transfer. Case studies are utilized to enhance the students' knowledge of the basic principles of heat transfer and to develop their problem-solving ability in conduction, convection and radiation heat transfer.

Max Credits: 3
Min Credits: 3

23.485 Introduction to SolidWorks

Course ID: 4027

Course Details: This course introduces the student to the use of CAD for construction of basic shapes and multiview drawings. It is a project oriented course introducing the student to graphic design using SolidWorks. SolidWorks is a three dimensional solid modeling program used to produce computer design models. Pre-Requisite: 23.200 or some experience with another CAD program is required.

Max Credits: 3
Min Credits: 3

23.492 Directed Study: Special Topics

Course ID: 4028

Course Details: Covers basic mechanical comprehension as it relates to solving problems associated with mechanical systems. Materials covered will be in the form of theoretical equations simplified and applied directly to physical components used for demonstration & verification.

Max Credits: 3
Min Credits: 3

24.331 Introduction to Nuclear Engineering I

Course ID: 1263

Course Details: Review of relevant nuclear physics topics including nuclear stability, various forms of radiation, radioactive decay, and
the interaction of radiation with matter (including health effects). Emphasis placed on neutron reactions in various core and structure materials, neutron cross sections, and the development and analysis of the neutron balance equation for various reactor types. Key aspects of nuclear reactor core physics and shielding design (criticality, power generation, reactor kinetics, reactivity control, fuel depletion, fission product poisoning, etc.) are treated. (10.331 and 24.331 are the same)

Max Credits: 3
Min Credits: 3

24.419 Nuclear Reactor Operator Training I

Course ID: 4047

Course Details: This course provides an introductory overview of nuclear physics and related theory and the various systems associated with the operation of the UMASS Lowell Nuclear Research Reactor (UMLRR). The course is intended for students who want to learn about the operations of the UMLRR and who are interested in a career in nuclear engineering and science. The course provides a multidisciplinary systems approach to education and training, which emphasizes "learning by doing". In a practical setting, students study and learn basic nuclear theory and design aspects of real-world systems associated with nuclear reactor operations. Knowledge is gained by working closely with experienced reactor operators and staff, and through independent study.

Max Credits: 3
Min Credits: 3

24.420 Nuclear Reactor Operator Training II

Course ID: 4048

Course Details: Continuation of 24.419. Upon completion of this course, the student will be given a simulated Reactor Operator examination, including a written test, an oral test about reactor systems, and a controls manipulation test.

Max Credits: 3
Min Credits: 3

24.432 Nuclear Systems Design & Analysis

Course ID: 4052

Course Details: A design course that focuses on the use of modern computer analysis tools for the design and analysis of nuclear systems. Reactor physics and shielding codes and thermal and transient analysis of nuclear systems are completed by small design teams with individual responsibility for a particular aspect of the design. Oral and written communication skills are emphasized. (10.432 and 24.432 are the same)

Max Credits: 3
Min Credits: 3

24.434 Introduction to Nuclear Engineering II

Course ID: 36717

Course Details: A continuation of 10.331/24.331 with further discussion of basic nuclear reactor theory and reactor operations. The 2nd half of the semester focuses on heat removal and energy conversion in pressurized and boiling water reactors, including heat transfer in fuel elements and shields and the heat transfer characteristics of boiling and non-boiling liquids. Engineered safety and overall reactor core and plant design considerations are also discussed. (10.434 and 24.434 are the same)

Max Credits: 3
Min Credits: 3

24.495 Directed Studies

Course ID: 4053

Course Details: Special problems in nuclear science and engineering assigned to the individual student, with emphasis on modern research methods and preparation of results for publication.

Max Credits: 3
Min Credits: 3
25.3CE Cooperative Education

Course ID: 37567

Course Details: This zero credit course is specifically designated for Plastics, Chemical, and Mechanical Undergraduate Engineering students who have successfully completed the Professional Development Seminar, are participating in the Professional Co-op program and have secured their first, full-time co-op employment. The co-op is designed to provide students the opportunity to develop and enhance their hands on, technical and professional skills within an industry related to their academic program of study. During the co-op employment experience, students will, in conjunction with their employer, develop and submit written learning goals, participate in a performance evaluation and facilitate an on-site visit by Co-op Coordinator.

Max Credits: 0
Min Credits: 0

25.4ACE Cooperative Education Experience

Course ID: 38649

Course Details: This zero credit course is specifically designated for College of Engineering students in Mechanical, Chemical and Electrical/Computer Engineering who have successfully completed the Professional Development Seminar, are participating in the Professional Co-op program, and have secured a third, full-time co-op employment experience. The co-op is designed to provide students the opportunity to develop and enhance their hands on, technical and professional skills within an industry related to their academic program of study. During the co-op employment experience, students will, in conjunction with their employer, develop and submit written learning goals, participate in a performance evaluation and facilitate an on-site visit by Co-op Coordinator.

Max Credits: 0
Min Credits: 0

25.4CE Cooperative Education

Course ID: 37566

Course Details: This zero credit course is specifically designated for Plastics, Chemical, and Mechanical Undergraduate Engineering students who have successfully completed the Professional Development Seminar, are participating in the Professional Co-op program and have secured their first, full-time co-op employment. The co-op is designed to provide students the opportunity to develop and enhance their hands on, technical and professional skills within an industry related to their academic program of study. During the co-op employment experience, students will, in conjunction with their employer, develop and submit written learning goals, participate in a performance evaluation and facilitate an on-site visit by Co-op Coordinator.

Max Credits: 0
Min Credits: 0

25.103 Environmental Biotechnology

Course ID: 34562

Course Details: This UML TEAMS Academy course will investigate the chemical and biological impact of human activity on aquatic environments. A specific focus of this course will be to observe the behavior of microorganisms impacted by pollutants introduced into the environment by humans. Students will explore possible engineering solutions to alleviate the problems caused by pollutants. This course can be described as "inquiry based discovery" and will rely heavily on laboratory investigations and laboratory based projects analyzing environmental samples collected in the field. This course is open only to high school students accepted to the UML-TEAMS Academy. Instructor permission required.

Max Credits: 3
Min Credits: 3

25.107 Introduction To Engineering I

Course ID: 4112

Course Details: This course provides a hands-on introduction to engineering and the engineering design process. Through assignments and projects, students learn how to: identify a problem, develop alternative solutions, select the best alternative, make critical decisions, and work as a team. The course is intended for freshmen in all engineering majors and provides an overview of the different engineering disciplines. Lecture and lab component.

Max Credits: 2
25.108 Introduction To Engineering II

Course ID: 4113

Course Details: This course is intended for first-year engineering students and provides an introduction to technical communications, teamwork and other skills. Topics vary depending on the department and include data analysis, computer-aided drafting/design/modeling program usage, report-writing and/or oral presentation. Depending on the department, software introduced may include Excel, PowerPoint, AutoCad, Matlab and/or MathCad. Team-based labs and projects may be employed. Students should enroll in the sections corresponding to their major or intended department to develop relevant skills.

Max Credits: 2
Min Credits: 2

25.130 Introduction to Nano-Engineering

Course ID: 30335

Course Details: The multi-billion dollar investment in nanoscience and nanotechnology is beginning to yield new products, including better sunscreens and wear-resistance materials. "Introduction to Nano-Engineering" is as overview of engineering at the nanoscale, including measurement techniques, nanoelectronics, nanomaterials, design of nanodevices, nanomanufacturing, and the societal impact of nanotechnology. "Lecture" material is accompanied by open-ended questions for chat-room discussion and five virtual laboratories. Targeted for the general public. This is an interdisciplinary course.

Max Credits: 3
Min Credits: 3

25.151 Assistive Technology & Electronics

Course ID: 34563

Course Details: UML-TEAMS Academy students will explore basic electronics physics in a hands-on laboratory environment. Students will apply their knowledge as they learn how to breadboard, test, and troubleshoot a series of lab projects. Students will use CAD tools as they learn how to fabricate printed circuit boards. The course culminates with groups projects that apply the engineering design process and electronics to design and build a product for disabled clients in our community. This course is open only to high school students accepted to the UML-TEAMS Academy. Instructor permission required.

Max Credits: 3
Min Credits: 3

25.200 Community-based Engineering Project I

Course ID: 32562

Course Details: Students work on multi-disciplinary teams and apply their engineering problem-solving skills on community-based design projects.

Max Credits: 1
Min Credits: 1

25.210 Professional Development Seminar

Course ID: 36962

Course Details: The Professional Development Seminar is designed to provide students with the necessary structure, resources, and support to successfully secure and engage in their first cooperative education experience. Through a variety of teaching methodologies and assignments, students will participate in a sequence of learning activities including self-assessment, industry research, and the development of co-op learning objectives. Students will prepare to engage in the job search process through resume writing, strategic interviewing, professional networking and through learning professional behavior and presentation skills. The goal of the course is to assist each student in developing a sound plan of action to successfully participate in the cooperative education experience.

Max Credits: 1
Min Credits: 1
25.300 Community-based Engineering Project II

Course ID: 32563
Course Details: Students work on multi-disciplinary teams and apply their engineering problem-solving skills on community-based design projects.
Max Credits: 1
Min Credits: 1

25.310 Co-op assessment 1

Course ID: 36964
Course Details: The primary goal of this seminar is to assist students in the overall assessment of their overall cooperative education experience. Through facilitated small group discussion, individual consultation and hands on practice, students will have an opportunity to identify and articulate their technical and professional skills, and explore how these skills and their co-op employment might be translated and leveraged into future work environments and their academic program at UML.
Max Credits: 1
Min Credits: 1

25.400 Community-based Engineering Project III

Course ID: 32564
Course Details: Students work on multi-disciplinary teams and apply their engineering problem-solving skills on community based design projects. Completion of 25.400, 25.300, and 25.200 can count as a mechanical engineering technical elective (academic petition required).
Max Credits: 1
Min Credits: 1

25.401 Engineering Capstone Design Project

Course ID: 32565
Course Details: Integrative design experience in engineering. Students work on multi-disciplinary teams and apply their engineering problem-solving skills on open-ended, real-world projects. Projects may be service-oriented in concept and teams may include members from other Departments and Colleges. Emphasis on communication, team-work, report-writing, oral presentations. This course may be used as a Technical elective for all Engineering Departments. Alternatively, this course may be used as a substitute for the culminating Capstone course in Electrical and Computer Engineering (16.499), Mechanical Engineering (22.423) and Plastics Engineering (26.416). Prerequisite: senior status & permission of instructor.
Max Credits: 3
Min Credits: 3

25.410 Co-op Assessment 2

Course ID: 36967
Course Details: This seminar is designed to support and assist students in the continued assessment of their cooperative education experience. Through a deepening of their work in Co-op Assessment 1, students will review their overall performance in the cooperative education program, while continuing to demonstrate their technical and professional skills through written work and public presentations to multiple audiences. It is expected that students will clearly define their future academic and career goals, enhance their professional networks, and develop a future plan to support their engineering aspirations.
Max Credits: 1
Min Credits: 1

25.490 Industrial Experience

Course ID: 35536
Course Details:
25.491 Industrial Experience I
Course ID: 4128
Course Details:
Max Credits: 12
Min Credits: 0

26.001 Plastics Safety Lecture
Course ID: 4147
Course Details: All Plastics Engineering students enrolled in a plastics laboratory course are required to attend a one hour per week safety lecture for safety training.
Max Credits: 0
Min Credits: 0

26.002 Plastics Safety Lecture
Course ID: 4148
Course Details: All Plastics Engineering students enrolled in a plastics laboratory course are required to attend a one hour per week safety lecture for safety training. Continuation of 26.001.
Max Credits: 0
Min Credits: 0

26.3CE Co-op Experience
Course ID: 37157
Course Details: This is a structured educational strategy integrating classroom studies with learning through productive work experiences in a field related to a student's academic or career goals. It provides progressive experiences in integrating theory and practice. Co-op is a partnership among students, educational institutions and employers, with specified responsibilities for each party.
Max Credits: 0
Min Credits: 0

26.4ACE Cooperative Education Experience
Course ID: 38650
Course Details: This zero credit course is specifically designated for Plastics Engineering students who have successfully completed the Professional Development Seminar, are participating in the professional Co-op program, and have secured a third, full-time co-op employment experience. The co-op is designed to provide students the opportunity to develop and enhance their hands on, technical and professional skills within an industry related to their academic program of study. During the co-op employment experience, students will, in conjunction with their employer, develop and submit written learning goals, participate in a performance evaluation and facilitate an on-site visit by Co-op Coordinator.
Max Credits: 0
Min Credits: 0

26.4CE Co-op Experience
Course ID: 37824
Course Details: This zero credit course is specifically designated for Plastics, Chemical, and Mechanical Undergraduate Engineering students who have successfully completed the Professional Development Seminar, are participating in the Professional Co-op program and have completed their first, full-time co-op employment. The co-op is designed to provide students the opportunity to develop and
enhance their hands on, technical and professional skills within an Industry related to their academic program of study. During the co-op employment experience, students will, in conjunction with their employer, develop and submit written learning goals, participate in a performance evaluation and facilitate an on-site visit by Co-op Coordinator.

Max Credits: 0
Min Credits: 0

**26.201 Polymer Materials I**

Course ID: 1258

Course Details: This introductory course in plastics materials first evaluates how commercial plastics were developed, characterized and compared throughout the relevant industry. Various ASTM testing protocols are reviewed followed by an initial study of commodity plastic materials, including polyethylene, poly (vinyl chloride), polystyrene, diene rubbers and other selected and relatively high-volume resins. Applicable commercial polymerization methods are introduced along with comparative structure/property relationships. Initial comparisons are drawn as between commodity thermoplastic resins and thermoset compositions. Comparative end-use applications are continuously discussed along with a consideration of selected environmental issues (recyclability).

Max Credits: 3
Min Credits: 3

**26.202 Polymer Materials II**

Course ID: 4149

Course Details: A critical review of the commercial family of materials known as engineering thermoplastics including an examination of relatively important thermoset polymer systems. Major commercial polymerization reactions are reviewed (e.g. applicable chain growth or step-growth polymerizations) including comparative market performance based upon mechanical, thermal, chemical properties and environmental considerations. Also considered are selective high performance plastic materials suitable for use at elevated temperatures and in other relatively extreme working environments. Recommended Pre-Req: 26.201 Polymer Materials I.

Max Credits: 3
Min Credits: 3

**26.210 Professional Development Seminar**

Course ID: 33446

Course Details: The Professional Development Seminar is designed to provide students with the necessary structure, resources, and support to successfully secure and engage in their first Plastics Cooperative Education experience. Through a variety of interactive teaching methodologies and assignments, students will participate in a sequence of learning activities including self-assessment, industry research, and the development of co-op learning objectives. Students will prepare to engage in the job search process through resume-writing, strategic interviewing, professional networking and learn professional behavior and presentation skills. The goal of the course is to assist each student in developing a sound plan of action to successfully participate in the cooperative education experience.

Max Credits: 1
Min Credits: 1

**26.211 Engineering Mechanics**

Course ID: 4153

Course Details: Equilibrium of structures subjected to forces and moments. Area and mass moments of inertia,. Internal forces, shear and bending moments acting on loaded structures, including cantilevers, beams, trusses, bridges and machine frames. Friction.

Max Credits: 3
Min Credits: 3

**26.212 Dynamics**

Course ID: 4154

Course Details: This course covers the fundamentals of Newtonian mechanics, including kinematics, motion relative to accelerated reference frames, work and energy, impulse and momentum, 2D and 3D rigid body dynamics. The course pays special attention to applications in plastics engineering including introductory topics in material and energy balance.
26.215 Plastics Processing Engineering Laboratory I
Course ID: 4155
Course Details: A plastics laboratory courses to study plastics properties and processability. This course focuses on physical property testing of plastics. The property tests covered in this lab course include tensile properties, flexural properties, pendulum impact resistance, drop impact resistance, bulk properties, surface properties, and melt flow rate. The effect of temperature on many of these properties is also evaluated.

26.216 Plastics Process Engineering Laboratory II
Course ID: 4156
Course Details: This laboratory introduces students to the processes of plastics single screw extrusion, plastics injection molding, blow molding and sheet thermoforming. Experiments are designed so that the student will understand the theory of polymer conversion techniques by the interaction between process variables and materials characteristics.

26.218 Introduction to Design
Course ID: 4157
Course Details: This course is designed to teach basic principles of technical drawing, fundamentals of design, dimensioning and tolerances. Basic concepts of manufacturing and rapid prototyping are covered. The lecture component covers theoretical information, and the lab component covers hands-on learning, where students learn to use a commercial CAD software.

26.247 Thermodynamics
Course ID: 4159
Course Details: The principles of thermodynamics, a study of the first and second laws of thermodynamics with applications to classic power generation and refrigeration systems. The concepts of entropy, reversibility, irreversibility and availability.

26.306 Methods of Experimental Analysis
Course ID: 4163
Course Details: Basic concepts dealing with the interpretation of experimental engineering results. Deterministic vs. stochastic processes. Elementary probability theory and common distributions. Graphical analysis and mathematical modeling. Statistical parameters and their applications to quality control, and tests of significance. Design of experiments (DOE) for process development and optimization.

26.310 Co-op Assessment I
Course ID: 35650
Course Details: The primary goal of this seminar is to assist students in the overall assessment of their overall cooperative education experience. Through facilitated small group discussion, individual consultation and hands on practice, students will have an opportunity
to identify and articulate their technical and professional skills, and explore how these skills and their co-op employment might be translated and leveraged into future work environments and their academic program at UML.

Max Credits: 1
Min Credits: 1

26.314 Fluid Flow

Course ID: 4164


Max Credits: 3
Min Credits: 3

26.315 Plastics Process Laboratory III

Course ID: 4165

Course Details: This laboratory introduces students to the processes of twin screw extrusion compounding, advanced injection molding and process monitoring, the plastics recycling process, and extrusion rheological measurements for plastics. Experiments are designed so that the student will understand the theory of polymer conversion techniques by the interaction between process variables and material characteristics.

Max Credits: 1
Min Credits: 1

26.316 Plastics Process Engineering Laboratory IV

Course ID: 4166

Course Details: This laboratory introduces students to the processes of blowm film extrusion, sheet extrusion, tubing extrusion with statistical quality control, twin screw compounding of nano-composites and over-molding. Experiments are designed so that the student will understand the theory of polymer conversion techniques by the interaction between process variables and material characteristics.

Max Credits: 1
Min Credits: 1

26.348 Heat Transfer

Course ID: 4168

Course Details: This course covers the theory and application of steady and transient heat conduction, convection, and radiation. Particular emphasis is placed on heat transfer problems in plastics processing and modern engineered systems. Computational methods and analysis of heat exchangers are covered.

Max Credits: 3
Min Credits: 3

26.373 Plastics Mold Engineering I

Course ID: 4169

Course Details: Course work entails the introduction to the fundamentals of plastics mold and die engineering with the objective to develop an overall appreciation of the mold engineer's job. Emphasis is placed on an integrated approach to mold engineering which includes the interrelationships of polymeric materials, engineering principles, processing, and plastics product design, mold and die design/construction, and design communications. Laboratory consists of the actual design of an old or mold components with emphasis on CAD and computerized Material Database. A semester project is required. Junior status or permission of instructor.

Max Credits: 3
Min Credits: 3
26.377 Plastics Process Engineering I

Course ID: 1256

Course Details: The first course in a two semester sequence to study the fundamental principles of polymer processing, i.e., the conversion of the polymeric materials into useful articles. The course will first study the properties of polymers (bulk and rheological and thermal properties) and why they are important to understanding polymer processing. This course will emphasize the fundamental principles of the extrusion process and examine the correlation between elements of the extruder, polymer properties, and processing variables and why they all must be considered when studying and understanding a plastics processing technique.

Max Credits: 3
Min Credits: 3

26.378 Plastics Process Engineering II

Course ID: 4171

Course Details: This course will study the basic extrusion processes of blown film, flat film, tube, pipe, extrusion coating, coextrusion, injection molding, thermoforming, rotational molding and blow molding with emphasis on how polymeric materials, machine components and process variables affect properties of the products produced with each process. Recommended Pre-Req: 26.377 Plastics Process Engineering I.

Max Credits: 3
Min Credits: 3

26.381 Polymer Science for Engineers I

Course ID: 33717

Course Details: An introduction to polymer science with a focus on making polymers. Topics covered include the chemistry, kinetics, and statistics of step and chain polymerizations and copolymerizations, polymerization processes. Industrially relevant polymers and commercial polymerization processes will be highlighted, with coverage of the health and safety aspects of various approaches to the preparation of various polymers given.

Max Credits: 3
Min Credits: 3

26.382 Polymer Science for Engineers II

Course ID: 33718

Course Details: An introduction to polymer science with a focus on polymer properties and behavior. Topics covered include analytical techniques (chemical, thermal, and microstructural analysis of polymers, measurement of molecular weight distribution, etc.), as well as the underlying physical, rheological and solution properties that make these techniques possible. Recommended Pre-Req: 26.381 Polymer Science for Engineers I

Max Credits: 3
Min Credits: 3

26.383 Polymer Science I Lab

Course ID: 34579

Course Details: Synthesis of polymers by step growth, condensation, suspension and free radical emulsion polymerization techniques. Fundamental concepts in polymerization kinetics and mechanism will be covered as well as structure-property considerations and polymerization with functional groups.

Max Credits: 1
Min Credits: 1

26.384 Polymer Science II Lab

Course ID: 34580

Course Details: Polymer characterization techniques including molecular weight distribution by gel permeation chromatography,
crystallinity and order by differential scanning calorimetry, polymer morphology and surface properties, and spectroscopic (nuclear magnetic resonance, Raman, infrared) and mechanical (tensile, dynamic mechanical, rheological) techniques will also be covered. Recommended Pre-Reqs: 26.381 Polymer Science for Engineers I and 26.383 Polymer Science I Lab; Co-Req: 26.382 Polymer Science for Engineers II.

Max Credits: 1
Min Credits: 1

26.403 Mechanical Behavior of Polymers

Course ID: 1260

Course Details: Topics covered in this course include linear viscoelasticity, creep, stress relaxation, dynamic behavior, hysteresis, stress-strain response phenomena, principles of time-temperature superposition, rubber elasticity, failure and fracture mechanisms for polymers, and the effect of additives on mechanical behavior. Real life design examples are used to demonstrate the topics and concepts as much as possible.

Max Credits: 3
Min Credits: 3

26.404 Process Control

Course ID: 4172

Course Details: Basic principles of control systems used with plastics processing equipment. Included are instrumentation, signal conditioning, data acquisition, feedback control, process monitoring, data reduction, and SPC/SQC.

Max Credits: 3
Min Credits: 3

26.406 Polymer Structure, Properties and Applications

Course ID: 4173

Course Details: The fundamental relationships between molecular structure, properties and end-use applications of plastics materials will be explored in detail. Molecular structural features include chemical composition, molecular size and flexibility, intermolecular order and bonding, and supermolecular structure. Properties include processability, mechanical, acoustic, thermal, electrical, optical and chemical properties, price, and balance of properties. Applications include rigid solids, flexible solids, foams, film and non-plastic applications.

Max Credits: 3
Min Credits: 3

26.409 Senior Research Plastics I

Course ID: 4175

Course Details: Individual research projects in plastics chemistry, properties, processing, products, and industry organization. Students will review the existing literature, obtain materials and equipment, plan and carry out research programs and submit final reports for publication.

Max Credits: 3
Min Credits: 3

26.410 Coop Assessment II

Course ID: 4176

Course Details: This seminar is designed to support and assist students in the continued assessment of their cooperative education experience. Through a deepening of their work in Co-op assessment 1, students will review their overall performance in the cooperative education program, while continuing to demonstrate their technical and professional skills through written work and public presentations to multiple audiences. It is expected that students will clearly define their future academic and career goals, enhance their professional networks, and develop a future plan to support their engineering aspirations.

Max Credits: 2
Min Credits: 2

26.415 Capstone Project I

Course ID: 4181

Course Details: A two-semester capstone laboratory project course. Student groups design, perform, analyze, report, and defend a research project which incorporates the processing and characterization of plastics materials. Supporting practicums on literature searches, plastics processing, basic plastics testing techniques, and data analysis are included in the course.

Max Credits: 1
Min Credits: 1

26.416 Capstone Project II

Course ID: 4182

Course Details: Continuation of 26.415.

Max Credits: 1
Min Credits: 1

26.417 Honors Capstone Project II

Course ID: 32560

Course Details: A section of capstone laboratory for honor students only. Honors student groups design, perform, analyze, report and defend a research project which incorporates the processing and characterization of plastics materials. Supporting practicum on literature searches, plastics processing, basic plastics testing techniques, and data analysis are included in the course.

Max Credits: 1
Min Credits: 1

26.418 Product and Process Design

Course ID: 4183

Course Details: Theoretical principles and sound engineering practice involved in the design of new end products made from polymers, applying the total systems approach to the balance between product design, choice of materials, tool design, and process techniques, as they affect competitive choices for commercial success. A semester project is required. Recommended Pre-Reqs: 26.373 Plastics Mold Engineering I and 26.378 Plastics Process Engineering II.

Max Credits: 3
Min Credits: 3

26.450 Nanoscale Transport Phenomena for Manufacturing Nanodevices

Course ID: 36698

Course Details: An interdisciplinary course taught by faculty from the Chemical, Mechanical and Plastics Engineering Departments, who have special knowledge in nanoscale fluid mechanics and heat transfer. The course on nanoscale transport phenomena constitutes a bridge between existing fluid and heat transfer courses in multiple disciplines and emerging nanoscale science and engineering concepts to reflect the forefront of nanomanufacturing. The course is designed to incorporate recent advances in manufacturing polymer based nanodevices. Key issues of the implementation and maintenance costs for fabrication will be addressed. Hands-on laboratory experiments will be performed to complement the lectures with the ultimate goal of designing and building a complete nanodevice at the end of the course. The course will prepare graduates for employment focused on designing and manufacturing nano/microfluidic systems, lab on ship devices, electronic devices, medical devices and other emerging technologies.

Max Credits: 3
Min Credits: 3

28.001 Independent Study (MSL IS I)

Course ID: 4412
Course Details: Advanced topics in leadership and management utilizing the military decision making process not covered in the regular curriculum. Content may vary from year to year. Due to the unique nature of this course, entrance into this course requires a permission number granted by the instructor.

Max Credits: 3
Min Credits: 3

**28.002 Independent Study II (MSL IS II)**

Course ID: 34682

Course Details: Advanced topics in leadership in a tactical environment with a focus on adventure training. Content may vary from year to year. Due to the unique nature of this course, entrance into this course requires a permission number granted by the instructor.

Max Credits: 3
Min Credits: 3

**28.140 Leadership and Personal Development (MSL 101)**

Course ID: 4413

Course Details: Leadership and personal development introduces students to the personal challenges and competencies that are critical for effective leadership. They will learn how the personal development of life skills such as goal setting, time management, physical fitness, and stress management relate to leadership, officership, and the Army profession. The focus is on developing basic knowledge and comprehension of Army leadership dimensions, attributes and core leader competencies while gaining a big picture understanding of the ROTC program, its purpose in the Army, and its advantages for the student.

Max Credits: 3
Min Credits: 3

**28.170 Introduction to Tactical Leadership (MSL 102)**

Course ID: 4416

Course Details: Introduction to tactical leadership overviews leadership fundamentals such as setting direction, problem-solving, listening, presenting briefs, providing feedback, and using effective writing skills. Students will explore dimensions of leadership attributes and core leader competencies in the context of practical, hands-on, and interactive exercises.

Max Credits: 3
Min Credits: 3

**28.230 Foundations of Leadership (MSL 201)**

Course ID: 4419

Course Details: Foundations of Leadership explores the dimensions of creative and innovative tactical leadership strategies and styles by examining team dynamics and two historical leadership theories that form the basis of the Army leadership framework. Aspects of personal motivation and team building are practiced planning, executing and assessing team exercises.

Max Credits: 3
Min Credits: 3

**28.240 Foundations of Tactical Leadership (MSL 202)**

Course ID: 4420

Course Details: Foundations of Tactical Leadership examines the challenges of leading tactical teams in the complex contemporary operating environment (COE). This course highlights dimensions of terrain analysis, patrolling, and operation orders. Further study of the theoretical basis of the Army Leadership Requirements Model explores the dynamics of adaptive leadership in the context of military operations. MSL 202 provides a smooth transition into MSL 301. Cadets develop greater self-awareness as they assess their own leadership styles and practice communication and team-building skills. COE case studies give insight into the importance and practice of teamwork and tactics in real-world scenarios.

Max Credits: 3
Min Credits: 3
28.330 Adaptive Team Leadership (MSL 301)

Course ID: 4422

Course Details: During this course students will study, practice, and apply the Fundamentals of Army Leadership, Officership, Army values and Ethics, personal development, and small unit tactics at the team and squad level. At the conclusion of this course, students will be capable of planning, coordinating, navigating, motivating and leading a team or squad in the execution of a tactical mission during a classroom PE, a Leadership Lab, or during a Situational Training Exercise (STX) in a field environment. Students will receive systematic and specific feedback on their leader attributes, values and core leader competencies using the ROTC Leader Development Program (LSP) model. Due to the unique nature of this course, entrance into this course requires a permission number granted by the Instructor.

Max Credits: 3
Min Credits: 3

28.340 Applied Team Leadership (MSL 302)

Course ID: 4423

Course Details: During this course students will study, practice, and apply the fundamentals of Army leadership, Officership, Army values and ethics, personal development, and small unit tactics at the team and squad level. At the conclusion of this course, students will be capable of planning, coordinating, navigating, motivating and leading a team or squad in the execution of a tactical mission during a classroom PE, a Leadership Lab, or during a Situational Training Exercise (STX) in a field environment. Students will receive systematic and specific feedback on their leader attributes, values and core leader competencies using the ROTC Leader Development Program (LDP) model. Due to the unique nature of this course, entrance into this course requires a permission number granted by the Instructor.

Max Credits: 3
Min Credits: 3

28.440 Adaptive Leadership (MSL 401)

Course ID: 4427

Course Details: Adaptive Leadership is designed for students to apply their leadership techniques. Throughout the semester, students are assigned the duties and responsibilities of an Army staff officer and must apply the fundamentals of principles of training and the military decision making process to plan, execute and assess ROTC training. Students will be given numerous opportunities to train, mentor and evaluate underclass students enrolled in the ROTC Basic Course. Students will study how Army values and leader ethics are applied in the Contemporary Operating environment and how these values and ethics are relevant to everyday life. Students will study the Army officer's role in the counseling of subordinates, administrative actions and the management of an Army Officer's career. Due to the unique nature of this course, entrance into this course requires a permission number granted by the Instructor.

Max Credits: 3
Min Credits: 3

28.450 Leadership in a Complex World (MSL 402)

Course ID: 4428

Course Details: Leadership in a Complex World explores the dynamics of leading in the complex situations of current military operations in the contemporary operating environment (COE). Students will examine differences in customs and courtesies, military law, principles of war, and rules of engagement in the face of international terrorism. This course places significant emphasis on preparing students for their careers in the military. It uses various case studies and scenarios to prepare students to face the complex ethical and practical demands of leading as a commissioned officer in the United States Army. Due to the unique nature of this course, entrance into this course requires a permission number granted by the Instructor.

Max Credits: 3
Min Credits: 3

29.001 AF ROTC Leadership Lab

Course ID: 4429

Course Details:

Max Credits: 0
29.101 Foundations of the United States Air Force-Part I

Course ID: 4430

Course Details: Topics relating to the Air Force and defense. Structure and missions of Air Force organizations, officership and professionalism, and an introduction to communication skills.

Max Credits: 1
Min Credits: 1

29.102 Foundations of the United States Air Force - Part II

Course ID: 4431

Course Details: Completion of the material described in 29.101.

Max Credits: 1
Min Credits: 1

29.201 Devel of United States Air Force Power

Course ID: 4432

Course Details: Factors contributing to the development of air power from its earliest beginnings through two World Wars, the evolution of air power concepts and doctrine, and an assessment of communication skills (speaking and writing).

Max Credits: 1
Min Credits: 1

29.202 Evolution of United States Air Force Power

Course ID: 4433

Course Details: Completion of the material described in 29.201.

Max Credits: 1
Min Credits: 1

29.301 Air Force Leadership Studies

Course ID: 4434

Course Details: Emphasizing the individual as a leader/manager in a Fortune 500/Air Force setting. The individual motivational and behavioral processes, leadership, communication, and group dynamics are covered to provide a foundation for the development of the professional skills needed by Air Force officers and middle managers. The basic managerial processes involving decision making, utilization of analytic aids in planning, organizing, and controlling in a changing environment are emphasized as necessary professional concepts. Organizational and personal values, management of forces in change, organizational power, politics, and managerial strategy and tactics are discussed within the context of the military organization. Actual Air Force and corporate case studies are used to enhance the learning and communication processes.

Max Credits: 3
Min Credits: 3

29.302 Air Force Leadership Studies II

Course ID: 4435

Course Details: Continuation of the material described in 29.301.

Max Credits: 3
Min Credits: 3
29.402 National Security

Course ID: 4437
Course Details: Continuation of the material described in 29.401.
Max Credits: 3
Min Credits: 3

IB.400 Introduction to Biomedical Engineering

Course ID: 37930
Course Details: Provides exposure to cutting-edge biomedical technologies in a number of different areas with a balance between biomedical engineering and biotechnology areas.
Max Credits: 3
Min Credits: 3

Change of Program

Students who wish to change their declarations of program within the College of Engineering are required to follow the procedure stipulated under . It should be noted that College of Engineering students who change their programs within the College of Engineering after the first semester of the sophomore year should expect to have to take semester credits beyond the minimum degree requirement, and thus extend the normal four-year period of study.

Students who wish to change from engineering to a major that is offered by another college within the University of Massachusetts Lowell must apply for an intercollegiate transfer. These procedures are described under .

Qualified students from other colleges in the University of Massachusetts Lowell may transfer into degree programs of the College of Engineering using the same procedure. However, these students may expect to extend their period of study beyond the normal four-year period, particularly if they transfer after the first semester of the sophomore year.

Declaration of a Second Major

Candidates for degrees in the College of Engineering may be permitted to elect additional majors offered in other colleges of the University, provided that all curriculum requirements in engineering are satisfied.

Engineering students who wish to take on a second major that is offered by the College of Engineering or by another college must formalize this intent by the start of the junior year. At that time the student is also required to submit for approval his or her intended program of study to the advisor in the department offering the second major. It should be noted that in most cases, the election of an additional major will extend the normal four-year period of undergraduate study. Students who elect to take a second academic major in another college are candidates for one degree in the College of Engineering only. A student who pursues an academic major in the College of Engineering and another college or two majors in the College of Engineering is subject to all degree requirements of the College of Engineering and is subject only to major course requirements specified by the department of the secondary major. For a complete statement of University Policy on double majors, refer to .

Degree Requirements

Each candidate for the undergraduate degree must satisfy the general requirements of the University of Massachusetts Lowell in order to graduate. The student must also meet the specific academic requirements of the College of Engineering as indicated in this section, as well as complete all credits and courses required by the department in which the student majors. The number of credits required for the completion of each College of Engineering program is established by the department offering the program.

Courses taken by freshmen entering any engineering discipline are for the most part similar and include calculus, physics, chemistry, college writing, and engineering design.

Introduction to Engineering I (25.107) introduces first-year students to the engineering design process for solving open-ended problems. Introduction to Engineering II (25.108) is department-specific and continues with computer tools and applications to department-specific problems.

Students who have completed their freshman programs with a grade-point average of 2.50 or better automatically qualify for admission to the sophomore program of their choice. Students who fail to achieve that required average will be admitted to the sophomore year of engineering programs only upon the recommendation of appropriate departmental committees.

Please refer to the university grade-point average policy for satisfying retention and graduation requirements.

Individuals who are not granted continued matriculation in the College of Engineering but who satisfy university retention requirements may file for intercollegiate transfer within the university. Students who are dismissed from the College of Engineering and who are
Transfer Policies

- General Policies
- Transfer from Other Institutions
- 2+2 and 2+3 Transfer Programs
- Repetition of Transferred Courses
- Intercollegiate Transfer to the College of Engineering

General Policies

It is the policy of the College of Engineering to accept transfer students from other institutions as well as from other colleges within the University of Massachusetts Lowell. Such students may expect recognition of previously completed courses if these are equivalent to those that are specified by the curricula of the College of Engineering. Transfer students are required to have at least a 2.5 grade-point average in order to be admitted to the College of Engineering.

Transfer from Other Institutions

UMass Lowell participates in the Joint Admissions Program of the Massachusetts Community Colleges and the University of Massachusetts. According to this program, a student from one of these community colleges is guaranteed admission to UMass Lowell provided the student is enrolled in a designated transfer program and earns an associate degree with a 2.5 or higher cumulative grade point average.

Courses that are transferred from other institutions are initially evaluated by the Office of Admissions in terms of general University of Massachusetts Lowell requirements. Professional courses are subsequently evaluated by the departments in which the student has been accepted. Credit is given for completed courses where the grade is C (2.000 on a 4.000 scale) or better.

The University of Massachusetts Lowell also subscribes to the Commonwealth Transfer Compact. Under this compact, the holder of an associate degree from a compact institution receives up to 66 credits for this work toward a Bachelor of Science in engineering or technology. Courses which are transferred to the University of Massachusetts Lowell under the provisions of the Commonwealth Transfer Compact, but which do not meet the credit requirements of the College of Engineering, or which are not acceptable as unrestricted elective courses, will be listed on the student’s transcript, but will not apply to the minimum degree requirements.

In the event that a student has first transferred to some other college in the University of Massachusetts Lowell under the Commonwealth Transfer Compact and subsequently makes a transfer to the College of Engineering, all previously completed courses, including transferred courses from other compact institutions, will be re-evaluated in terms of their applicability toward degree requirements of the College of Engineering.

The policies of each of the colleges in the University determine the applicability of grades received in transfer to the grade-point average of the student’s major at the University of Massachusetts Lowell. It is the policy of the College of Engineering not to count such grades for the purpose of determining the student’s grade-point average in his or her professional area.

2 + 2 and 2 + 3 Transfer Programs

The College of Engineering has been a leader in the development and implementation of 2 + 2 and 2 + 3 Programs in the Commonwealth of Massachusetts. More and more students who are interested in earning a Bachelor of Science degree in one of the engineering disciplines pursue their first two years of the curriculum at selected community and state colleges and complete the degree requirements during two to three final years at the University of Massachusetts Lowell. The program is ideal from the standpoint of the student who is not ready to enter a four-year college, allowing the participant to ease into college life while still remaining close to home and within the environment of a smaller college.

The contractual agreements among participating schools require an on-going review of coursework normally offered in the first two years. Curricula and other requirements are carefully established and examined by faculty at both institutions.

Transfer agreements vary with each institution participating in the 2 + 2 or 2 + 3 programs. Some participating colleges offer programs that prepare students for transfer to mechanical and electrical engineering; programs in other schools lead to entry into chemical, civil or plastics engineering. High school students who are considering this program should consult the office of admissions at the University of Massachusetts Lowell for information about available programs in participating institutions.

Repetition of Transferred Courses

A student who has been granted transfer credit from another institution, and on this basis has been assigned to advanced courses for which the transferred course is a prerequisite, may be subsequently advised to repeat such transferred work at the University of Massachusetts Lowell. Such cases arise when preparation of the student is demonstrably inadequate to allow successful performance.

To repeat a transferred course a student must file an academic petition with the Dean of the College. Since credit may not be granted more than once for the completion of any course, a condition for filing such a petition is the simultaneous filing of a request to revoke recognition statement to dispose of the previously transferred course credit.

Intercollegiate Transfer to the College of Engineering
Students wishing to transfer to the College of Engineering from another college within the University of Massachusetts Lowell, or from a baccalaureate (degree granting) Division of Continuing Education program, must file a form for change of major together with a transcript, with the Dean of the College of Engineering and with the appropriate engineering department head. Petitions for transfer must be filed no later than November 1 in order to transfer in the spring semester, and no later than April 1 in order to transfer in the fall semester.

Any student who wishes to transfer from another college in the University to the College of Engineering must have a minimum grade-point average of 2.500. Irrespective of the grade received, all courses that may not be applied to the College of Engineering program requirements will be deleted from the student’s cumulative grade-point average.

For further procedural details about the university’s policies concerning intercollegiate transfers, students are referred to .

**Policies**

Please review the following policies:

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