

# UNIVERSITY OF PITTSBURGH

## Mechanical Engineering

### Undergraduate Academic Program Manual

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# Forward

This *Mechanical Engineering Undergraduate Academic Program Manual* is a supplement to the information provided on the University of Pittsburgh Swanson School of Engineering's website (<https://www.engineering.pitt.edu>), which is the official source of information about the School's academic programs and degree requirements. This supplemental manual provides specific information about departmental policies, procedures, and programs that is not included in the Swanson School of Engineering's website. It is provided so that you will be better informed about your department and for your convenience in monitoring progress towards completion of your degree. The latest version of this manual can be found on the MEMS Department's [student resources](#) webpage.



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# Chapter 1

## About Mechanical Engineering

Prospective students often ask, “What is mechanical engineering? What do mechanical engineers do, exactly?” In an attempt to answer these questions, the American Society of Mechanical Engineers (ASME) offers the following:

Mechanical engineering plays a dominant role in enhancing safety, economic vitality, enjoyment and overall quality of life throughout the world. Mechanical engineers are concerned with the principles of force, energy, and motion. The men and women who work as mechanical engineers are professionals with expert knowledge of the design and manufacturing of mechanical systems and thermal devices and processes. Some examples of products and processes developed by mechanical engineers include engines and control systems for automobiles and aircraft, electric power generation plants, lifesaving medical devices and consumer products ranging from air conditioners to personal computers and athletic equipment. They also design the machines that mass-produce these products. Virtually every aspect of life is touched by mechanical engineering. If something moves or uses energy, a mechanical engineer was probably involved in its design or production.<sup>1</sup>

The breadth and diversity of the profession requires an undergraduate curriculum that provides a solid foundation in the basic sciences, computational skills including the use of the latest sophisticated software tools, and the fundamentals of engineering and engineering design. The curriculum provides a base for future professional growth and is also an excellent background for those who wish to pursue careers in other professions, such as management, law, or medicine.

The Bachelor of Science programs in this department are fully accredited by the Accreditation Board for Engineering and Technology (ABET), which is the accreditation organization for engineering and technology programs in the United States.

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<sup>1</sup>ASME Brochure MP0398, *What is a Mechanical Engineer?*

## 1.1 Program Educational Objectives

Consistent with the criteria set by ABET, the overall educational objective of the undergraduate program in the Department of Mechanical Engineering and Materials Science is to educate students with excellent technical capabilities in the mechanical engineering discipline and related fields, who will be responsible citizens and continue their professional advancement through life-long learning.

In their career and professional activities, we expect our graduates to:

- Demonstrate successful application of mechanical engineering knowledge and skills for industry, public sector organizations, or their profession.
- Pursue life-long learning through advanced professional degrees, graduate studies in engineering, professional training, or engineering certification.
- Demonstrate professional and intellectual growth as leaders in their profession and/or community.

## 1.2 Curriculum Overview

The curriculum is designed to educate in four years a professional engineer who has, and will continue to have, a wide range of career options. In the first two years, the Mechanical Engineering curriculum concentrates on the fundamentals of the sciences, mathematics, and engineering. The last two years provide increased depth in the engineering sciences, including thermodynamics, fluid mechanics, heat transfer, and systems analysis, and in engineering applications such as mechanical measurements, manufacturing, mechanical design, and thermal systems. Students have the freedom to pursue areas of personal interest in mechanical engineering via their choice of technical elective courses.

Course work in the humanities and social sciences is included for the enhancement of the student's awareness of the importance of societal, political, and economic issues in the practice of engineering. Where appropriate, the upper-level Mechanical Engineering courses introduce consideration of human values, social benefits, and social constraints to prepare future practicing engineers to be responsive to such concerns.

### 1.2.1 Mechanical Engineering Design

Design is central to mechanical engineering. The design experience begins in the freshman year through the design of computer programs. This introduces the student to the concept of problems that have more than one valid solution and to methods for generating parametric solutions to problems. Ill-defined problems are also introduced in the freshman year, so that the student begins to learn the necessity of restating problems and how to deal with insufficient information.

In the sophomore year, the design experience is expanded to include the construction of physical models. During the same year, students learn to use computer-aided engineering design tools. The students also address design problems and problems in manufacturing, mechanisms, and thermo-fluids engineering.

In the junior year, students continue to expand their knowledge of design by addressing problems and projects in courses on mechanical design, applied thermodynamics, and applied fluid mechanics. During this year, students are also introduced to the finite element method and learn how to use ANSYS<sup>TM</sup>, a commercial implementation of the finite element method, as a tool in mechanical design.

Design is a large part of the senior year. Design problems in heat transfer and a second course in mechanical design are included in the first term. All seniors are also required to take a capstone design course in which small groups of students work with a faculty member to design, manufacture, and test a product or some aspect of a product. Often, problems of interest to local industry are used. Students are given a modest budget and objectives to meet, and are required to create a project plan, develop drawings, procure parts and materials, manufacture parts to assemble and operate the device, and report on the results in a manner that is common in industry.

### **1.2.2 Teamwork**

Small groups of students usually work together on design projects. The objective behind employing this approach is to help students learn how to work as part of a team. Students also learn about other important facets of mechanical engineering, including ethical issues and meeting budget and schedule constraints.

### **1.2.3 Written and Oral Communication**

A mechanical engineer must be able to communicate effectively to be successful. The engineering admission requirements include a verbal SAT score of at least 500. All freshmen are tested during orientation for proficiency in English writing and literacy. If they score below a satisfactory level, they are required to take a basic writing course, which does not count toward the degree requirements. Students are also required to take a Communication Skills Elective ([Section 2.6](#)). Subsequent laboratory and project reports reinforce the skills learned in this elective. The senior design project course includes a written report and an oral presentation during a symposium held near the end of the term.

### **1.2.4 Computer Experience**

Computer experience is distributed throughout the Mechanical Engineering curriculum. In the freshman year, students are introduced to computer programming, the use of spreadsheets, and word processors. Students perform programming assignments, illustrating selected numerical methods applied to problems in engineering analysis. Students receive instruction in the computer application Matlab<sup>TM</sup> in addition to the programming languages C and HTML.

In the sophomore year, mechanical engineering students learn to use a proprietary solid modeling application, an integrated software package that allows development of parametric models in two and three dimensions and generates design drawings. Students are also exposed to programming of CNC machines.

In addition, many of the technical electives involve extensive use of computers. For example, the digital control courses involve machine language programming of microprocessors.

### **1.2.5 Laboratory Experience**

The Mechanical Engineering program has long emphasized a balanced theoretical/experimental curriculum in its undergraduate program. To accomplish this balance, traditional mechanical engineering courses are supplemented by an experimental mechanical measurements sequence. This sequence consists of two courses, which begin in the second term of the junior year.

MECHANICAL MEASUREMENTS 1 consists of 12 one-week experiments covering a wide range of topics from flow measurements to strain measurements and touching on practically all of the major areas of mechanical engineering. This is a hands-on course, where the students are exposed to a wide variety of measuring instruments and various recording, signal processing, and readout techniques and devices. Each student is required to prepare a laboratory report for every experiment, describing the experimental procedure, results and conclusions.

MECHANICAL MEASUREMENTS 2 is a laboratory course that teaches students how to properly design and perform experiments on complex mechanical systems, in order to determine specific characteristics or performance of that system. Included within this framework is knowledge of instrumentation, data acquisition, and data analysis. Students are required to give technical presentations.

### **1.2.6 Capstone Design Experience**

The SENIOR DESIGN PROJECT is the senior capstone design experience. The objective of this course is to expose the students to real world engineering problems and situations. Many of the projects performed consist of integrated product and process development, system analysis, design, and manufacturing problems suggested by industry. The students are divided into small groups and work for the full term under the direction of a faculty advisor and, in most instances, an industrial advisor. The results of their investigations are reported in a formal written report, a poster display, and by an oral presentation at the Technical Symposium at the end of the term.

### **1.2.7 Student Development in Engineering Professional Practice**

Ethics and professionalism are presented to students by example in most courses and by the actions and attitudes of the faculty. Each year, as a part of the required departmental seminar, speakers on ethics and professionalism are invited to give a presentation. Also, the senior technical symposium in which all students make presentations is conducted in the manner of a professional meeting.

There are two student chapters of professional societies in the department, the American Society of Mechanical Engineers (ASME) and the Society of Automotive Engineers (SAE). Both regularly participate in national or regional activities. Each year, SAE student members

design and build a formula car, which they enter into a national competition. Pi Tau Sigma, the National Honorary Mechanical Engineering Fraternity, is also active in the department.



# Chapter 2

## Undergraduate Curriculum

The requirements for obtaining a Bachelor of Science (B.S.) degree in Mechanical Engineering are described below. In addition to required courses within and outside of the Mechanical Engineering and Materials Science Department, students are also required to take four (4) Mechanical Engineering Technical Electives, one (1) Engineering Elective, six (6) Social Science and Humanities Electives, and one (1) Communication Skills Elective. There are a total of 128 passed credits required for graduation, all of which must be taken with the letter grade option.

### 2.1 Required Mechanical Engineering Courses

Students must satisfactorily complete the following sixteen (16) Mechanical Engineering courses, for a total of forty-five (45) credits.

**MEMS 0024**      **INTRODUCTION TO MECHANICAL ENGINEERING DESIGN (3 cr.)**  
Fundamentals of the design process, basic techniques of graphic communication, and an introduction to the most common mechanical components and manufacturing processes. Prerequisite: ENGR 0011.

**MEMS 0031**      **ELECTRICAL CIRCUITS (3 cr.)**  
Fundamental laws, principles, and analysis techniques for DC and AC linear circuits whose elements consist of passive and active components used in modern engineering practice, including the determination of steady-state and transient responses. Prerequisite: PHYS 0175. Co-requisite: MATH 0290.

**MEMS 0040**      **MATERIALS & MANUFACTURING (3 cr.)**  
Manufacturing and processing of ceramics, semiconductors, metals, and polymers covering refining, product formation, and control of properties. Prerequisite: ENGR 0022.

MEMS 0051 INTRODUCTION TO THERMODYNAMICS (3 cr.)

Principles of classical thermodynamics; thermodynamic properties of simple substances, property tables, equations of state and ideal gases; first law of thermodynamics; second law of thermodynamics; thermodynamic functions and relationships; chemical reacting systems; phase equilibrium of one-component systems. Prerequisites: PHYS 0174, CHEM 0960. Co-requisite: MATH 0290.

MEMS 0071 INTRODUCTION TO FLUID MECHANICS (3 cr.)

Fundamental of fluid mechanics, with emphasis on inviscid and linearly viscous, incompressible fluids. Basic physical phenomena of fluid mechanics. Fluid kinematics. Governing equations (both integral and local forms). Exact solutions. Internal flows. Dimensional analysis and modeling. Prerequisites: PHYS 0174, CHEM 0960. Co-requisite: MATH 0290.

MEMS 1014 DYNAMIC SYSTEMS (3 cr.)

Modeling and analysis of physical systems. Time and frequency domain analysis. Transient and steady-state system response to various excitations. Transfer function and state space model representations. Laplace and Fourier transforms. Prerequisites: MATH 0280, ENGR 0012, MEMS 0031, MEMS 1015.

MEMS 1015 RIGID-BODY DYNAMICS (3 cr.)

Dynamics of particles, systems of particles, and rigid bodies including energy and momentum methods, problems of varying forces and constraints, and relationship of motion to different reference frames. Prerequisites: MATH 0240, ENGR 0135.

MEMS 1028 MECHANICAL DESIGN 1 (3 cr.)

Stress and deflection analysis; survey of mechanical design criteria; selection and application of working stresses for ductile and brittle materials; static, fatigue, and impact loading and combination of stresses. Prerequisite: ENGR 0145.

MEMS 1029 MECHANICAL DESIGN 2 (3 cr.)

Design and selection of various machine components including bearings, belts, gears, chains, screws, brakes, clutches, shafts and springs. Emphasis is placed on how these components are incorporated into various machines. Case studies, laboratory mini-projects and an open ended design project are also included. Prerequisites: MEMS 0024, MEMS 1028.

MEMS 1041 MECHANICAL MEASUREMENTS 1 (3 cr.)

Fundamentals of mechanical measurements, including steady-state and dynamic signals, detector-transducer elements, signal conditioning and readout systems, standards, instrument calibration, statistical treatment of data, error analysis, and technical report writing. Prerequisites: ENGR 0145, MEMS 0031. Co-requisite: MEMS 1014.

MEMS 1042 MECHANICAL MEASUREMENTS 2 (3 cr.)

Builds on the foundation of mechanical measurements provided in MEMS 1041 to provide students with the ability to properly design and perform an experiment on a complex mechanical system in order to determine specific characteristics or performance of that system. Specific material includes extended knowledge of statistics and error analysis, computer-based data acquisition, and technical communications. Prerequisite: MEMS 1041.

MEMS 1043 SENIOR DESIGN PROJECT (3 cr.)

A major project involving literature search, planning, design, fabrication, experimentation, analysis, technical report, poster presentation, and presentation at a technical symposium is performed by a small team of students under the direction of a faculty advisor and corporate advisor on a project presented by the corporate advisor. Prerequisite: *senior standing*.

MEMS 1051 APPLIED THERMODYNAMICS (3 cr.)

Thermodynamic processes involving energy and entropy changes in real and ideal gases, vapors and liquids, and mixtures of those fluids. Basic thermodynamic cycles (vapor and gas power, refrigeration, and heat pumps). Discussion of thermodynamic relations for simple compressible substances and introduction to psychometrics. Prerequisite: MEMS 0051.

MEMS 1052 HEAT & MASS TRANSFER (3 cr.)

One- and two-dimensional steady- and unsteady-state heat conduction; internal and external forced convection; free convection; engineering principle of radiation; heat exchangers and special topics. Prerequisite: MEMS 0051.

MEMS 1071 APPLIED FLUID MECHANICS (3 cr.)

Basic principles of computational fluid dynamics (CFD). Hands-on experience using a commercial CFD package. Students will use this tool to solve a design problem. External flows with particular emphasis on aerodynamics. Fluid machinery. Experimental fluid mechanics. Prerequisite: MEMS 0071.

MEMS 1085 DEPARTMENTAL SEMINAR (0 cr.)

Seminars are designed to acquaint the student with aspects of mechanical engineering not normally encountered in classes and include a wide range of topics such as the significance of engineering as a profession and the relation of engineering to current social problems.

## 2.2 Other Required Courses

Students must satisfactorily complete each of the following courses from outside of the Mechanical Engineering and Materials Science Department. There are fourteen (14) of these courses for a total of forty-seven (47) credits.

CHEM 0960 GENERAL CHEMISTRY FOR ENGINEERS 1 (3 cr.)

The courses CHEM 0960 and 0970 comprise a two-term introduction to the fundamental properties of matter. The courses emphasize applications to industrial and environmental chemistry and biochemistry. CHEM 0960 covers stoichiometry; the properties of solids, liquids, and gases; thermochemistry; and the electronic structure of atoms and molecules. (If a student has difficulty enrolling in CHEM 0960, then CHEM 0110 is an acceptable substitute.)

CHEM 0970      GENERAL CHEMISTRY FOR ENGINEERS 2 (3 cr.)

The course emphasizes applications to industrial and environmental chemistry and biochemistry, building upon material presented in CHEM 0960 or 0110. (If a student has difficulty enrolling in CHEM 0970, then CHEM 0120 is an acceptable substitute.) Prerequisite: CHEM 0110 or CHEM 0960.

ENGR 0011      INTRODUCTION TO ENGINEERING ANALYSIS (3 cr.)

Introduces students to basic topics in engineering, the role of the computer in engineering, ill-structured problem solving, and report writing. The course includes material on the use of Unix, HTML, spread sheets, and MATLAB. Data analysis and curve fitting is done in both MATLAB and Excel. The writing component includes four detailed reports and includes an oral presentation. The course goals are: to introduce the fundamentals of what engineering is, what engineers do, why a diverse work force is needed, and what values come with working in a group environment; to introduce the required library research skills and communication skills used by all engineers; to introduce the role of the computer in engineering problem solving, including the basic analytical, programming design, graphical, and problem solving skills used by most engineers in their profession; and to provide an overview of how material in the basic sciences and mathematics is applied by engineers to solve practical problems of interest to society.

ENGR 0012      INTRODUCTION TO ENGINEERING COMPUTING (3 cr.)

Introduces students to social topics in engineering, the role of the computer in engineering, ill-structured problem-solving and report writing. The course includes material on the use of MATLAB and C++. Students learn the fundamentals of computing in engineering, including program design, program development, and debugging. Applications to problems in engineering analysis with topics selected from ENGR 0011. The writing component includes four detailed reports and includes an oral presentation. Prerequisites: ENGR 0012.

ENGR 0022      MATERIALS STRUCTURE & PROPERTIES (3 cr.)

An introduction to the basic concepts of materials science and engineering. The concepts of atomic, crystal, micro- and macrostructure; and their control and effects on chemical, electrical, magnetic, optical, and mechanical properties. Modification of properties by heat treatment and control of processing. Fundamental considerations in materials selection. Prerequisites: MATH 0230, PHYS 0174.

ENGR 0135      STATICS & MECHANICS OF MATERIALS 1 (3 cr.)

First of a two course sequence covering statics and mechanics of materials. Topics covered include: concurrent force systems, equilibrium, axial loading, stress, strain, deformation, moments, equivalent systems, centroids, centers of mass and distributed loads, free-body diagrams, equilibrium of rigid and deformable bodies, plane trusses, frames and machines, equilibrium in 3D, torsion, and friction. Prerequisites: MATH 0230, PHYS 0174.

ENGR 0145      STATICS & MECHANICS OF MATERIALS 2 (3 cr.)

Second of a two course sequence covering statics and mechanics of materials. Topics include: flexure; second moment of areas, shear force and bending moment diagrams, composite beams, shearing stresses, beam deflections, energy methods, combined static loading, and buckling of columns. Prerequisite: ENGR 0135.

MATH 0220      ANALYTIC GEOMETRY & CALCULUS 1 (4 cr.)

First of a sequence of three basic calculus courses intended for all engineering, mathematics, statistics, and science students. It covers the derivative and integral of functions of one variable and their applications.

MATH 0230      ANALYTIC GEOMETRY & CALCULUS 2 (4 cr.)

Second of a sequence of three basic calculus courses intended for engineering, mathematics, statistics, and science students. It covers the calculus of transcendental functions, techniques of integration, series of numbers and functions, polar coordinates, and conic sections. Prerequisite: C or better in MATH 0220.

MATH 0240      ANALYTIC GEOMETRY & CALCULUS 3 (4 cr.)

Third of a sequence of three basic calculus courses intended for engineering, mathematics, statistics, and science students. It covers vectors and surfaces in space and the calculus of functions of several variables, including partial derivatives and multiple integrals, Stokes theorem, and first-order differential equations. Prerequisite: C or better in MATH 0230.

MATH 0280      INTRODUCTION TO MATRICES & LINEAR ALGEBRA (3 cr.)

The topics which this course cover include: vectors, matrices, determinants, linear transformations, eigenvalues and eigenvectors, and selected applications. Prerequisite: C or better in MATH 0220.

MATH 0290      DIFFERENTIAL EQUATIONS (3 cr.)

The course presents an introduction to the theory of differential equations from an applied perspective. Topics covered include linear and nonlinear ordinary differential equations, Laplace transforms, and introduction to partial differential equations. Prerequisite: C or better in MATH 0230.

PHYS 0174      BASIC PHYSICS FOR SCIENCE & ENGINEERING 1 (4 cr.)

The integrated curriculum version of PHYS 0104, the first part of a two-term sequence that introduces students to the basic principles of mechanics. An effort has been made to achieve a better integration of physics with the first term of calculus, engineering, and chemistry. The theory of waves and the kinetic theory of gases will be discussed. Co-requisite: MATH 0220.

PHYS 0175      BASIC PHYSICS FOR SCIENCE & ENGINEERING 2 (4 cr.)

The integrated curriculum version of PHYS 0105, the second part of a two-term sequence that introduces students to the basic principles of physics. An effort has been made to achieve a better integration of physics with the first term of calculus, engineering, and chemistry. Modern physics (special relativity, elementary quantum mechanics, and atomic structure) will be discussed. Prerequisite: C or better in PHYS 0174. Co-requisite: MATH 0230.

## 2.3 Mechanical Engineering Technical Electives

Students are required to satisfactorily complete four (4) of the following Mechanical Engineering Technical Elective courses, for a total of twelve (12) credits. The courses are first presented by general subject area, to assist students who wish to choose courses from an area of personal interest (note that some courses are listed under more than one subject area). *At least one* of the four technical electives must be from the Dynamics Systems subject area. The courses are then listed in numerical order with course descriptions. Included is a selection of 2000-level (i.e., Masters-level) courses that students may use to satisfy the technical elective requirements.

Note also the following:

- After completing three co-op rotations, co-op students can earn three (3) credits for a written report on their co-op experience which may be counted as a ME Technical Elective. However, the Dynamic Systems Technical Elective requirement must still be satisfied.
- ENGR courses and courses from other engineering departments (i.e., BIOENG, CHE, CEE, etc.) that are not part of another engineering program's freshman or sophomore curriculum may be used as ME Technical Electives, subject to the approval of the Undergraduate Director. To request approval for such a substitution, the student must submit a *Technical Elective Approval Request* form to the Undergraduate Director. This is typically associated with the pursuit of an engineering minor ([Section 5.2](#)) or certificate ([Section 5.4](#)).
- Technical electives are usually not offered during the Summer Term.
- Students must have completed the corresponding prerequisites before enrolling in any of the technical electives.

### 2.3.1 Technical Electives by Subject Area

#### Dynamic Systems

MEMS 1020 MECHANICAL VIBRATIONS

MEMS 1045 AUTOMATIC CONTROLS

MEMS 1049 MECHATRONICS

MEMS 1082 ELECTROMECHANICAL SENSORS AND ACTUATORS

ME 2027 ADVANCED DYNAMICS

ME 2045 LINEAR CONTROL SYSTEMS

ME 2046 DIGITAL CONTROL SYSTEMS

#### Engineering Mathematics & Computation

MEMS 1047 FINITE ELEMENT ANALYSIS

MEMS 1120 APPLIED ENGINEERING SIMULATION IN DESIGN

ME 2001 DIFFERENTIAL EQUATIONS

ME 2002 LINEAR AND COMPLEX ANALYSIS  
ME 2060 NUMERICAL METHODS

### **Fluid/Thermal Systems**

MEMS 1065 THERMAL SYSTEMS DESIGN  
ME 2003 INTRODUCTION TO CONTINUUM MECHANICS  
ME 2056 INTRODUCTION TO COMBUSTION THEORY

### **Materials Science & Engineering**

MEMS 1010 EXPERIMENTAL METHODS IN MATERIALS SCIENCE & ENGINEERING  
MEMS 1011 STRUCTURES & PROPERTIES LABORATORY  
MEMS 1030 MATERIAL SELECTION IN MECHANICAL DESIGN  
MEMS 1053 STRUCTURE OF CRYSTALS & DIFFRACTION  
MEMS 1058 ELECTROMAGNETIC PROPERTIES OF MATERIALS  
MEMS 1059 PHASE EQUILIBRIA IN MULTI-COMPONENT MATERIALS  
MEMS 1063 PHASE TRANSFORMATIONS & MICROSTRUCTURE EVOLUTION  
MEMS 1070 MECHANICAL BEHAVIOR OF MATERIALS  
MEMS 1101 FERROUS PHYSICAL METALLURGY  
MEMS 1102 PRINCIPLES & APPLICATIONS OF STEEL ALLOY DESIGN  
MEMS 1103 PRINCIPLES & APPLICATIONS OF STEEL PROCESSING & DESIGN  
MEMS 1163 CERAMIC MATERIALS

### **Manufacturing**

MEMS 1030 MATERIAL SELECTION IN MECHANICAL DESIGN  
MEMS 1033 FRACTURE MECHANICS FOR MANUFACTURING & PERFORMANCE  
MEMS 1045 AUTOMATIC CONTROLS  
MEMS 1047 FINITE ELEMENT ANALYSIS  
MEMS 1049 MECHATRONICS  
MEMS 1057 MICRO/NANO MANUFACTURING

### **Nuclear Engineering**

ENGR 1700 INTRODUCTION TO NUCLEAR ENGINEERING  
ENGR 1701 FUNDAMENTALS OF NUCLEAR REACTORS  
ENGR 1702 NUCLEAR PLANT TECHNOLOGY

### **Solid Mechanics**

MEMS 1030 MATERIAL SELECTION IN MECHANICAL DESIGN  
MEMS 1033 FRACTURE MECHANICS FOR MANUFACTURING & PERFORMANCE  
MEMS 1047 FINITE ELEMENT ANALYSIS  
ME 2003 INTRODUCTION TO CONTINUUM MECHANICS  
ME 2022 APPLIED SOLID MECHANICS

## 2.3.2 Technical Elective Course Descriptions

### ENGR 1700 INTRODUCTION TO NUCLEAR ENGINEERING (3 cr.)

Introduction to nuclear science and technology; applications of nuclear engineering; careers in nuclear industry; nuclear history; reactor types; elementary nuclear and reactor physics; nuclear radiation and safety; fuel cycle; regulations and sustainability. Prerequisites: PHYS 0175; CHEM 0970.

### ENGR 1701 FUNDAMENTALS OF NUCLEAR REACTORS (3 cr.)

Nuclear physics, fission and fusion; cross-sections; neutron flux and slowing-down; diffusion and transport; criticality condition and calculations; reactor kinetics and shielding; heat generation, transfer and cooling; reactor materials; reactor structure. Prerequisite: PHYS 0175; CHEM 0970.

### ENGR 1702 NUCLEAR PLANT TECHNOLOGY (3 cr.)

Current and future reactor systems; nuclear power plants; balance of plant configuration; fuel cycle management; reactor operation principles; reactor plant economics; analysis and design of nuclear systems; design projects. Prerequisite: PHYS 0175; CHEM 0970.

### MEMS 1010 EXPERIMENTAL METHODS IN MSE (3 cr.)

This laboratory will give the student practical experience of the experimental methods used in modern materials science and engineering. The first set of experiments will introduce the common methods for analyzing material structure including: optical microscopy, X-ray diffraction, and scanning electron microscopy (SEM). The second part of the course will concentrate on methods used to measure material properties such as the tensile test, hardness test, impact testing as well as electrical and magnetic property measurement methods. Prerequisite: ENGR 0022.

### MEMS 1011 STRUCTURES & PROPERTIES LABORATORY (3 cr.)

This laboratory will build on the students experience of the experimental methods introduced in MEMS 1010 by applying them to processing-structure-property relationships in materials from the different material classes. Examples include: the effect of mechanical work and heat treatment on the properties of metal alloys, the effect of ceramic powder characteristics on the pore structure of sintered ceramics and the effect of temperature on the extent of cross-linking in a thermosetting polymer. Prerequisite: MEMS 1010.

### MEMS 1020 MECHANICAL VIBRATIONS (3 cr.)

Review of free and forced vibrations of single-degree-of-freedom systems with and without damping, multi-degree-of-freedom systems, vibration isolation, nonlinear vibrations, Lagrange's equations, and vibration of continuous systems. Prerequisite: MEMS 1014.

### MEMS 1030 MATERIAL SELECTION IN MECHANICAL DESIGN (3 cr.)

Methodology for materials selection in mechanical design processes. Includes: (i) design process and consideration, (ii) criteria for materials and their shape selection, and (iii) design case study. Mechanical components have mass; they carry loads; they conduct heat and electricity; they are exposed to wear and to corrosive environments; they are made of one or more materials; they have shape; and they must be manufactured. This course provides knowledge on how these activities are related. Prerequisites: ENGR 0022, MEMS 1028.

MEMS 1033      FRACTURE MECHANICS FOR MANUF. & PERFORM. (3 cr.)  
An introduction to the principles of fracture mechanics; the essential concepts underlying appropriate materials selection including the effects of shape selection for maximum performance; and the strengths and weaknesses inherent in the choice of, say, metals versus ceramics versus polymers, etc. Prerequisites: ENGR 0022, MEMS 1028.

MEMS 1045      AUTOMATIC CONTROLS (3 cr.)  
Modeling of mechanical systems and classical feedback control theory for single-input-single-output systems. Prerequisite: MEMS 1014.

MEMS 1047      FINITE ELEMENT ANALYSIS (3 cr.)  
The finite element method applied to solid mechanics, fluid dynamics, and heat transfer. Prerequisites: MEMS 1028.

MEMS 1049      MECHATRONICS (3 cr.)  
An introduction to mechatronics, or the interfacing of mechanical and electrical systems. Focus is on embedded controllers (Motorola 68HC11 and PIC 16F84) and their programming, power and interfacing electronics, actuators, sensors, and integration of these components to create a complete functional mechatronic system. Prerequisite: MEMS 1014.

MEMS 1053      STRUCTURE OF CRYSTALS & DIFFRACTION (3 cr.)  
Crystallography of materials; Bravais lattices, crystal systems, and crystal structures. Diffraction methods; X-ray, electron, and neutron scattering; atomic scattering factor; structure factor; powder techniques; Laue method; reciprocal lattice; electron diffraction; amorphous materials; thermodynamics of crystals and crystal defects; polymorphism; order-disorder phenomena. Prerequisite: ENGR 0022.

MEMS 1057      MICRO/NANO MANUFACTURING (3 cr.)  
Explores different micro/nano manufacturing options, material choices, and a variety of applications. The goal is to gain an understanding of various micro/nano fabrication techniques, learn major applications and principles of micro/nano systems, and develop an ability to design and fabricate new micro/nano systems.

MEMS 1058      ELECTROMAGNETIC PROPERTIES OF MATERIALS (3 cr.)  
Review of basic principles—quantum theory, band and zone theory. Transport, electrical, and thermal properties; semiconductors and semiconductor devices; magnetic materials hard and soft; dielectric and optical properties. Prerequisite: ENGR 0022.

MEMS 1059      PHASE EQUILIBRIA IN MULTI-COMPONENT MATERIALS (3 cr.)  
Thermodynamics of solutions with applications to materials systems; heterogeneous phase equilibria; relations between free energy and phase diagrams; electrochemistry; rate processes; thermodynamics of surfaces. Prerequisites: ENGR 0022, MEMS 0051.

MEMS 1063      PHASE TRANSFORMATIONS & MICROSTRUCTURE EVOLUTION (3 cr.)  
Phase equilibria; binary and ternary system; phase rule; thermodynamics and phase diagrams; diffusion in materials; phase transformations; nucleation and growth kinetics; precipitation reactions; solidification; glass-forming systems; phase separation; displacive or martensitic transformations; microstructural development in metallic and non-metallic systems; electron theory of solids; zone theory; electrical and magnetic properties of materials. Prerequisites: MEMS 1053, MEMS 1059.

MEMS 1065 THERMAL SYSTEMS DESIGN (3 cr.)

Design, analysis, and optimization of thermal systems. Systems analysis applied to heat exchanger, power conversion, air conditioning, refrigeration, and heat recovery systems. Economics, equation fitting, and thermal property evaluation are integrated into simulation and optimization of thermal system designs. Prerequisites: MEMS 0071, MEMS 1051, MEMS 1052.

MEMS 1070 MECHANICAL BEHAVIOR OF MATERIALS (3 cr.)

Theory of elasticity, stress, strain, constitutive equations, isotropic and anisotropic elasticity, wave propagation in brittle solids, time dependent deformation, viscoelasticity, vibrations, damping, anelasticity, creep, design of creep resistant microstructures, deformation of polymers, physics of fracture, fracture mechanisms, brittle fracture, ductile fracture, design of fracture-resistant microstructures. Prerequisites: ENGR 0022, ENGR 0145.

MEMS 1082 ELECTROMECHANICAL SENSORS & ACTUATORS (3 cr.)

The objective of this course is to provide a thorough understanding of the various mechanisms that can be exploited in the design of electromechanical sensors and actuators. These transduction mechanisms include: 1) transduction based on changes; in the energy stored in the electric field, 2) in the energy stored in the magnetic field, 3) piezoelectricity and pyroelectricity, 4) linear inductive transduction mechanisms, and 5) resistive transduction mechanisms. Will discuss various transduction materials, sensors and actuators from a wide range of applications. Prerequisite: MEMS 1014.

MEMS 1097 SPECIAL PROJECTS (1–3 cr.)

Investigation and research embodying testing; original design or research on an approved subject; or individual course of study guided by an approved departmental faculty member.

MEMS 1098 SPECIAL PROJECTS 2 (1–3 cr.)

Investigation and research embodying testing; original design or research on an approved subject; or individual course of study guided by an approved departmental faculty member.

MEMS 1101 FERROUS PHYSICAL METALLURGY (3 cr.)

This course will introduce the student to the thermomechanical processing of austenite in plain carbon, high strength low alloy steels, high formability sheet steels and high alloy and special steels. The course will also present the use of hot rolling as a thermomechanical treatment. The importance of thermomechanical treatment, microstructural control and mechanical properties will be presented. Prerequisites: ENGR 0022, MEMS 0051, MEMS 1010.

MEMS 1102 PRINC. & APPL. OF STEEL ALLOY DESIGN (3 cr.)

This course will present the students with a discussion of the properties that are required of engineering alloys for a given commercial application. The alloy design, thermomechanical processing and required package of mechanical properties for plate, strip, bar, rod, wire and tubular products will be reviewed. These include: strength, toughness, formability, weldability, fatigue resistance, and corrosion/oxidation resistance. Prerequisite: MEMS 1101.

MEMS 1103 PRINC. & APPL. OF STEEL PROCESSING AND DESIGN (3 cr.)

This course will present case studies of actual components used in commercial applications in the automotive, construction, oil and gas and nuclear industries. This course will guide the student from the alloy selection, microstructural processing, mechanical properties to the final fabrication steps. Prerequisite: MEMS 1102.

MEMS 1120 APPLIED ENGINEERING SIMULATION IN DESIGN (3 cr.)

This course will focus on the development of critical thinking skills tailored to engineering simulation in mechanical design. Commonly used computational simulation tools including finite element analysis and computational fluid dynamics will be highlighted. Students will examine the role of simulation in product design and learn to recognize opportunities to integrate simulation-based analysis into traditional engineering analysis and design workflows. A term-long project will offer exposure to simulation tools and provide students the context to practice their skills in a complex design environment. Students are required to take the one-credit course MEMS 1121 Simulation Workshop concurrently. Prerequisites: MEMS 0051, MEMS 0071, MEMS 1028.

MEMS 1163 CERAMIC MATERIALS (3 cr.)

Structure of ceramics and glasses. Microstructures and their development. Properties, processing, and applications. Prerequisite: MEMS 1064.

ME 2001 DIFFERENTIAL EQUATIONS (3 cr.)

Ordinary differential equations; series solutions of differential equations; introduction to partial differential equations. Prerequisite: MATH 0290.

ME 2002 LINEAR AND COMPLEX ANALYSIS (3 cr.)

Linear algebra; vector analysis; complex variables; introduction to calculus of variations. Prerequisite: MATH 0290.

ME 2003 INTRODUCTION TO CONTINUUM MECHANICS (3 cr.)

The fundamental concepts of continuum mechanics are necessary for studying the mechanical behavior of solids and fluids. Includes a review of vectors and tensors; stress; strain and deformation; general principles in the form of balance laws; constitutive equations and their restrictions; and specialization to the theories of linearized elasticity and fluid mechanics. Prerequisites: MATH 0290, MEMS 1028.

ME 2022 APPLIED SOLID MECHANICS (3 cr.)

Stress and strain transformations; applied elasticity problems in torsion and plane problems; thermal stresses and elementary plasticity; energy methods; fundamentals of finite element methods. Prerequisites: MATH 0290, MEMS 1028.

ME 2027 ADVANCED DYNAMICS (3 cr.)

Variational principles, Lagrangian and Hamiltonian formalisms, kinematics and dynamics of rigid bodies, first integrals, Routh's method, stability, canonical transformations, the Hamilton-Jacobi theory. Prerequisite: MEMS 1015.

ME 2042            MEASUREMENT AND ANALYSIS OF VIBRO-ACOUSTIC SYSTEMS (3 cr.)

This course will present measurement and analysis techniques for dynamic systems, with particular emphasis on mechanical vibrations and acoustics. Background on vibration of lumped and continuous parameter systems, acoustics, and noise and vibration control will be given. Other concepts include FFTs, windowing, input/output relationship calculations, test methods, transducers, instrumentation, and the use of dynamic signal analyzers. Application to system identification and modal analysis will be included, as well as hardware demonstrations. Prerequisite: MEMS 1014.

ME 2045            LINEAR CONTROL SYSTEMS (3 cr.)

This course builds upon the foundation laid in a classical feedback control course. The tools will be developed for analyzing and designing controllers for multi-input, multi-output dynamic systems. Ideas of controllability and observability will be discussed, as well as modern control design techniques such as pole-placement. Prerequisite: MEMS 1045.

ME 2046            DIGITAL CONTROL SYSTEMS (3 cr.)

This course provides the student with the tools necessary to analyze and design discrete-time (digital computer) control systems for real time control of dynamic systems. It builds upon the background of classical control topics including Nyquist, Bode, and root locus. Transforms ideas will be used extensively for design and analysis to give the student an understanding of how discrete-time and classical control systems are related. State-space representations will be used for MIMO systems, so a prior understanding of modern control ideas is important. Prerequisite: MEMS 1045.

ME 2056            INTRODUCTION TO COMBUSTION THEORY (3 cr.)

Covers the general solution techniques associated with combustion phenomena as well as chemical thermodynamics, heat and mass transfer, laminar flame theory, one-dimensional reactive flow, heterogeneous combustion, and turbulent combustion.

ME 2060            NUMERICAL METHODS (3 cr.)

Introduction to numerical techniques for the solution of linear and nonlinear equations, numerical integration and differentiation, interpolation, ordinary and partial differential equations, and eigenvalue problems.

## 2.4 Engineering Elective

Students are required to complete one (1) Engineering Elective course, for a total of at least three (3) credits. Any course offered within the Swanson School of Engineering may be used to satisfy this requirement, provided only that it does not substantially replicate another course in a student's curriculum. The purpose of the Engineering Elective is to allow students the flexibility to explore possible areas of interest outside of mechanical engineering (e.g., CEE 1210 GREEN BUILDING DESIGN AND CONSTRUCTION or IE 1040 ENGINEERING ECONOMIC ANALYSIS).

- In contrast to the requirements for a ME Technical Elective, the Engineering Elective *can* be from another engineering program’s sophomore curriculum (i.e., it does not have to be an “upper-level” course).
- A fifth ME Technical Elective may be used to fulfill this requirement.
- For students pursuing an engineering minor ([Section 5.2](#)) or certificate ([Section 5.4](#)), one of the courses required for the minor or certificate can be used to fulfill this requirement.

## 2.5 Humanities and Social Science Electives

All Swanson School of Engineering undergraduates must complete six (6) humanities and social science elective courses, for a total of at least eighteen (18) credits. These courses must be on the School’s list of [approved humanities and social science elective courses](#). A link to this list can be found on the MEMS Department’s [student resources](#) webpage.

Additionally, all Mechanical Engineering students must fulfill the following requirements when choosing their six humanities and social science elective courses:

### Depth Requirement

- Students must complete at least two courses from the *same* department or program within the Dietrich School of Arts and Sciences.
- Alternatively, a student may satisfy the Depth Requirement by completing two or more courses with a related theme, e.g., courses that focus on a geographic region, historic period, or ideological perspective.
- At least one of these courses must be a non-introductory course. Introductory courses are designated by an asterisk [\*] on the School’s list of approved courses.

### Breadth Requirement

- Students must select courses from at least three different departments in the Dietrich School of Arts and Sciences.
- Students must choose classes from both humanities and social science departments.

The humanities and social science courses on the School’s list of approved courses satisfy the Swanson School of Engineering’s requirements. However, students may petition the Senior Associate Dean for Academic Affairs to have a course added to the list of approved courses by submitting an *Approval Request for Humanities/Social Science Elective* form, available in the Mechanical Engineering and Materials Science Undergraduate Program Office (636 Benedum Hall). The form must be turned in to the Senior Associate Dean for Academic Affairs Office (147 Benedum Hall) for approval. Students can contact the Undergraduate Program Office approximately one week later to see if the course was approved. It is helpful to include a copy of a course description for the course. Courses that are deemed

sufficiently relevant and academically appropriate generally are approved. Broad survey courses (typically below the 100 level that are generally taught in large lecture sections) are usually not approved. Skills courses (courses that focus more on acquiring a skill than on conveying intellectual knowledge) are also usually not approved.

### **Notes and Restrictions on Selecting Courses**

- Transfer students may be required to take ENGCMP 0200 SEMINAR IN COMPOSITION. This does not count as one of the six required elective courses.
- No more than two of the six required elective courses can be satisfied via advanced standing credit from AP exam scores.
- If a student has obtained transfer credit from a community college prior to enrolling in the Swanson School of Engineering, no more than three of the six required elective courses can be satisfied via community college credit.
- Courses that are cross-listed with other departments may be taken under either course number (e.g., ANTH 1524 is equivalent to HAA 1650) and may be used to satisfy the depth requirement in either department.
- Students are strongly encouraged to use language courses to partially satisfy the humanities and social science elective requirements. Three out of five, or six out of ten first-year language course credits are acceptable toward fulfilling the humanities and social science elective requirements. However, the following restrictions apply:
  1. The language(s) must be other than English.
  2. The language(s) must be other than the student's mother tongue.
  3. The course(s) must be a bona fide language course.

No more than two of the six required elective courses can be satisfied by language courses.

- Only an officially listed School of Arts and Sciences course may be used to fulfill a humanities and social science elective requirement. Courses from the College of General Studies (including External Studies courses), the College of Business Administration, and the School of Information Sciences cannot be used to fulfill the humanities and social science requirements.

## **2.6 Communication Skills Elective**

To satisfy the Communication Skills Elective requirement, students must satisfactorily complete one of the following courses offered by the Swanson School of Engineering (ENGR), the Communication Department (COMMRC), and the English Department (ENGCMP). The Communication Skills Elective should be taken as soon as possible, in order that a student might benefit from it in other courses.

### COMMRC 0500 ARGUMENT (3 cr.)

This course is designed to acquaint students with fundamental principles of argumentation through the use of elementary debating techniques and strategies. Students will participate in several in-class debates on a question of policy.

### COMMRC 0520 PUBLIC SPEAKING (3 cr.)

This course is designed to help students develop increased skill in public speaking by means of theory and practice. This course covers research, organization, style, delivery, and criticism of informative, deliberative, and ceremonial speeches.

### COMMRC 0540 DISCUSSION (3 cr.)

This course is designed to increase skills in critical thinking, decision making, and small group discussion. Students are introduced to theories of group process and practice step-by-step group problem solving related to contemporary issues.

### ENGCMP 0400 WRITTEN PROFESSIONAL COMMUNICATION (3 cr.)

This course explores the methods of inquiry, analysis and composition characteristic of written communication in professional settings. The course will examine such writing's specialized use of language, conventions and formats, premises, motives, and purposes. By preparing letters, resumes, proposals, reports, etc. Students will get a feel not only for what "professional" communication is, but also for how and why it does, or can, or should function. Prerequisite: ENGCMP 0200 or ENGR 0012.

### ENGCMP 0600 INTRODUCTION TO TECHNICAL WRITING (3 cr.)

This introductory course is for students in various technical fields. Representative technical reports will be studied, as well as abstracts, the presentation of visuals and oral communication. Writing assignments will emerge from case studies reflecting on-the-job challenges.

### ENGR 1010 COMMUNICATION SKILLS FOR ENGINEERS (3 cr.)

Utilizing a variety of spoken, written, and audio-video activities, students learn how to give instructions, use feedback, listen, conduct a job and appraisal interview, conduct meetings, make use of groups, make presentations, manage crises most of the skills they need to strengthen their personal, interpersonal, group, and organizational communicative skills. The instructing-learning process emphasizes motivation, concentration, participation, organization, comprehension, repetition, articulateness, and confidence.

## 2.7 Writing Requirement

All Swanson School of Engineering students must complete at least one writing intensive course (referred to from now on as a W-course), as certified by the Dietrich School of Arts and Sciences. When viewing the Class Detail for courses online, W-courses are distinguished by having "Writing Requirement Course" listed as one of their Class Attributes. Only courses that have this Class Attribute can be used to satisfy the writing requirement.

- The writing requirement will normally be fulfilled by ensuring that either one of the six required humanities and social science electives or the communications skills elective is a W-course. It will not typically require a student to take an additional course.
- The Dietrich School of Arts and Sciences maintains a Course Descriptions webpage (<http://www.courses.as.pitt.edu>) that can be used to find W-courses. Under the *General Education Requirements* dropdown menu, choose W - Writing Intensive and click on the semester to see a list of W-courses being offered that term.
- There are a variety of W-courses offered each term to choose from, particularly from the English Literature Department. Note that ENGCMP 0400 WRITTEN PROFESSIONAL COMMUNICATION and ENGCMP 0600 INTRODUCTION TO TECHNICAL WRITING are normally offered as W-courses.
- ENGCMP 0200 SEMINAR IN COMPOSITION is *not* a W-course and does not satisfy the writing requirement.

## 2.8 Advanced Standing and Transfer Credit

Students transferring into the Mechanical Engineering and Materials Science Department from other colleges and universities will have their academic records reviewed for advanced standing after they have been accepted for admission (see [Section 4.4](#) for more information on how to apply for transfer to the Swanson School of Engineering from another college or university). Advanced standing for a University of Pittsburgh course means that a student receives transfer credit for that course. Only the credits will transfer for the course, not the grade received at the previous institution, but in all other respects it as if the student took the course at the University of Pittsburgh.

The determination of advanced standing is made by the MEMS Undergraduate Director, in accordance with Swanson School of Engineering policy and criteria established by the Accreditation Board for Engineering and Technology (ABET).

- Only courses in which the applicant received a grade of at least 2.00 on a 4.00 scale will be considered for advanced standing, and then only if the course can be used to satisfy degree requirements.
- Advanced standing for engineering or engineering science courses will be given only if the courses were taken from an ABET accredited engineering program.
- Advanced standing for mathematics and science courses will be awarded to the extent that those courses match Dietrich School of Arts and Sciences courses.
- Humanities and social science courses must either correspond to those on the Swanson School of Engineering's approved list of humanities and social science electives or meet the Swanson School of Engineering's requirements for an acceptable humanities and social science elective, as determined by the Undergraduate Director.

- A maximum of 96 transfer credits may be applied towards the degree (75% of the 128 credits required for graduation).

Students transferring from either an institution maintaining a 3/2 program with the Swanson School of Engineering or a community college having an articulation agreement with the school will receive advanced standing in accordance with those agreements.

### 2.8.1 Advanced Placement (AP) Credit

The Swanson School of Engineering encourages students to take advantage of college prep courses offered at their high schools. This allows students to start ahead in the freshman curriculum and can create openings in future terms, which can be used for courses toward a minor or dual degree. We do, however, caution students that core courses such as Calculus, Chemistry, and Physics are building blocks for future success, and so credit should only be used if a student is truly confident in their retention of the material. Please see the freshman engineering web page (<https://www.engineering.pitt.edu/freshman>) for the current Swanson School of Engineering policy relating AP scores with advanced standing credit.

### 2.8.2 Transfer Credit for Courses Taken After Enrollment

Students enrolled in the Swanson School of Engineering may take courses at other universities to satisfy graduation requirements only if those courses are approved in advance by the Undergraduate Director. Such courses must be taken at a college or university that offers a full four-year degree program. Specifically, once a student is enrolled in the Mechanical Engineering and Materials Science Department, he/she is not permitted to take courses at a community college or other two-year institution as part of his/her engineering education. Students residing in the Pittsburgh area are expected to take all of their courses at the University of Pittsburgh, unless there is a special course offered at one of the other area four-year colleges that is not available at the University of Pittsburgh. See [Section 4.2](#) for more information on cross-registering at PCHE-member institutions. Students may take courses at the Greensburg and Johnstown campuses of the University of Pittsburgh. Engineering and engineering science courses must have been taken from an ABET-approved engineering program.

Only the credits will transfer for the equivalent class, not the grade or grade point average, and credit will only be given if the student receives at least 2.0 on a 4.0 scale. It is the student's responsibility to have their transcript sent to the Undergraduate Office, 636 Benedum Hall, at the completion of the class.

## 2.9 Undergraduate Resources Web Page

A variety of resources is available on the [Undergraduate/Student Resources](#) page of the department's website. Here you will find:

- The latest versions of this Academic Program Manual, the Curriculum Checklist, the Schedule of Course Offerings by Term, etc.

- Semester course schedules.
- Departmental information regarding co-op participants, the departmental seminar, graduation, humanities and social science electives, etc.
- Various university forms for Anticipated Graduation Date, Graduation Application, Permission to register for more than 18 credits, etc.

# Chapter 3

## Academic Policy

### 3.1 Grading System

The University of Pittsburgh uses a standard letter grade system, as described below. All of the courses taken for fulfillment of the requirements for a Bachelor of Science in Engineering must be taken with the Letter Grade Option—the H/S/U and S/NC grade options are not allowed. The only exception is for courses through University of Pittsburgh International Programs, which are taken pass/fail (S/U). The minimum grade for satisfactory completion of a course is a “D–.”

#### 3.1.1 Letter Grades and Grade Points

The University’s letter grades and their associated grade points are as follows:

<b>Grades</b>	<b>Grade Points</b>
A+ =	4.00
A =	4.00 Superior
A– =	3.75
B+ =	3.25
B =	3.00 Meritorious
B– =	2.75
C+ =	2.25
C =	2.00 Adequate
C– =	1.75
D+ =	1.25
D =	1.00 Minimal
D– =	0.75
F =	0.00 Failure

### 3.1.2 Other Grades: Incomplete, Withdrawn, Resigned

Upon a student's completion of a course, one of the grades listed below may appear on the student's transcript in lieu of the letter grades discussed above.

- A “G” grade signifies unfinished course work due to extenuating circumstances. Students assigned “G” grades are required to complete course requirements within the next term of registration or within the time specified by the instructor. The instructor of the course will complete a grade change authorization form and send it to the School of Engineering Office of Administration for processing. If a “G” grade is not removed within one year, the instructor may change it to an “F” grade for the course.
- An “I” grade signifies incomplete course work due to the nature of the course, clinical work, or incomplete research work in individual guidance courses or seminars. It is not typically used for undergraduates.
- A “R” grade signifies that a student resigned from the University.
- A “W” grade signifies that a student has withdrawn from a course (see Withdrawal below).

## 3.2 Withdrawal

To receive a refund, a student must officially drop a course during the term's add/drop period. Through the ninth week of the term, a student may withdraw from a course by completing a Monitored Withdrawal form available in the Undergraduate Program Office. The course instructor must sign the form. Withdrawal forms for courses offered by the Swanson School of Engineering must be processed through the Engineering Office of Administration. Withdrawal forms for courses offered by the Dietrich School of Arts and Sciences must be processed through that school's dean's office. A “W” grade will then be assigned for the course. Withdrawal from a course after the ninth week of the term is permitted only for extremely extenuating circumstances. It requires the approval of the Associate Dean for Academic affairs.

## 3.3 Calculation of the Grade Point Average

Each credit carried for a letter grade is awarded grade points as shown in the table above. A student's term grade point average (term GPA) is the total grade points earned for the term divided by the total credits assigned letter grades. A student's cumulative grade point average (cumulative GPA) is determined by dividing the total number of grade points by the total number of credits assigned letter grades. Only credits that are taken at the University of Pittsburgh are used in the calculation of the grade point averages.

### 3.3.1 Course Repeats

If a student receives a grade of “C–” or lower in a course, repeats the course within one calendar year, and receives a better grade the second time, then the second grade will replace the previously assigned grade when calculating the cumulative GPA.

- The time limit can be extended if a student is not able to repeat a course within one calendar year due to extenuating circumstances (e.g., the course was only offered when the student was on a co-op rotation). Such an extension must be approved by the Associate Dean for Academic Affairs.
- No sequence course may be repeated for credit after a higher-numbered sequence course has been satisfactorily completed with a “C” or better.
- Students are only permitted to repeat a course twice. For the purposes of this rule, grades of “R” or “W” do not count as repeats. If a student receives a better grade the third time, then that grade will replace the two previously assigned grades when calculating the cumulative GPA. Special permission from the Associate Dean for Academic Affairs is required to take a course for a fourth time and will be granted only for extremely extenuating circumstances.
- Grades for courses that have been repeated will remain on a student’s transcript, even if they are not used in determining the GPA.

## 3.4 Academic Honors

At the end of each term, the academic records of all undergraduate degree students in the School of Engineering are reviewed to determine eligibility for the Term Honor List and the Dean’s Honor List. Students who qualify for both honor lists will appear only on the Dean’s Honor List.

### 3.4.1 Term Honor List

To be eligible for the Term Honor List, a student must have (1) earned a term grade point average of at least 3.25, (2) completed a minimum of 15 credits of academic work for letter grades at the University of Pittsburgh, and (3) completed a minimum of six credits of work for letter grades in the term of eligibility.

### 3.4.2 Dean’s Honor List

To be eligible for the Dean’s Honor List, a student must have (1) earned cumulative and term grade point averages of at least 3.25, (2) completed a minimum of 30 credits of academic work for letter grades at the University of Pittsburgh, and (3) completed a minimum of six credits of work for letter grades in the term of eligibility.

## 3.5 Academic Discipline

To be considered in good academic standing, a student's cumulative GPA must be at least 2.00 and the student must be making satisfactory progress toward earning an engineering degree. Each engineering student's academic record is reviewed at the end of each term.

### 3.5.1 Warning

If a student's *term* GPA is less than 2.00, but his/her *cumulative* GPA is still greater than or equal to 2.00, then the student will receive a warning letter from the School of Engineering that he/she is in academic difficulty, which could eventually lead to probation if academic performance does not improve. The student is still in good academic standing.

### 3.5.2 Probation

A student whose *cumulative* GPA drops below 2.00 is no longer in good academic standing and will be placed on academic probation. A student is subject to suspension or dismissal if his/her cumulative GPA remains below 2.00 for two consecutive terms.

### 3.5.3 Suspension

After being suspended, students are not eligible to reenroll for one calendar year, after which they are required to apply for reinstatement through the Swanson School of Engineering Office of Administration. Students returning from academic suspension are reinstated on academic probation and their academic performance will be reviewed after each subsequent term. If the student's cumulative GPA remains below 2.00 for two consecutive terms, he/she will be subject to dismissal.

### 3.5.4 Dismissal

Dismissal is a final action. Dismissed students are not eligible for future enrollment in the Swanson School of Engineering.

## 3.6 Reinstatement

An engineering student in good academic standing who has not attended the University of Pittsburgh for three consecutive terms, and has attended no other institution in the intervening period, will be considered for reinstatement after making an application to the Undergraduate Director. If the student has attended another institution and completed more than 12 credits, then the student must reapply through the University's Office of Admission and Financial Aid in accordance with the procedure for transfer applicants from other colleges or universities.

## 3.7 Graduation Requirements

In order to graduate with a Bachelor of Science in Engineering in the Mechanical Engineering program:

1. A student must have satisfactorily completed all required courses, as defined in [Chapter 2](#), for a total of at least 128 credits.
  - (a) All of the courses taken for fulfillment of the degree requirements must be taken with the Letter Grade Option. The only exception is for courses through University of Pittsburgh International Programs, which are taken pass/fail (S/U).
  - (b) Advanced standing credit accepted by the Swanson School of Engineering may partially fulfill degree requirements, up to a maximum of 96 credits.
  - (c) Only credits approved by the Mechanical Engineering and Materials Science Undergraduate Director count towards the 128-credit requirement. In particular, remedial writing, remedial mathematics, PEDC, and AFROTC credits will not count towards this requirement.
  - (d) No course in which an “F” or a non-letter grade was received can be used to satisfy the 128-credit requirement. A minimum “D–” letter grade is required.
2. A student must have a cumulative GPA of at least 2.00.
3. The work of the senior year (a minimum of 26 credits) must be completed while in residence at the Swanson School of Engineering. Exceptions to this regulation may be granted for a limited number of credits through petition to the department.

Students must complete an Application for Graduation form in the term that they are graduating. This form is available in the Undergraduate Program Office and on the [Undergraduate/Student Resources](#) page of the department’s website. After completing the form, students turn it in to the Engineering Office of Administration. Students should pay attention to the application deadlines to avoid late fees. The deadlines are posted online.

- It is suggested that students schedule an appointment with their advisor to review their records in the term preceding the term in which they plan to graduate, in order to make sure everything is in order. It is the students’ responsibility to meet all of the department’s requirements for graduation.
- During the add/drop period of the term that a student is planning to graduate, students must notify the MEMS Department’s Undergraduate Academic Administrator. The MEMS Undergraduate Director will then review each student’s records and communicate to the student what needs to be done in order to complete his/her graduation requirements. It is important that this happens during the add/drop period, in case there are any changes required to a student’s academic schedule.

To be considered for honors at graduation, a student must earn at least 68 letter grade credits at the University of Pittsburgh. The minimum cumulative GPA for graduation cum laude is 3.25, for magna cum laude is 3.50, and for summa cum laude is 3.75.

### **3.7.1 Statute of Limitations**

All required academic work for the Bachelor of Science degree in Engineering, including courses for which advanced-standing credit has been granted, must be completed within 12 consecutive calendar years. Under unusual circumstances a student may, with the approval of the Undergraduate Director, request a waiver of this policy.

# Chapter 4

## Registration

A lot of useful information and many of the necessary forms associated with registration can be found on the [Undergraduate/Student Resources](#) page of the department's website. These and other forms are also available in the Undergraduate Program Office, 636 Benedum Hall.

### 4.1 Self-Enrollment

Students enroll for courses on-line. There is an interactive video on the Student Services Portal on <https://my.pitt.edu> that provides step-by-step instructions on how to register and process add/drops.

- Prior to each term, students will be provided with an Enrollment Appointment, which is the date and time at which they may begin registering for courses. The Enrollment Appointments are based on seniority (seniors first, then juniors, etc.).
- All students will initially have an “Academic Advisement Required” hold on their account, which will prevent them from self-enrolling. Students should meet with their advisors to resolve questions regarding their curricular schedules. After it has been documented that a student has been advised, we are authorized to remove the student's hold. Ideally a student's hold should be removed before his/her Enrollment Appointment.

All full-time engineering students are expected to register for a normal full term of academic courses (i.e., 12–18 credits). No student will be allowed to register for more than 18 credits without specific written permission from the Undergraduate Director and approval by the Associate Dean for Academic Affairs. Such permission is given selectively and only after a review of the student's record and planned course work suggests that such an overload is academically justifiable. All credits over 18 will be billed over and above the full-time tuition rate at the prevailing per-credit tuition charge.

### 4.2 PCHE Cross-Registration

Cross-college and cross-university registration is a program designed to provide for enriched educational opportunities for undergraduates at any of the ten institutions that comprise

the Pittsburgh Council on Higher Education (PCHE): Carnegie Mellon, Carlow College, Chatham College, Community College of Allegheny County, Duquesne University, Point Park College, LaRoche College, Robert Morris College, Pittsburgh Theological Seminary, and the University of Pittsburgh. Under the terms of this program, full-time students at any one of these institutions are granted the opportunity to enroll for a maximum of six credits per term at any of the other institutions. Each institution provides the others with lists of those courses approved by department chairpersons as being open to cross-registration. Such courses must be selected from those regularly accredited toward baccalaureate programs, and a student registering for them must meet all prerequisites. Priority in registration goes to the students of the host college. Credits and grades are transferred.

The following limitations apply:

- Cross-registration is available only during the Fall and Spring Terms.
- Undergraduates and post-baccalaureate students must be registered for a total of at least 12 credits (including the cross-registration credits).
- Students may not cross-register for courses available at the home institution.
- Students cannot use cross-registration to repeat courses taken at the University of Pittsburgh.
- Once a student is enrolled in the Mechanical Engineering and Materials Science Department, he/she is not permitted to take courses at the Community College of Allegheny County or any other two-year institution as part of his/her engineering education.
- Students may not use cross-registration to take courses that are not acceptable for an Engineering degree.
- The grading system for a cross-registered course is determined by the college or university that offers the course. The student must also follow that school's procedures and deadlines for add/drop, etc.

Cross-registration takes place during the add/drop period, ending the last day of the University of Pittsburgh's add/drop period. Interested students should go to the Engineering Office of Administration, 151 Benedum Hall, for a PCHE registration form and additional instructions.

### 4.3 Internal Transfers

Students wishing to transfer into the Swanson School of Engineering from another University of Pittsburgh undergraduate school or college, or from a University of Pittsburgh regional campus, should consult the [information page](#) for internal transfer students on the Swanson School of Engineering website.

A student in another Swanson School of Engineering program, whose academic record satisfies the minimum requirements for continued registration, may apply for transfer into

the Mechanical Engineering program by submitting an Undergraduate Academic Program Change form to their current program's administration office. Once approved by the current program's Undergraduate Director, the student's records will be sent to the MEMS department for evaluation. It is then the prerogative of the MEMS department to either approve or reject the change-of-status transfer request.

## 4.4 External Transfers

Students wishing to transfer into the Swanson School of Engineering from another college or university should consult the [information page](#) for external transfer students on the Swanson School of Engineering website. To be considered for admission, a student must:

- Have a GPA of at least 3.0. Community college students must have a GPA of at least 3.25.
- Have completed at least 24 credits appropriate for engineering, including two semester sequences of calculus, chemistry, calculus-based physics, and computer programming in C or C++.

If a student has fewer than 24 credits, then his/her high school record will also be evaluated in the admissions decision.

Advanced standing credit will be granted for college course work at another accredited institution depending on the relevance to the applicant's proposed program in the Swanson School of Engineering and on grades received. Only courses in which the applicant received at least 2.00 on a 4.00 scale will be considered for transfer, and then only if the courses are an integral part of the proposed degree program. See [Section 2.8](#) for more information on the transfer of credit.



# Chapter 5

## Degree Options

Brief descriptions of some of the degree options available to students in the Mechanical Engineering and Materials Science Department are given below. More information, including links to specific web sites for each of the degree options listed below, is available online at <https://www.engineering.pitt.edu/mems>.

### 5.1 Cooperative Education Program

The Cooperative Education (Co-op) Program at Pitt is one of the most exciting opportunities available to engineering students. By alternating work and school terms, the co-op program provides students with relevant, challenging, paid work assignments with local, national, or international employers.

The program integrates a rotation of school and employment terms that enables the cooperative education student to complement his or her formal classroom training with additional technical knowledge, hands-on experience, and financial remuneration. The co-op graduate possesses the maturity and assurance of a more seasoned employee and the ability to incorporate academic knowledge and theory into practice. During co-op rotations, students earn competitive salaries, which makes this program also financially rewarding.

Mechanical Engineering and Materials Science students have the option of using their co-op credits (ENGR 1090) towards one of the technical electives in the curriculum, provided that a technical paper is submitted to the department. The guidelines and due dates for the co-op paper are available on the [Undergraduate/Student Resources](#) page of the department's website.

The co-op option is available to all engineering undergraduates. Students must be in good academic standing (minimum 2.00 GPA) and must be eligible to complete a minimum of three work terms. Most students begin during the sophomore year and complete the program during the senior year. Students who are interested in participating in the co-op program should contact the Cooperative Education Program Office, located on the first floor of Benedum Hall.

## 5.2 Engineering Minors

Undergraduate students in the Mechanical Engineering and Materials Science department can choose to enhance their education by minoring in another engineering area of interest. Each of the departments in the School of Engineering offers at least one minor. Descriptions of these minors and their requirements are available online.

## 5.3 Arts and Sciences Minors

Many departmental minors are available in programs offered by the Dietrich School of Arts and Sciences, including architectural studies, computer science, economics, history, mathematics, and physics. Students must complete at least half of the credits earned for a minor at the University of Pittsburgh and must complete a minor with at least a 2.00 GPA.

## 5.4 Certificate Programs

Swanson School of Engineering undergraduate students are encouraged to broaden their educational experience by electing to take one of the certificate programs currently offered by the Dietrich School of Arts and Sciences, the University Center for International Studies, and the Swanson School of Engineering. Typically, the certificate programs may be used by engineering students to partially fulfill the humanities/social sciences or technical elective requirements, thereby allowing specialization in an area of interest while pursuing an engineering degree. The requirements for each certificate vary, and students should contact the appropriate certificate program director.

The Swanson School of Engineering offers thirteen certificates at the undergraduate level:

- Civil Engineering and Architectural Studies
- Conceptual Foundations of Medicine
- Energy Resource Utilization
- Engineering for Humanity
- Engineering Simulation
- Fessenden Honors Engineering
- Health Systems Engineering
- Innovation, Product Design, and Entrepreneurship
- International Engineering Studies
- NanoScience and Engineering
- Nuclear Engineering

- Supply Chain Management
- Sustainable Engineering

## **5.5 Arts and Sciences-Engineering Joint Degree Program**

The Dietrich School of Arts and Sciences and the Swanson School of Engineering have developed an undergraduate joint degree program that permits students to combine a major in arts and sciences with a program in engineering and then receive degrees from both the Dietrich School of Arts and Sciences and the Swanson School of Engineering. Students can apply for admission into the program through either the Dietrich School of Arts and Sciences or the Swanson School of Engineering and must be admitted into both schools.

## **5.6 Engineering-School of Education Certification Program**

Engineering students may apply for a fifth-year program that leads to mathematics, general science, or physics teaching certification from the School of Education. Students who complete the program are qualified to teach in the Commonwealth of Pennsylvania. Students interested in pursuing this option should apply prior to the start of their junior year.

## **5.7 University Honors College**

The University Honors College is something of a paradox: Though headquartered in a newly renovated suite at the University of Pittsburgh's Cathedral of Learning, it's not really a bricks-and-mortar school within the University. And although UHC offers specific courses and the bachelor of philosophy degree, the options are available to any student (in any major) who demonstrates an extraordinary ability to pursue independent scholarship.

## **5.8 Emerging Leaders Program**

Emerging Leaders introduces participants to four fundamentals of leadership; self-knowledge, valuing others, personal accountability, and integrity. Learners explore these topics while building skills in group dynamics, conflict management, power and influence, diversity, ethics, and life-work planning. This 10-week program provides learners with opportunities to:

- Explore and assess your leadership skills and style.
- Practice and experiment with new leadership behavior.
- Receive feedback on your style and behavior.
- Plan for your on-going leadership development.

## **5.9 International Education**

The Swanson School of Engineering is making a concerted effort to expand students' knowledge through international education. As the world becomes increasingly interconnected and globalization is a way of life, engineering students must understand how to operate in a global manner to remain competitive. The school's programs provide opportunities for students to broaden their horizons in numerous ways.

## **5.10 Receiving Graduate Credit**

An undergraduate student who intends to continue towards an advanced degree may arrange to schedule a limited number of courses for graduate credit during the next to the last term or final term of registration for the B.S. degree. Approval will be granted only if the student's total program for the term does not exceed 18 credits. A maximum of 6 credits can be applied to a master's degree program. These credits will only apply to graduate degree requirements.

## **5.11 Combined Liberal Arts & Engineering 3/2 Programs with Other Colleges and Universities**

The Swanson School of Engineering has developed combined liberal arts and engineering joint-degree programs with a number of accredited liberal arts colleges and universities. These programs are typically referred to as 3/2 programs, since the student initially enrolls at the liberal arts institution, completing a three-year structured program. Those first three years usually include the general education requirements for the liberal arts degree, specific courses in areas of concentration required for all engineering programs, and the courses necessary for acceptance to the Swanson School of Engineering. With the recommendation of the review committee at the liberal arts institution, the student then applies for transfer to the Swanson School of Engineering. If accepted, the student spends the final two years in the Mechanical Engineering program.

At the request of the student, his or her Swanson School of Engineering academic record will be forwarded to the liberal arts institution for evaluation, and a liberal arts degree will be awarded in accordance with the policy of the liberal arts institution. The engineering degree will be awarded upon completion of the engineering requirements.

Interested students should be referred to the Director of Freshman Programs for specific information and requirements. The 3/2 agreements and articulation agreements should be followed very closely. If students take courses that are not listed on the 3/2 agreement, the classes most likely will not transfer.

## APPENDICES



# Appendix A - ME Curriculum Checklist

Name: \_\_\_\_\_

Date: \_\_\_\_\_

Course	Credits	Course Title	Prerequisites/Corequisites
CHEM0960	3 _____	Gen. Chem. for Engr. 1	
CHEM0970	3 _____	Gen. Chem. for Engr. 2	CHEM0960
MATH0220	4 _____	Anal. Geometry & Calc. 1	
MATH0230	4 _____	Anal. Geometry & Calc. 2	MATH0220 (C or better)
MATH0240	4 _____	Anal. Geometry & Calc. 3	MATH0230 (C or better)
MATH0280	3 _____	Matrices & Linear Algebra	MATH0220
MATH0290	3 _____	Differential Equations	MATH0230
PHYS0174	4 _____	Phys. for Sci. & Engr. 1	<i>MATH0220</i> <sup>1</sup>
PHYS0175	4 _____	Phys. for Sci. & Engr. 2	PHYS0174, <i>MATH0230</i>
_____	3 _____	Humanity Elective	
_____	3 _____	Social Science Elective	<u>Student has fulfilled</u>
_____	3 _____	Humanity/Soc. Sci. Elective	<input type="checkbox"/> Breadth
_____	3 _____	Humanity/Soc. Sci. Elective	<input type="checkbox"/> Depth
_____	3 _____	Humanity/Soc. Sci. Elective	<input type="checkbox"/> W-course
_____	3 _____	Humanity/Soc. Sci. Elective	
_____	3 _____	Communication Skills Elective	
ENGR0011	3 _____	Intro. to Engr. Analysis	
ENGR0012	3 _____	Engr. Computing	ENGR0011
ENGR0022	3 _____	Mater. Struct. & Properties	MATH0230, PHYS0174
ENGR0135	3 _____	Statics & Mech. of Mater. 1	MATH0230, PHYS0174
ENGR0145	3 _____	Statics & Mech. of Mater. 2	ENGR0135
_____	3 _____	Engineering Elective	
MEMS0024	3 _____	Intro. to ME Design	ENGR0011
MEMS0031	3 _____	Electrical Circuits	PHYS0175, <i>MATH0290</i>
MEMS0040	3 _____	Materials & Manufacturing	ENGR0022
MEMS0051	3 _____	Intro. to Thermodynamics	PHYS0174, CHEM0960, <i>MATH0290</i>
MEMS0071	3 _____	Intro. to Fluid Mechanics	PHYS0174, CHEM0960, <i>MATH0290</i>
MEMS1014	3 _____	Dynamic Systems	MATH0280, ENGR0012, MEMS0031, MEMS1015
MEMS1015	3 _____	Rigid-Body Dynamics	MATH0240, ENGR0135
MEMS1028	3 _____	Mechanical Design 1	ENGR0145
MEMS1029	3 _____	Mechanical Design 2	MEMS0024, MEMS1028
MEMS1041	3 _____	Mechanical Measurements 1	ENGR0145, MEMS0031, <i>MEMS1014</i>
MEMS1042	3 _____	Mechanical Measurements 2	MEMS1041
MEMS1043	3 _____	Senior Design Project	<i>Senior Standing</i>
MEMS1051	3 _____	Applied Thermodynamics	MEMS0051
MEMS1052	3 _____	Heat and Mass Transfer	MEMS0051
MEMS1071	3 _____	Applied Fluid Mechanics	MEMS0071
_____	3 _____	ME Technical Elective	
_____	3 _____	ME Technical Elective	
_____	3 _____	ME Technical Elective	
_____	3 _____	Dynamic Systems Elective	

<sup>1</sup>Italicized courses indicate corequisites, that is, courses that must be taken before or concurrently.



## Appendix B - ME Course Offerings by Term

To assist you in long term schedule planning, a term-by-term listing of course offerings is provided below. This schedule will be especially helpful to students who decide to enroll in the co-op program.

Course Number	Fall Term	Spring Term	Summer Term
ENGR0022	•	•	
ENGR0135	•	•	•
ENGR0145	•	•	•
Engr. Electives	•	•	•
MEMS0024	•		
MEMS0031		•	•
MEMS0040		•	•
MEMS0051		•	•
MEMS0071	•	•	
MEMS1014	•	•	
MEMS1015		•	•
MEMS1028	•	•	
MEMS1029		•	•
MEMS1041	•	•	
MEMS1042	•	•	•
MEMS1043	•	•	•
MEMS1051	•	•	
MEMS1052	•		•
MEMS1071		•	•
MEMS1085	•	•	
Tech. Electives	•	•	
Dyn. Sys. Elec.	•	•	

- Note that, in general, Mechanical Engineering Technical Electives are only offered during the Fall and Spring Terms.
- This is a tentative schedule that is subject to change. However, changes will not be made without appropriate accommodation for students' existing plans.



## Appendix C - ME Sample Schedule

Shown below is an example of a schedule of courses that leads to a B.S. in Mechanical Engineering in four years. It satisfies all of the relevant course prerequisites and the Mechanical Engineering degree requirements.

### FIRST TERM

Subject	Credits
CHEM0960 Gen. Chem. for Engr. 1	3
MATH0220 Anal. Geometry & Calc. 1	4
PHYS0174 Phys. for Sci. & Engr. 1	4
ENGR0011 Intro. to Engr. Analysis	3
<i>Humanity/Soc. Sci. Elective</i>	3
ENGR0081 Freshman Seminar	<u>0</u>
	17

### SECOND TERM

Subject	Credits
CHEM0970 Gen. Chem. for Engr. 2	3
MATH0230 Anal. Geometry & Calc. 2	4
PHYS0175 Phys. for Sci. & Engr. 2	4
ENGR0012 Engr. Computing	3
<i>Humanity/Soc. Sci. Elective</i>	3
ENGR0082 Freshman Seminar	<u>0</u>
	17

### THIRD TERM

Subject	Credits
MATH0240 Anal. Geometry & Calc. 3	4
MATH0280 Matrices & Linear Algebra	3
ENGR0022 Mater. Struct. & Properties	3
ENGR0135 Statics & Mech. Mater. 1	3
MEMS0024 Intro. to ME Design	3
MEMS1085 Departmental Seminar	<u>0</u>
	16

### FOURTH TERM

Subject	Credits
MATH0290 Differential Equations	3
ENGR0145 Statics & Mech. Mater. 2	3
MEMS0031 Electrical Circuits	3
MEMS0051 Intro. to Thermodynamics	3
MEMS1015 Rigid-Body Dynamics	3
<i>Communication Skills Elective</i>	3
MEMS1085 Departmental Seminar	<u>0</u>
	18

### FIFTH TERM

Subject	Credits
MEMS0071 Intro. to Fluid Mechanics	3
MEMS1014 Dynamic Systems	3
MEMS1028 Mechanical Design 1	3
<i>Engineering Elective</i>	3
<i>Humanity/Soc. Sci. Elective</i>	3
MEMS1085 Departmental Seminar	<u>0</u>
	15

### SIXTH TERM

Subject	Credits
MEMS0040 Materials & Manufacturing	3
MEMS1029 Mechanical Design 2	3
MEMS1041 Mechanical Measurements 1	3
MEMS1051 Applied Thermodynamics	3
<i>Humanity/Soc. Sci. Elective</i>	3
MEMS1085 Departmental Seminar	<u>0</u>
	15

### SEVENTH TERM

Subject	Credits
MEMS1042 Mechanical Measurements 2	3
MEMS1052 Heat and Mass Transfer	3
<i>ME Technical Elective</i>	3
<i>Dynamic Systems Elective</i>	3
<i>Humanity/Soc. Sci. Elective</i>	3
MEMS1085 Departmental Seminar	<u>0</u>
	15

### EIGHTH TERM

Subject	Credits
MEMS1043 Senior Design Project	3
MEMS1071 Applied Fluid Mechanics	3
<i>ME Technical Elective</i>	3
<i>ME Technical Elective</i>	3
<i>Humanity/Soc. Sci. Elective</i>	3
MEMS1085 Departmental Seminar	<u>0</u>
	15



## Appendix D - Co-op Schedule Form

Student Name: \_\_\_\_\_

Department: \_\_\_\_\_

Anticipated Co-op Start Date: \_\_\_\_\_

Current Status (circle one):      Sophomore 2      Junior 1      Junior 2      Senior 1

	<i>Fall</i>	<i>Spring</i>	<i>Summer</i>
<i>Year 1</i>	_____ _____ _____ _____	_____ _____ _____ _____	_____ _____ _____ _____
<i>Year 2</i>	_____ _____ _____ _____	_____ _____ _____ _____	_____ _____ _____ _____
<i>Year 3</i>	_____ _____ _____ _____	_____ _____ _____ _____	_____ _____ _____ _____
<i>Year 4</i>	_____ _____ _____ _____	_____ _____ _____ _____	_____ _____ _____ _____
<i>Year 5</i>	_____ _____ _____ _____	_____ _____ _____ _____	_____ _____ _____ _____

Co-op Advisor's Signature: \_\_\_\_\_

Date: \_\_\_\_\_

Student's Signature: \_\_\_\_\_

Date: \_\_\_\_\_

Any changes in scheduling *must* be approved by your faculty advisor. The co-op office will not be responsible for students who deviate from their schedules without departmental approval.



## Appendix E - ME Co-op Schedule A

Student Name: \_\_\_\_\_

Department: \_\_\_\_\_

Anticipated Co-op Start Date: \_\_\_\_\_

Current Status (circle one):      Sophomore 2      Junior 1      Junior 2      Senior 1

	<i>Fall</i>	<i>Spring</i>	<i>Summer</i>
<i>Year 1</i>	CHEM0960 MATH0220 PHYS0174 ENGR0011 <i>Soc. Sci./Hum.</i>	CHEM0970 MATH0230 PHYS0175 ENGR0012 <i>Soc. Sci./Hum.</i>	
<i>Year 2</i>	MATH0240 MATH0280 ENGR0022 ENGR0135 MEMS0024	MATH0290 ENGR0145 MEMS0031 MEMS0051 MEMS1015	<b>Work Rotation</b>
<i>Year 3</i>	MEMS0071 MEMS1014 MEMS1028 MEMS1051 <i>Engr. Elective</i>	<b>Work Rotation</b>	MEMS0040 MEMS1029 MEMS1052 <i>Soc. Sci./Hum. Comm. Skills</i>
<i>Year 4</i>	<b>Work Rotation</b>	MEMS1041 <i>ME Tech. Elec. ME Tech. Elec. Dyn. Sys. Elec. Soc. Sci./Hum.</i>	MEMS1042 MEMS1043 MEMS1071 <i>Soc. Sci./Hum. Soc. Sci./Hum.</i>
<i>Year 5</i>	_____	_____	_____
	_____	_____	_____
	_____	_____	_____
	_____	_____	_____

Co-op Advisor's Signature: \_\_\_\_\_

Date: \_\_\_\_\_

Student's Signature: \_\_\_\_\_

Date: \_\_\_\_\_

Any changes in scheduling *must* be approved by your faculty advisor. The co-op office will not be responsible for students who deviate from their schedules without departmental approval.



## Appendix F - ME Co-op Schedule B

Student Name: \_\_\_\_\_

Department: \_\_\_\_\_

Anticipated Co-op Start Date: \_\_\_\_\_

Current Status (circle one):      Sophomore 2      Junior 1      Junior 2      Senior 1

	<i>Fall</i>	<i>Spring</i>	<i>Summer</i>
<i>Year 1</i>	CHEM0960 MATH0220 PHYS0174 ENGR0011 <i>Soc. Sci./Hum.</i>	CHEM0970 MATH0230 PHYS0175 ENGR0012 <i>Soc. Sci./Hum.</i>	
<i>Year 2</i>	MATH0240 MATH0280 ENGR0022 ENGR0135 MEMS0024	<b>Work Rotation</b>	MATH0290 ENGR0145 MEMS0031 MEMS0051 MEMS1015
<i>Year 3</i>	<b>Work Rotation</b>	MEMS0071 MEMS1014 MEMS1028 <i>Engr. Elective Comm. Skills</i>	<b>Work Rotation</b>
<i>Year 4</i>	MEMS1041 MEMS1051 MEMS1052 <i>ME Tech. Elec. Soc. Sci./Hum.</i>	MEMS0040 MEMS1029 <i>ME Tech. Elec. Dyn. Sys. Elec. Soc. Sci./Hum.</i>	MEMS1042 MEMS1043 MEMS1071 <i>Soc. Sci./Hum. Soc. Sci./Hum.</i>
<i>Year 5</i>	_____ _____ _____ _____	_____ _____ _____ _____	_____ _____ _____ _____

Co-op Advisor's Signature: \_\_\_\_\_

Date: \_\_\_\_\_

Student's Signature: \_\_\_\_\_

Date: \_\_\_\_\_

Any changes in scheduling *must* be approved by your faculty advisor. The co-op office will not be responsible for students who deviate from their schedules without departmental approval.