

UNIVERSITY OF PITTSBURGH

Materials Science & Engineering

Undergraduate Academic Program Manual

Dr. Minking Chyu
Chairman

Dr. William S. Slaughter
Undergraduate Director

University of Pittsburgh
Mechanical Engineering and Materials Science Department
648 Benedum Hall
3700 O'Hara Street
Pittsburgh, PA 15261
Phone: (412)624-9780
Fax: (412)624-4846

Web Address: www.engr.pitt.edu/mems

For information regarding admissions and financial aid, see
www.engr.pitt.edu/admissions/undergraduate.html

October 7, 2009

Forward

This *Materials Science and Engineering Undergraduate Academic Program Manual* is a supplement to the information provided on the *University of Pittsburgh School of Engineering Web Site* (www.engr.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 School of Engineering Web Site, as well as some relevant information from the School of Engineering Web Site.¹ It is provided so that you will be better informed about your department and for your convenience in monitoring your progress towards completion of your degree.

¹If there are any discrepancies between the *Materials Science and Engineering Undergraduate Academic Program Manual* and the *School of Engineering Web Site*, then the ultimate authority is the *School of Engineering Web Site*.

Table of Contents

1	About Materials Science & Engineering	1
1.1	Program Educational Objectives	1
1.2	Curriculum Overview	2
1.2.1	Engineering Design	3
1.2.2	Teamwork	3
1.2.3	Written and Oral Communication	3
1.2.4	Computer Experience	4
1.2.5	Laboratory Experience	4
1.2.6	Student Development in Engineering Professional Practice	5
2	Undergraduate Curriculum	7
2.1	Required Materials Science & Engineering Courses	7
2.2	Other Required Courses	10
2.3	Technical Electives	12
2.3.1	Technical Elective Course Descriptions	13
2.4	Humanities and Social Science Electives	17
2.5	Communication Skills Elective	19
2.6	Advanced Standing and Transfer Credit	20
2.6.1	Advanced Placement (AP) Credit	20
2.6.2	Transfer Credit for Courses Taken After Enrollment	20
2.7	Academic Advising	21
2.7.1	Undergraduate Resources Web Page	21
3	Academic Policy	23
3.1	Grading System	23
3.1.1	Letter Grades	23
3.1.2	Other Grades: Incomplete, Withdrawn, Resigned	23
3.2	Withdrawal	24
3.3	Calculation of the Grade Point Average	24
3.3.1	Course Repeats	25
3.4	Academic Honors	25
3.4.1	Term Honor List	25
3.4.2	Dean's Honor List	25
3.5	Academic Discipline	25
3.5.1	Warning	25

3.5.2	Probation	26
3.5.3	Suspension	26
3.5.4	Dismissal	26
3.6	Graduation Requirements	26
3.6.1	Statute of Limitations	27
3.6.2	Reinstatement	27
4	Registration	29
4.1	Self-Enrollment	29
4.2	PCHE Cross-Registration	30
4.3	Interdepartmental Transfers	30
4.4	Transfer Students from Other Universities	31
4.4.1	Regional Transfers	31
5	Degree Options	33
5.1	Arts and Sciences-Engineering Joint Degree Program	33
5.2	Engineering-School of Education Certification Program	33
5.3	Certificate Programs	33
5.4	University Honors College	34
5.5	PCHE Cross-Registration Program	34
5.6	Cooperative Education Program	34
5.7	School of Engineering Minors	35
5.8	School of Arts & Sciences Minors	35
5.9	Emerging Leaders Program	35
5.10	International Education	36
5.11	Receiving Graduate Credit	36
5.12	Combined Liberal Arts & Engineering 3/2 Programs	36
	Appendix A - MSE Curriculum Checklist	39
	Appendix B - MSE Sample Schedule	41
	Appendix C - MSE Course Offerings by Term	43
	Appendix D - Co-op Schedule Form	45
	Appendix E - MSE Co-op Schedule A	47
	Appendix F - MSE Co-op Schedule B	49

Chapter 1

About Materials Science & Engineering

Materials limitations often impede technological and social progress. The materials engineer applies special knowledge of the structure, behavior, and properties of materials to solve these materials problems. The engineer may be concerned with developing and improving processes for producing materials, developing new materials or improving existing materials, and/or achieving better utilization of materials. New materials must be designed for a variety of functions, e.g., structural, aesthetic, electrical, or magnetic, and operating environments. Materials are dealt with in forms so minute that the work is done under a microscope and so large that special handling cranes are required.

Materials Science and Engineering is a relatively new field and a very interdisciplinary one. MSE is a field for students who genuinely want to be involved with using engineering science at the cutting edge of today's technological world. Modern MSE creates the "stuff" out of which we fabricate our society, using concepts of engineering design from the microscopic level of atoms, molecules, and electrons to the macroscopic scale of bridges, machines, motors, turbine engines, and supersonic aircraft.

A major attraction of this major is the breadth of career opportunities available to graduates because of the impact and influence of materials on an ever-greater number of critical manufacturing and processing technologies and because of their critical role in vital areas such as transportation, energy, and communications. Materials scientists and engineers are heavily recruited by the primary metallurgical, aerospace, and electronics industries. Moreover, opportunities are growing in the emerging biomedical/bioengineering technologies.

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.

1.1 Program Educational Objectives

Consistent with the criteria set by ABET, the overall educational objective of the undergraduate programs in the Department of Mechanical Engineering and Materials Science is to educate students with excellent technical capabilities in the materials science and engineering

discipline and related fields, who will be responsible citizens and continue their professional advancement through life-long learning.

The objectives of the Materials Science and Engineering program are to

- Prepare students to assume positions of technical leadership in industries that require their specialized knowledge of materials science and engineering.
- Provide students with an education, grounded in the fundamentals, enabling them to succeed in graduate studies and research in materials science and engineering.
- Encourage students to remain committed and engaged in the discipline of materials science and engineering throughout their careers.
- Provide students with a comprehensive education in engineering science that will prepare them to succeed in management positions in industry or other professional careers (e.g., teaching or law).

1.2 Curriculum Overview

The Materials Science and Engineering 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 Materials Science and Engineering curriculum concentrates on the fundamentals of the sciences, mathematics, and engineering. The last two years provide increased depth in the engineering sciences, including heat and mass transfer, energetics, and the structure and properties of materials, and in engineering applications such as experimental methods, mechanical design, and material selection. Students have the freedom to pursue areas of personal interest in materials science and 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 social, political and economic problems in the practice of engineering. Where appropriate, the upper-level Materials Science and Engineering courses introduce consideration of human values, social benefits, and social constraints to prepare future practicing engineers to be responsive to such concerns.

The following undergraduate programs are available in our department:

- Bachelor of Science in Materials Science and Engineering (Chapter 2, page 7)
- Bachelor of Science in Materials Science and Engineering via the 3/2 Program (Section 5.12, page 36)
- Combined CAS-Engineering Joint Degree (Section 5.1, page 33)
This program requires *all* of the requirements for two degrees, such as Computer Science and Materials Science and Engineering, to be fulfilled. This program usually takes 5–6 years to complete.

In addition, each of the departments in the School of Engineering offers minors in such diverse areas as bioengineering, petroleum engineering and environmental engineering (Section 5.7,

page 35). A student may earn a minor along with a Bachelor of Science in Materials Science and Engineering. Each of the above degrees can be obtained in conjunction with the co-op engineering program (Section 5.6, page 34).

1.2.1 Engineering Design

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-assisted engineering design tools. The primary tool introduced is Pro/ENGINEER™, an integrated software package that allows development of parametric tools in two and three dimensions. The student also addresses design problems in mechanics, manufacturing, 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, heat and mass transfer, and experimental methods.

Design is a large part of the senior year. Design problems in material selection 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 a part of a team. Students also learn about other important facets of materials science and engineering, including ethical issues and meeting budget and schedule constraints.

1.2.3 Written and Oral Communication

A materials scientist and 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. During the sophomore or junior year, students are required to take a Communication Skills Elective (Section 2.5, page 19). 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. Each presentation is video taped and students are required to view the video of their talk.

1.2.4 Computer Experience

Computer experience is distributed throughout the Materials Science and 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 MatlabTM in addition to the programming languages C and HTML.

In the sophomore year, students learn to use Pro/ENGINEERTM, an integrated software package that allows development of parametric models in two and three dimensions and generates design drawings.

In addition, many of the technical electives involve extensive use of computers. For example, COMPUTER APPLICATIONS IN MSE utilizes software packages developed for applications such as diffraction, thermodynamics, and electronic materials.

1.2.5 Laboratory Experience

Laboratory experience is an important component of the Materials Science and Engineering undergraduate curriculum. This experience comes primarily through three courses, beginning in the junior year.

EXPERIMENTAL METHODS IN MSE gives students practical experience of the experimental methods used in modern materials science and engineering. The first set of experiments introduces the common methods for analyzing material structure including: optical microscopy, X-ray diffraction, and scanning electron microscopy (SEM). The second part of the course concentrates 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.

STRUCTURES & PROPERTIES LABORATORY builds on the students experience of experimental methods 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 crosslinking in a thermosetting polymer.

The SENIOR MATERIALS RESEARCH PROJECT is a major project involving literature search, planning, experimentation, analysis, an oral presentation, and a final technical report. The project is either sponsored by the department or a local company and is conducted by an individual or a small team of students with a faculty adviser.

1.2.6 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 is a student chapter of the American Society for Metals (ASM) International, a professional society for materials scientists and engineers whose mission is to gather, process, and disseminate technical information. ASM fosters the understanding and application of engineered materials and their research, design, reliable manufacture, use, and economic and social benefits. This is accomplished via a unique global information-sharing network of interaction among members in forums and meetings, education programs, and publications and electronic media.

Chapter 2

Undergraduate Curriculum

The requirements for obtaining a Bachelor of Science (B.S.) degree in Materials Science and 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 three (3) Materials Science and Engineering Technical Electives, six (6) Social Science and Humanities Electives, and one (1) Communication Skills Elective. There are a total of 128 passed units required for graduation, all of which must be taken with the letter grade option.

2.1 Required Materials Science & Engineering Courses

Students must satisfactorily complete the following seventeen (17) Materials Science and Engineering courses, for a total of forty-seven (47) units.

MEMS 0024 **INTRODUCTION TO MECHANICAL ENGINEERING DESIGN (3 units)**
Provides knowledge of design graphics and manufacturing processes by conventional and computer-aided methods. Prerequisite: ENGR 0011.

MEMS 0031 **ELECTRICAL CIRCUITS (3 units)**
The study of linear circuit networks, including constitutive equations for circuit elements and Ohm's and Kirchoff's laws. Mesh and node equations, Thevenin/Norton equivalents, maximum power transfer, transient and AC analyses, and operational amplifiers. Prerequisite: PHYS 0175. Corequisite: MATH 0290.

MEMS 0040 **MATERIALS & MANUFACTURING (3 units)**
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 units)**
Synthesis of the basic concepts from thermodynamics and fluids, including: properties of pure substances, first law analysis, and introduction to the second law; fluid statics, kinematics, stress, and viscosity; and control volume analysis of the conservation equations. Prerequisites: PHYS 0174, CHEM 0960. Corequisite: MATH 0290.

MEMS 1010 EXPERIMENTAL METHODS IN MSE (3 units)

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 (2 units)

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 crosslinking in a thermosetting polymer. Prerequisite: MEMS 1010.

MEMS 1028 MECHANICAL DESIGN 1 (3 units)

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 1030 MATERIAL SELECTION IN MECHANICAL DESIGN (3 units)

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 1043 SENIOR DESIGN PROJECT (3 units)

A major project involving literature search, planning, design, fabrication, experimentation, analysis, and technical report writing is performed by a small team of students under the guidance of a faculty director and culminates in an oral presentation at a technical symposium. Prerequisite: *senior standing*.

MEMS 1052 HEAT & MASS TRANSFER (3 units)

One and two-dimensional steady and unsteady-state conduction, empirical and practical relations for forced and natural convection. Principle of radiation using “radiation network” method. Heat exchangers and special topics. Prerequisite: MEMS 0051.

MEMS 1054 MATERIALS SCIENCE 1 (3 units)

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 1056 ENERGETICS (3 units)

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 1058 ELECTROMAGNETIC PROPERTIES OF MATERIALS (3 units)

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 1064 MATERIALS SCIENCE 2 (3 units)

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 1054, MEMS 1056.

MEMS 1070 MECHANICAL BEHAVIOR OF MATERIALS (3 units)

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 1079 SENIOR MATERIALS RESEARCH PROJECT (3 units)

A major project involving literature search, planning, experimentation, analysis, an oral presentation, and a final technical report. The project is either sponsored by the department or a local company and is conducted by an individual or a small team of students with a faculty adviser. Prerequisite: *senior standing*.

MEMS 1085 DEPARTMENTAL SEMINAR (0 units)

Seminars are designed to acquaint the student with aspects of 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 fifteen (15) of these courses for a total of fifty-one (51) units.

CHEM 0960 GENERAL CHEMISTRY FOR ENGINEERS 1 (3 units)

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. It includes three hours of lecture per week and one hour of recitation per week. Enrollment is limited to School of Engineering students. An Honors Section is available. (If a student has difficulty enrolling in CHEM 0960, then CHEM 0110 is an acceptable substitute.)

CHEM 0970 GENERAL CHEMISTRY FOR ENGINEERS 2 (3 units)

The course emphasizes applications to industrial and environmental chemistry and biochemistry, building upon material presented in CHEM 0960 or 0110. Enrollment is limited to School of Engineering students. An Honors Section is available. (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 units)

Introduction to engineering analysis and engineering design. Includes units and conversion factors, graphs, data analysis and curve fitting. Use of spreadsheets. Introduction to engineering analysis, including statics, strength of materials, electrical circuits, heat transfer, fluid mechanics, and introduction to rate phenomena. Applications to engineering design. Fundamentals of report writing.

ENGR 0012 ENGINEERING COMPUTING (3 units)

Course is designed to teach students the fundamentals of computing and the concept of engineering design as applied to the design of software. Fundamentals include basic computer organization, formulation of algorithms, basic data structures, pseudo-code, and top-down iterative refinement. In the concurrent laboratory, proficiency is developed in a high-level language and a text editor/word processor. This course is closely linked to ENGR 0011.

ENGR 0020 PROBABILITY & STATISTICS FOR ENGINEERS (4 units)

A basic course in probability and statistics. Topics covered include: data analysis, probability, random variables, discrete and continuous probability distributions, estimation, hypothesis testing, and regression analysis statistical process control. Prerequisite: MATH 0230.

ENGR 0022 MATERIAL STRUCTURE & PROPERTIES (3 units)

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 units)

A basic course in statics and mechanics of materials. Topics covered include the effect of external forces acting on particles and deformable bodies. The free-body diagram is emphasized. Use is made of computers for problem solving. Prerequisites: MATH 0230, PHYS 0174.

ENGR 0145 STATICS & MECHANICS OF MATERIALS 2 (3 units)

An introductory course in the mechanics of deformable solids. Material covers the internal stresses, strains, and displacements that occur when a structure is subjected to applied loads. Open-ended design problems are presented and discussed. Prerequisite: ENGR 0135

MATH 0220 ANALYTIC GEOMETRY & CALCULUS 1 (4 units)

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. Honors Section is also available. Prerequisite: MATH 0032 or MATH 0200.

MATH 0230 ANALYTIC GEOMETRY & CALCULUS 2 (4 units)

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. Honors Section is also available. Prerequisite: MATH 0220.

MATH 0240 ANALYTIC GEOMETRY & CALCULUS 3 (4 units)

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. Honors Section is also available. Prerequisite: MATH 0230.

MATH 0280 INTRODUCTION TO MATRICES & LINEAR ALGEBRA (3 units)

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

MATH 0290 DIFFERENTIAL EQUATIONS (3 units)

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: MATH 0230.

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

First of a sequence of two basic physics courses for science and engineering students. Subjects covered include: kinematics; Newton's laws of motion; energy; momentum, rotational motion, rigid body motion, angular momentum, simple harmonic motion, gravitation, mechanical waves, sound waves, and the kinetic theory of gases. Recitation sections are for discussion of difficult points from the lecture and for reviewing homework assignments. Check time schedule of classes for associated recitation sections. The lecturer may use one of the lecture hours for student teamwork such as computer exercises, dependent on availability of suitable rooms. Corequisite: MATH 0220.

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

Second of a sequence of two basic physics courses for science and engineering students. Subjects covered include: electrostatics, electric currents, magnetism, induction, simple AC circuits, Maxwell's equations, electromagnetic waves, geometric and wave optics, followed by an introduction to quantum physics, including photons, the Bohr atom and spectra, and elementary wave mechanics. Recitation sections are for discussion of difficult points from the lecture and for reviewing homework assignments. Check time schedule of classes for associated recitation sections. The lecturer may use one of the lecture hours for student teamwork such as computer exercises, dependent on availability of suitable rooms. Prerequisite: PHYS 0174. Corequisite: MATH 0230.

2.3 Technical Electives

Students are required to satisfactorily complete three (3) of the following Materials Science and Engineering Technical Elective courses, for a total of nine (9) units. 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:

- Co-op students can earn three (3) units for a written report on their co-op experience, which may be substituted for one of the technical electives.
- Upper-level engineering courses from other engineering departments may be substituted for Materials Science and Engineering 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 a minor (Section 5.7, page 35).
- Technical electives are usually not offered during the Summer Term.
- Students must have completed the proper prerequisites before enrolling in any of the technical electives and should have acquired junior standing.

2.3.1 Technical Elective Course Descriptions

ENGR 1700 INTRODUCTION TO NUCLEAR ENGINEERING (3 units)

Overview course that provides broad subject-area coverage to introduce students to application of theory to practical aspects of nuclear science and technology in the world today with special emphasis on commercial nuclear power. Prerequisites: PHYS 0175; CHEM 0970.

ENGR 1701 FUNDAMENTALS OF NUCLEAR REACTORS (3 units)

Covers the nuclear reactor core and other components inside the reactor pressure vessel. Reactor core physics, energy removal from the core, heat transfer and fluid mechanics, reactor mechanical design, and selection of materials that can withstand the high temperature, high radiation environment of the reactor. Prerequisite: PHYS 0175; CHEM 0970.

ENGR 1702 NUCLEAR PLANT TECHNOLOGY (3 units)

Covers practical applications of nuclear energy to produce power for the generation of electricity or propulsion of mobile systems. Aspects of a nuclear power plant beyond the reactor vessel and the reactor core, prominent types of existing and future nuclear power plants with emphasis on the design and operating characteristics, primary systems and balance of plants systems, standards used in design of nuclear plants. Prerequisite: PHYS 0175; CHEM 0970.

MEMS 1033 FRACTURE MECHANICS FOR MANUF. & PERFORM. (3 units)

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 1057 MICRO/NANO MANUFACTURING (3 units)

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. Prerequisite: MEMS0040.

MEMS 1097 SPECIAL PROJECTS (1–3 units)

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 units)

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 units)

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 units)

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 units)

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 1162 COMPUTER APPLICATIONS IN MSE (3 units)

Applications of computer programming, computer software, and databases for materials science and engineering. Students will first apply computing and statistics fundamentals to solve materials science and engineering problems. Review recently developed software packages such as those of diffraction, thermodynamics, electronic materials, etc. The students will also learn about the techniques for using computerized databases for obtaining information on engineered materials. Prerequisites: MEMS 1052, MEMS 1054, MEMS 1056.

MEMS 1163 CERAMIC MATERIALS (3 units)

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

MEMS 1172 PHYSICAL METALLURGY (3 units)

Concepts introduced in Materials Science I, energetics and materials processing are used to provide an understanding of the development of structure in metals and alloys, and the dependence of properties on structure. Specific topics include dislocations and slip phenomena; twinning; the nature of the cold-worked state; annealing-recovery, recrystallization, and grain growth; textures; grain boundaries and other interfaces; and strengthening mechanisms. Prerequisite: MEMS 1054. Corequisite: MEMS1064.

MEMS 1174 CERAMIC PROCESSING (3 units)

Raw materials, powder, preparation, characterization of powders; forming processes: powder pressing, slipcasting, plastic forming; drying and firing, sintering, and vitrification; special processes. Prerequisites: MEMS 1163.

MEMS 1180 ADVANCED MECHANICAL BEHAVIOR OF MATERIALS (3 units)

Fracture mechanics, design of tough microstructures, fatigue behavior, S-N curves, role of surface condition, statistical approach, strain-life curves, high cycle fatigue, low cycle fatigue, design of fatigue resistant microstructures, creep of materials, processing and properties of composite materials. Prerequisite: MEMS 1070.

MSE 2032 FAILURE OF MATERIALS (3 units)

Principles of continuum mechanics and physical metallurgy are applied in the fundamental description of failure in metals, ceramics, and polymers. After a brief review of the concepts of stress, strain, modes of failure, and fractography, in-depth study is made of fracture mechanics, fatigue failure, fretting, wear, creep, shock loading, and corrosion-assisted failures. Case studies are given throughout to illustrate the methods of load and stress analysis combined with fractography.

MSE 2033 MAGNETIC PROPERTIES OF MATERIALS (3 units)

Magnetic properties of matter; ferro-, ferri-, and anti-ferromagnetism; diamagnetic and paramagnetic substances; magnetostatics; the fundamental quantities in the description magnetic behavior; measurement of magnetic quantities; hysteresis; magnetic domains; magnetic anisotropy; magnetostriction; permeability; coercivity; and hard and soft magnetic materials for engineering applications; thin film and fine-particle behavior.

MSE 2041 ADVANCED PHYSICAL METALLURGY 1 (3 units)

The cold-worked state: point defects, dislocations, crystal plasticity, work hardening, stored energy; dynamic restoration processes: dynamic recovery, dynamic recrystallization, and postdynamic recrystallization; static restoration processes: static recovery, static primary recrystallization; deformation and restoration of two-phase alloys; grain coarsening behavior: normal, abnormal (secondary recrystallization), and tertiary recrystallization; genesis of preferred orientation: inverse and full pole figures, crystallite orientation distribution functions, deformation textures, and recrystallization textures.

MSE 2043 ELECTRON MICROSCOPY IN MATERIALS SCIENCE (3 units)

Electron optics, lens aberrations, depth of field, depth of focus, resolution, contrast, bright and dark field microscopy, selected area diffraction, calibration, specimen preparation, electron scattering, electron diffraction, Bragg's law, Laue conditions, structure factor, Ewald construction, double diffraction, twinning, Kikuchi lines, contrast theory, kinematical theory of diffraction by perfect and imperfect crystals, limitations, column approximation, extinction contours, dynamical theory, special techniques, high voltage microscopy, applications.

MSE 2044 SCANNING ELECTRON MICROSCOPY & EPMA (3 units)

This course is designed to introduce the students to the SEM and associated techniques in particular electron probe microanalysis (EPMA). It will also give an understanding of SEM and EPMA so that users can make the most of these techniques. The course will include demonstrations on a state of the art field emission microscope. Major topics are: Interaction of electrons with solids, Electron optics, Image formation in the SEM, X-ray microanalysis (qualitative and quantitative), Introduction to other techniques, Applications, Special techniques of imaging, Electron backscattering diffraction.

MSE 2045 ADVANCED FERROUS PHYSICAL METALLURGY (3 units)
The first part of the course reviews the basic concepts of the physical metallurgy of plain carbon steels, including the phase diagram and the various phase transformations that can occur. The second part of the course discusses high-strength, low-alloy steels along with their processing and heat treatment. The third part of the course reviews sheet steels for high formability applications. The fourth part of the course discusses specialty steels such as stainless steels and tool steels. Throughout this course, the relationship that exists among composition, processing, microstructure and properties will be emphasized.

MSE 2046 PHYSICAL METALLURGY OF ENGINEERING ALLOYS (3 units)
Property requirements of engineering alloys are discussed: strength, toughness, formability, weldability, fatigue resistance, corrosion/oxidation resistance. Review is made of pertinent phase diagrams, transformations and microstructures in the Fe-Fe₃C and other alloy systems. Composition, processing, microstructure and properties of important structural steels, sheet steels, stainless steels, tool steels, aluminum alloys, titanium alloys, as well as nickel-based and copper-based alloys will be presented. Case studies, design problems and selection criteria are discussed.

MSE 2071 PROPERTIES OF CERAMICS (3 units)
Microstructure of ceramics; principles and application to ceramic products; thermal properties; mechanical properties; elasticity and strength, plastic deformation, and creep.

MSE 2074 SURFACES AND COLLOIDS (3 units)
Concepts from physical chemistry and transport phenomena are extended to study surface and colloidal phenomena, and related applications to materials processing and separations technology. Topics include: molecular theory of surface tension, surface energy surface thermodynamics, adsorption, electrostatic double layer, interparticle forces in aqueous and non-aqueous dispersions, dominant forces on the colloidal and meso-length scale, colloid stability, electrokinetic phenomena, and suspension rheology, surface probes.

MSE 2077 THIN FILM PROCESSES & CHARACTERIZATION (3 units)
This course will be an overview of the major thin film processing methods and the primary techniques to characterize thin surfaces and interfaces. Topics to be included in the first part of the course include: vacuum science and technology, thin-film deposition techniques, such as physical vapor deposition (PVD), molecular beam epitaxy (MBE), and chemical vapor deposition (CVD), as well as the fundamental surface processes of epitaxial growth. In the second part of the course, the principles and applications of modern structural and analytical techniques will be presented that use electrons, photons, ions, etc. to probe the surface, near surface and interface regions. Some of the techniques that will be covered include electron microscopy (including situ), Auger electron spectroscopy (AES), X-ray photoelectron spectroscopy (XPS), atomic force microscopy (AFM) and scanning tunneling microscopy (STM).

MSE 2078 NANOPARTICLES: SCIENCE & TECHNOLOGY (3 units)
This interdisciplinary course introduces students to the science and technology of nanoparticles. Synthesis of nanoparticles will be discussed. Applications of nanoparticles for advanced electronic, magnetic, biomedical, catalysis and other areas will be presented.

2.4 Humanities and Social Science Electives

All School of Engineering undergraduates must complete at least six (6) humanities and social science elective courses, for a total of eighteen (18) units, from the School's list of approved courses (available online at www.engr.pitt.edu/students/electives.html) in order to satisfy School of Engineering and ABET accreditation requirements for breadth and depth. In order to meet these standards, all Materials Science and Engineering undergraduate students must fulfill the following requirements when choosing their six elective classes:

Depth Requirement

- Students must complete two or more courses (only one of which can be an introductory course designated by an asterisk [*]) from one of the departments or programs within the School of Arts and Sciences.
- A student may also 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.

Breadth Requirement

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

Writing Requirement

- All School of Engineering students must also complete at least one “W”-designated course in which the “W” indicates that a course has a substantial writing component, as approved by the School of Arts and Sciences. Students should refer to the Registrar's website each term to determine whether a course is being offered as a “W”-designated course. Note that every School of Arts and Sciences department offers “W”-designated courses, which may or may not satisfy School of Engineering humanities or social science requirements.

Departmental Requirement

- Students must include PHIL 0300 INTRODUCTION TO ETHICS as one of the six Humanities/Social Science courses.

The humanities and social science courses on the School's list of approved course (available online at www.engr.pitt.edu/students/electives.html) satisfy the School of Engineering requirements. However, students may petition the 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 Office (648 Benedum Hall). The form must be turned in to the Associate Dean's Office (323 Benedum Hall) for approval. Students can contact the Undergraduate 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

- No more than two of the required six elective courses can be satisfied via high school Advanced Placement credit.
- If a student has obtained elective credit from a community college prior to enrolling in the School of Engineering, no more than three of the six elective courses can be satisfied via community college credit.
- Courses that are cross-listed with other departments may be taken under either course number (i.e. 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 units are acceptable toward fulfilling the humanities and social science 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 required six 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 requirement. Courses from the College of General Studies (including External Studies courses), the College of Business Administration, or the School of Information Sciences cannot be used to fulfill the humanities and social science requirements.
- Most courses at or above the 100-level by the following departments have been approved as acceptable to satisfy the humanities and social science elective requirements (see www.engr.pitt.edu/students/electives.html for detailed list of approved courses): Africana Studies, Anthropology, Bioethics, Chinese, Classics, Communication, East Asian Studies, Economics, English Literature, English Writing, Film Studies, German, Greek, History, History and Philosophy of Science, History of Art and Architecture, Italian, Japanese, Jewish Studies, Korean, Latin, Linguistics, Medieval and

Renaissance Studies, Music, Philosophy, Polish, Political Science, Portuguese, Religious Studies, Russian, Slavic, Slovak, Sociology, Spanish, Ukrainian, Urban Studies, and Women's Studies.

- Certain courses from the departments of Music, Psychology, Studio Arts, and Theatre Arts may also be acceptable. See www.engr.pitt.edu/students/electives.html for a comprehensive list of School of Engineering-approved humanities and social science courses from the School of Arts and Sciences.

2.5 Communication Skills Elective

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

COMMRC 0500 ARGUMENT (3 units)

This course introduces students to fundamental principles of argument, and develops argument skills through in-class debates.

COMMRC 0520 PUBLIC SPEAKING (3 units)

This course is designed to develop rhetorical understanding and increased skill in public speaking. Students will learn to research, organize, compose and deliver public speeches.

COMMRC 0540 DISCUSSION (3 units)

The purpose of this course is to learn and sharpen discussion and critical thinking skills, which are absolutely essential elements in the process of group decision making. There is a clear trend in the modern world to reduce the decision making power of individuals and increase the influence of groups. This is a hands-on course that will give students practical experience in the process of group decision-making, a valuable and highly marketable skill.

ENGCMP 0400 WRITTEN PROFESSIONAL COMMUNICATION (3 units)

Written Professional Communication prepares students to develop effective plans, written documents and presentations for a variety of professional audiences. Classes are interactive workshops in which students assess and respond to realistic writing scenarios and sample texts. Each student creates a personalized writing portfolio that may be used on the job market. Note that most sections of this class are "W" designated.

ENGR 1010 COMMUNICATION SKILLS FOR ENGINEERS (3 units)

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, and 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.

2.6 Advanced Standing and Transfer Credit

Students transferring into the Mechanical Engineering and Materials Science Department from other college-level programs will have their academic records reviewed for advanced standing credit after they have been accepted for admission (see Section 4.4 on page 31 for more information on how to apply for transfer to the School of Engineering from another college or university). Only the units will transfer for the equivalent class, not the grade or grade point average.

The determination of advanced standing is made by the Undergraduate Director, in accordance with School of Engineering policy and criteria established by the Accreditation Board for Engineering and Technology (ABET). Only courses in which the applicant received at least 2.0 on a 4.0 scale will be considered for transfer, and then only if the courses are an integral part of the proposed degree program. In general, advanced standing for engineering or engineering science courses will be given only if the courses were taken from an ABET-approved engineering program. Advanced standing for mathematics, science, humanities, and social sciences courses will be awarded to the extent that those courses match University of Pittsburgh School of Arts and Sciences courses that are required by the School of Engineering. In particular, humanities and social sciences courses must correspond to those on the School of Engineering's approved list of humanities and social science electives. A maximum of 96 units of transfer credit may be applied towards the degree.

Students transferring from either a college maintaining a 3/2 program with the School of Engineering, a community college having an articulation agreement with the School of Engineering, or a pre-engineering program at a University of Pittsburgh regional campus will receive advanced standing in accord with those agreements.

2.6.1 Advanced Placement (AP) Credit

The 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 www.engr.pitt.edu/freshman/advising/apcredit.html for the current School of Engineering policy relating AP scores with advanced standing credit.

2.6.2 Transfer Credit for Courses Taken After Enrollment

Students enrolled in the 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 on page 30 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 units 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, 648 Benedum Hall, at the completion of the class.

2.7 Academic Advising

- The Undergraduate Director will be your initial transfer advisor when you apply for admission to the Mechanical Engineering and Materials Science Department. The Undergraduate Administrator will assist you with your initial registration. After the transitional period, you will be notified of your permanent academic advisor.
- If you decide to enroll in the co-op program, you must see the Undergraduate Administrator in Room 648 Benedum to be assigned to a co-op advisor (Section 5.6, page 34).
- An alphabetical listing of all the mechanical engineering students along with their assigned advisor's name is available on the MEMS Undergraduate Resources web page.
- All of the department advisors' office hours and room numbers are available on the MEMS Undergraduate Resources web page.
- Students must make an appointment with their advisors for registration at least one week before the registration period begins.

2.7.1 Undergraduate Resources Web Page

A broad range of information, including information on student advisors and faculty office hours is available at www.engr.pitt.edu/mems/undergraduate/resources.html. Many of the forms needed for registration, graduation, etc. can also be downloaded from this web page.

Chapter 3

Academic Policy

3.1 Grading System

The University of Pittsburgh has a standard letter grade system, as described below. All of the courses taken for fulfillment of the requirements for a B.S. in Materials Science and Engineering must be taken with the Letter Grade Option—the H/S/U and S/NC Grade Options are not allowed.

3.1.1 Letter Grades

The University's letter grade system identified below will be followed without exception.

Grades	Grade Points
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.

- G - The “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.
- I - The “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.
- R - The “R” grade signifies that a student resigned from the University.
- W - The “W” grade signifies that a student has withdrawn from a course (see Withdrawal below).
- Z - The “Z” grade indicates that an instructor has issued an invalid grade.

3.2 Withdrawal

To receive a refund, a student must officially drop a course during the term’s add/drop period. This is done by processing an Enrollment form, signed by the student’s academic advisor, through the Undergraduate Program Office, 648 Benedum Hall.

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, 648 Benedum Hall. The course instructor must sign the form. Withdrawal forms for courses offered by the School of Engineering must be processed through the Engineering Office of Administration, 253 Benedum Hall. Withdrawal forms for courses offered by the School of Arts and Sciences, the Faculty of Arts and Sciences, or the College of General Studies must be processed through their respective dean’s office. A “W” grade will then be assigned for the course.

Withdrawal from a School of Engineering 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 unit carried for a letter grade towards a student’s degree is awarded grade points as shown in the grading system table. A student’s term grade point average (term GPA) is the total grade points earned for the term divided by the total units 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 units assigned letter grades. Only units that are taken at the University of Pittsburgh and count towards a student’s degree are used in the calculation of the grade point averages. In particular, preparatory writing, preparatory mathematics, PEDC, and AFROTC units are not included in the calculation of a student’s GPA.

3.3.1 Course Repeats

A course resulting in a grade of “C–” or lower may be retaken within one calendar year. When calculating the cumulative GPA, the letter grade assigned for the later course will then replace the previously assigned grade, though the original grade will not be removed from the student’s transcript. No sequence course may be repeated for credit after a higher-numbered sequence course has been satisfactorily completed with a “C” or better. For the purpose of this rule, grades of “R” or “W” do not count as repeats. Students are only permitted to repeat a course twice.

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 units of academic work for letter grades at the University of Pittsburgh, and (3) completed a minimum of six units 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 units of academic work for letter grades at the University of Pittsburgh, and (3) completed a minimum of six units 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 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 School of Engineering.

3.6 Graduation Requirements

1. To graduate with a Bachelor of Science in Engineering, a student must have satisfactorily completed all required courses and earned the total number of units required by the department in which the student is enrolled. The student must also have obtained a minimum cumulative GPA of 2.00 for (a) all courses completed at the University of Pittsburgh and (b) all departmental courses.
2. Students who have a cumulative GPA of 2.00, but have not obtained the minimum 2.00 departmental GPA, can only be certified for graduation by the department by repeating all departmental courses in which a grade of "D+" or worse was awarded and earning a grade of "C" or better for each repeated course. Such students must maintain a cumulative GPA of 2.00 for all courses taken at the University.
3. Students must complete the 128-unit course requirement. Only units approved by the Mechanical Engineering and Materials Science Undergraduate Director count towards this requirement. In particular, remedial writing, remedial mathematics, PEDC, and AFROTC units will not count towards this requirement.
4. Advanced standing credit accepted by the School of Engineering may partially fulfill course requirements for graduation, but grades and units earned in such courses are not included in the GPA calculations.
5. No course in which an "F" or a non-letter grade was received can be used to satisfy the 128-unit requirement. A minimum "D-" letter grade is required.

6. Students must complete an Application for Graduation form in the term that they are graduating. These forms are available in the Undergraduate Program Office and online at www.engr.pitt.edu/mems/undergraduate/resources.html. After completing the form, students turn it in to the Office of Administration, 253 Benedum Hall. Students need to pay attention to the application deadlines to avoid late fees. The deadlines are posted outside of the Undergraduate Program Office and throughout Benedum Hall.
7. 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.
8. In the term that the student is graduating, he/she must make an appointment to see the Undergraduate Director before the add/drop period ends. The Undergraduate Director will sign off on their final academic graduation folder and verify that graduation requirements will be satisfied.
9. The work of the senior year (a minimum of 26 units) must be completed while in residence at the School of Engineering, University of Pittsburgh. Exceptions to this regulation may be granted for a limited number of units through petition to the department.
10. To be considered for honors at graduation, a student must earn at least 68 letter grade units 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.

3.6.1 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. This policy means that part-time students must progress toward the degree at a minimum of 10.67 units per calendar year.

3.6.2 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 units, 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.

Chapter 4

Registration

A lot of useful information and many of the necessary forms associated with registration can be found on the MEMS Undergraduate Resources Web Page:

www.engr.pitt.edu/mems/undergraduate/resources.html

These and other forms are also available in the Undergraduate Program Office, 648 Benedum Hall.

4.1 Self-Enrollment

Students enroll for courses on-line. There is an interactive video on the Student Services Portal on 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 manually 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. No student shall be allowed to register for more than 18 units 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 units over 18 will be billed over and above the full-time tuition rate at the prevailing per-unit 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 units 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. Units 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 units (including the cross-registration units).
- 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 Office of Administration, 253 Benedum Hall, for a PCHE registration form and additional instructions.

4.3 Interdepartmental Transfers

A student whose academic record satisfies the minimum requirements for continued registration may apply for transfer from the Mechanical Engineering program to another engineering discipline. An Undergraduate Academic Program Change form, available in the

Undergraduate Office, should be completed to initiate a change of departmental status. The Undergraduate Director must initial the form, and the student then returns the form to the Office of Administration, 253 Benedum. The student's academic records will be sent to the requested department. The acceptance of a change-of-status request must have the approval of the department to which the student desires to transfer. It is the prerogative of that department to approve or reject a change-of-status transfer request.

4.4 Transfer Students from Other Universities

An applicant for transfer to the School of Engineering from another college or university should request an Application for Admission with Advanced Standing from the Office of Admissions and Financial Aid, 2nd Floor, Bruce Hall, Pittsburgh, PA 15260. Applicants for the Spring Term should apply by November 15; for the Summer Term by March 15; and for the Fall Term by July 15. A transfer applicant will typically not be admitted to the School of Engineering without a grade point average of 2.50 on a 4.00 scale at the institution previously attended. 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 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 2.6 on page 20 for more information on the transfer of credit.

Students transferring from the School of Arts and Sciences and the College of General Studies of the University of Pittsburgh should initiate the request for transfer in their academic dean's office. To be considered for transfer, a minimum cumulative grade point average of 2.50 is required. All the freshman-level engineering courses should be completed before applying for transfer.

4.4.1 Regional Transfers

Request forms for relocation from the pre-engineering program at Bradford, Greensburg, Johnstown, or Titusville are available at each regional campus. The student must initiate the request for relocation in accordance with the regulations at the regional campus. The regional campus sends the request for relocation to Pittsburgh and the student's records to the Engineering Office of Administration for review and action by the School of Engineering. Students who have a grade point average of 2.75 or higher in the required engineering curricula are guaranteed relocation to the Oakland campus.

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 www.engr.pitt.edu/mems/undergraduate/curricular_options.html.

5.1 Arts and Sciences-Engineering Joint Degree Program

The School of Arts and Sciences (A&S) and the 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 A&S and the School of Engineering. Students can apply for admission into the program through either A&S or the School of Engineering and must be admitted into both schools.

5.2 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.

5.3 Certificate Programs

School of Engineering undergraduate students are encouraged to broaden their educational experience by electing to take one of the certificate programs currently offered by A&S, the University Center for International Studies, or the 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 School of Engineering offers seven certificates at the undergraduate level.

- Energy Resource Utilization
- Fessenden Honors in Engineering Program
- International Education
- Mining Engineering
- Nuclear Engineering
- Product Realization
- Sustainable Engineering

5.4 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.

5.5 PCHE Cross-Registration Program

The Pittsburgh Council on Higher Education (PCHE) cross-registration program provides opportunities for enriched educational programs by permitting full-time undergraduate and graduate students to cross-register at any other PCHE school (Section 4.2, page 30).

5.6 Cooperative Education Program

The Co-Op Education Program at Pitt is one of the most exciting opportunities available to engineering students. By alternating work and school terms, co-op education 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 sessions, 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 units (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 in the Undergraduate Program Office, 648 Benedum Hall.

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 in B77/78 Benedum Hall or call (412) 624-9882 or 9883.

5.7 School of 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.

5.8 School of Arts & Sciences Minors

Twenty-one departmental minors are available in programs offered by the A&S. The minors are applied statistics, chemistry, classics, economics, English literature, French, German, history, Italian, Japanese, linguistics, music, neuroscience, philosophy, physics, political science, religious studies, Slovak studies, sociology, studio arts, and theatre arts. Students must complete at least half of the units earned for a minor at the University of Pittsburgh and must complete a minor with at least a 2.00 GPA.

5.9 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.

5.10 International Education

The 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.

5.11 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 units. A maximum of 6 units can be applied to a master's degree program. These units will only apply to graduate degree requirements.

5.12 Combined Liberal Arts & Engineering 3/2 Programs with Other Universities

The University of Pittsburgh School of Engineering has developed combined liberal arts and engineering joint-degree programs with a number of accredited liberal arts colleges. These programs are typically referred to as 3/2 programs, since the student initially enrolls at the liberal arts college, 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 University of Pittsburgh School of Engineering. With the recommendation of the review committee at the liberal arts college, the student then applies for transfer to the University of Pittsburgh School of Engineering. If accepted, the student spends the final two years in the Materials Science and Engineering program.

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

Interested students should be referred to the Director of Freshman Programs, B-80 Benedum Hall 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 - MSE 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
MATH0240	4 _____	Anal. Geometry & Calc. 3	MATH0230
MATH0280	3 _____	Matrices & Linear Algebra	MATH0220
MATH0290	3 _____	Differential Equations	MATH0230
PHYS0174	4 _____	Phys. for Sci. & Engr. 1	<i>MATH0220</i> ¹
PHYS0175	4 _____	Phys. for Sci. & Engr. 2	PHYS0174, <i>MATH0230</i>
PHIL0300	3 _____	Intro. to Ethics (Humanity)	
_____	3 _____	Humanity/Soc. Sci. Elective	
_____	3 _____	Humanity/Soc. Sci. Elective	
_____	3 _____	Humanity/Soc. Sci. Elective	
_____	3 _____	Humanity/Soc. Sci. Elective	
_____	3 _____	Humanity/Soc. Sci. Elective	
_____	3 _____	Communication Skills Elective	
ENGR0011	3 _____	Intro. to Engr. Analysis	
ENGR0012	3 _____	Engr. Computing	ENGR0011
ENGR0020	4 _____	Probability and Statistics	MATH0230
ENGR0022	3 _____	Mater. Struct. & Properties	MATH0230, PHYS0174
ENGR0135	3 _____	Statics & Mech. of Mater. 1	MATH0230, PHYS0174
ENGR0145	3 _____	Statics & Mech. of Mater. 2	ENGR0135
MEMS0024	3 _____	Intro. to ME Design	ENGR0011
MEMS0031	3 _____	Electrical Circuits	PHYS0175, <i>MATH0290</i>
MEMS0040	3 _____	Materials & Manufacturing	ENGR0022
MEMS0051	3 _____	Intro. to Thermo-Fluids	PHYS0174, CHEM0960, <i>MATH0290</i>
MEMS1010	3 _____	Experimental Methods in MSE	ENGR0022
MEMS1011	2 _____	Struct. & Prop. Lab	MEMS1010
MEMS1028	3 _____	Mechanical Design 1	ENGR0145
MEMS1030	3 _____	Material Selection	ENGR0022, MEMS1028
MEMS1043	3 _____	Senior Design Project	<i>Senior Standing</i>
MEMS1052	3 _____	Heat and Mass Transfer	MEMS0051
MEMS1054	3 _____	Materials Science 1	ENGR0022
MEMS1056	3 _____	Energetics	ENGR0022, MEMS0051
MEMS1058	3 _____	Electromagnetic Prop. Mater.	ENGR0022
MEMS1064	3 _____	Materials Science 2	MEMS1054, MEMS1056
MEMS1070	3 _____	Mech. Behavior of Materials	ENGR0022, ENGR0145
MEMS1079	3 _____	Senior Mater. Research Proj.	<i>Senior Standing</i>
_____	3 _____	MSE Technical Elective	
_____	3 _____	MSE Technical Elective	
_____	3 _____	MSE Technical Elective	

¹Italicized courses indicate corequisites, that is, courses that must be taken prior to or concurrently with the subject course.

Appendix B - MSE Sample Schedule

Shown below is an example of a schedule of courses that leads to a B.S. in Materials Science and Engineering in four years. It satisfies all of the relevant course prerequisites and the Materials Science and 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
MEMS0040	Materials & Manufacturing	3
MEMS0051	Intro. to Thermo-Fluids	3
	<i>Communication Skills Elective</i>	3
MEMS1085	Departmental Seminar	<u>0</u>
		18

FIFTH TERM

Subject		Credits
MEMS1010	Experimental Methods in MSE	3
MEMS1052	Heat and Mass Transfer	3
MEMS1054	Materials Science 1	3
MEMS1056	Energetics	3
MEMS1058	Electromagnetic Prop. Mater.	3
MEMS1085	Departmental Seminar	<u>0</u>
		15

SIXTH TERM

Subject		Credits
MEMS1011	Struct. & Prop. Lab	2
MEMS1028	Mechanical Design 1	3
MEMS1064	Materials Science 2	3
MEMS1070	Mech. Behavior of Materials	3
	<i>MSE Technical Elective</i>	3
MEMS1085	Departmental Seminar	<u>0</u>
		14

SEVENTH TERM

Subject		Credits
ENGR0020	Probability and Statistics	4
MEMS1030	Material Selection	3
MEMS1079	Senior Mater. Research Proj.	3
	<i>MSE Technical Elective</i>	3
	<i>Humanity/Soc. Sci. Elective</i>	3
MEMS1085	Departmental Seminar	<u>0</u>
		16

EIGHTH TERM

Subject		Credits
MEMS1043	Senior Design Project	3
	<i>MSE Technical Elective</i>	3
	<i>Humanity/Soc. Sci. Elective</i>	3
	<i>Humanity/Soc. Sci. Elective</i>	3
MEMS1085	Departmental Seminar	<u>0</u>
		15

Appendix C - MSE Course Offerings by Term

To assist you in long term schedule planning, a *tentative* 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
ENGR0020	•	•	•
ENGR0022	•	•	•
ENGR0135	•	•	•
ENGR0145	•	•	•
MEMS0024	•		
MEMS0031		•	•
MEMS0040		•	•
MEMS0051		•	•
MEMS1010	•		
MEMS1011		•	
MEMS1028	•	•	
MEMS1030	•		
MEMS1043	•	•	•
MEMS1052	•		•
MEMS1054	•		
MEMS1056	•		
MEMS1058	•		
MEMS1064		•	
MEMS1070		•	
MEMS1079	•	•	•
MEMS1085	•	•	
Tech. Electives	•	•	

- Note that, in general, Materials Science and Engineering Technical Electives are only offered during the Fall and Spring Terms.
- This is a tentative schedule that is subject to change without notice.

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 - MSE 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 MEMS0040 MEMS0051	Work Rotation
<i>Year 3</i>	MEMS1010 MEMS1054 MEMS1056 MEMS1058 <i>Comm. Skills</i>	Work Rotation	ENGR0020 MEMS1052 <i>Soc. Sci./Hum.</i> <i>Soc. Sci./Hum.</i> <i>Soc. Sci./Hum.</i>
<i>Year 4</i>	Work Rotation	MEMS1011 MEMS1028 MEMS1064 MEMS1070 <i>MSE Tech. Elec.</i>	Work Rotation (Optional)
<i>Year 5</i>	MEMS1030 MEMS1043 MEMS1079 <i>MSE Tech. Elec.</i> <i>Soc. Sci./Hum.</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 - MSE 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	Work Rotation	MATH0290 ENGR0145 MEMS0031 MEMS0040 MEMS0051
<i>Year 3</i>	Work Rotation	ENGR0020 MEMS1028 MEMS1070 <i>Soc. Sci./Hum.</i> <i>Comm. Skills</i>	Work Rotation
<i>Year 4</i>	MEMS1010 MEMS1030 MEMS1054 MEMS1056 MEMS1058	MEMS1011 MEMS1064 <i>MSE Tech. Elec.</i> <i>MSE Tech. Elec.</i> <i>Soc. Sci./Hum.</i>	MEMS1043 MEMS1052 MEMS1079 <i>Soc. Sci./Hum.</i> <i>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.