UNIVERSITY OF PITTSBURGH

Engineering Science

Undergraduate Academic Program Manual

Dr. Brian Gleeson

Chairman

Dr. Paul Ohodnicki

Program Director

Dr. William S. Slaughter

Undergraduate Coordinator

University of Pittsburgh

Swanson School of Engineering

Mechanical Engineering and Materials Science Department

636 Benedum Hall

3700 O'Hara Street

Pittsburgh, PA 15261

Phone: (412) 624-9720

Fax: (412) 624-4846

Web Address: www.engineering.pitt.edu/engineeringscience

For information regarding admissions and financial aid, see
www.engineering.pitt.edu/Undergraduate_Admissions

June 2020

Forward

This Engineering Science Undergraduate Academic Program Manual is a supplement to the information provided on the University of Pittsburgh School of Engineering Web Site (www.engineering.pitt.edu), which is the official source of information about the School's academic programs and degree requirements. This supplemental manual provides specific information about departmental policies, procedures and programs that is not included in the School of Engineering Web Site, as well as some relevant information from the School of Engineering Web Site. It is provided so that you will be better informed about your academic program and for your convenience in monitoring your progress towards completion of your degree.

Note: If there are any discrepancies between the Engineering Science 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

Chapter 1

About Engineering Science

Prospective students often ask, ñWhat is Engineering Science?ò

Engineering Science is an Engineering Degree in the Swanson School of Engineering. The Engineering Science Program offers flexible curricula in several interdisciplinary *areas of concentration*. The program is built on sequences of courses from multiple science and engineering programs. In this way it is different from a more traditional Engineering discipline like, for example, Mechanical Engineering or Civil Engineering.

All *areas of concentration* require in-depth exposure to both science and engineering. The Engineering Physics curriculum (which had been available as a separate program until 2010) is now one of the areas of concentration within Engineering Science.

The goal of this program is to develop each studentõs ability to think analytically across disciplines and develop a knowledge base well-suited to tackle future technical challenges that will require a thorough understanding of a discipline in the physical sciences combined with engineering.

All Engineering Science curricula require substantial additional higher-level science and mathematics courses over and above a typical Engineering Major. This is a challenging major. All areas of concentration offer a possible a two-term capstone design experience.

The Engineering Science program is ideal preparation for graduate school in a wide range of disciplines, for rewarding careers in industry, and is an excellent background for those who wish to pursue careers in other professions, such as management, law, education, medicine, or public service.

The Engineering Science program had its initial accreditation review by the Accreditation Board for Engineering and Technology (ABET) during the 2013 ï 2014 academic year. ABET is the accreditation organization for engineering and technology programs in the United States.

1.1 Program Educational Objectives

Consistent with the student outcomes set by ABET, program educational objectives for Engineering Science have been adopted:

The Engineering Science Program seeks to produce engineers who build successful, diverse careers based on:

1. **an understanding of the physical and/or life sciences to engineering analysis and design, leading to a solution of problems often of an interdisciplinary nature;**
2. **a commitment to ongoing professional development as exemplified by, for example, graduate study, training, conference participation, and certification;**
3. **advancement and leadership in professional and/or community life.**

The Program Educational Objectives support the ABET accreditation student outcomes which are given below:

(a) An ability to apply knowledge of mathematics, science, and engineering (mathematics, chemistry, physics, engineering)

(b) An ability to design and conduct experiments, as well as analyze and interpret data (experiments, data)

(c) An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability

(d) An ability to function on multidisciplinary teams

(e) An ability to identify, formulate, and solve engineering problems

(f) An understanding of professional and ethical responsibility

(g) An ability to communicate effectively (written, oral)

(h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context

(i) A recognition of the need for, and ability to engage in life-long learning

(j) A knowledge of contemporary issues

(k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice (equipment, software, CAD

1.2 Curriculum Overview

Engineering Science curricula are constructed as follows: During the first two terms (freshman year), students are part of the common freshman year, acquiring knowledge of the fundamentals of mathematics (calculus), as well as the fundamental principles and methods of physics, chemistry, and engineering, similar to all other Swanson School of Engineering freshmen. Study of the fundamentals is completed in the third term (sophomore year). Starting in the fourth term, the curriculum branches into an approved area of concentration in the Engineering Science degree program.

All current Engineering Science curricula conform to the following set of requirements. If new areas of concentration and associated curricula are added to the program they will be required to conform to the same requirements.

Requirements for Engineering Science program curricula:

Å Minimum 48 hours Engineering
Å Minimum 44 hours Science + Math (minimum 18 hours of Math)
Å Minimum 15 hours concentrated in a single Engineering program
Å Minimum 101 hours total óSTEMô classes (Science + Engineering + Math)
Å Minimum 18 hours (six courses) of H/SS electives including one W course (per approved SSOE H/SS courses)

The Engineering Science program currently offers three areas of concentration: *Engineering Physics*, *Nanotechnology and Engineering Mechanics*.

Engineering Physics prepares students for engineering practice based on a curriculum designed to develop an understanding of physics and its application in electrical engineering and materials science through classroom instruction and hands-on laboratory experience. The core of the curriculum is comprised of a sequence of fundamental courses in modern physics, electricity and magnetism, thermodynamics of materials, materials structure, structure-property relationships of materials, design of electronic circuits, semiconductor devices, and signal processing. The curriculum culminates with program electives and two design-oriented courses in the senior year. The design project builds on the knowledge gained in coursework and emphasizes independent and team problem solving under the guidance of a faculty mentor.

Nanotechnology prepares students for engineering practice based on a curriculum designed to develop an understanding of the effect of nanoscale dimensions on the physical behavior of materials, systems, and devices (nanocharacterization and nanometrology), as well as knowledge of processes used to fabricate useful nanoscale materials, systems, and devices (nanomanufacturing). Students take courses in modern physics or chemistry, materials engineering or bioengineering, nanotechnology and nanoscience and the materials science of nanostructures. The curriculum culminates with program electives and two design oriented senior courses. The design project builds on the knowledge gained in coursework and emphasizes problem solving under the guidance of a faculty mentor. Nanotechnology has two curricular options, one emphasizing Physics and Materials Science and the other Chemistry and Bioengineering. Both have substantial flexibility.

Engineering Mechanics prepares students for engineering practice based on a curriculum designed to develop a strong fundamental understanding of the physics and mathematics principles that underlie the areas of Mechanical Engineering, Civil Engineering and Materials Science. The core of the curriculum is comprised of a sequence of fundamental courses in the mechanical sciences such as statics, strength of materials, dynamics and vibrations and fluid dynamics. The curriculum has two electives which allow specialization in a given area such as structural analysis, biomechanics or the mechanics of material science.

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

Each of the departments in the Swanson School of Engineering offers minors (Section 5.7). A student may earn a minor along with a Bachelor of Science in Engineering Science. Engineering Science students may also participate in the co-op engineering program (Section 5.6).

Chapter 2

Undergraduate Curriculum

The requirements for obtaining a Bachelor of Science (B.S.) degree in Engineering Science are described below. The Engineering Science program currently offers three areas of concentration: *Engineering Physics*, *Nanotechnology, and Engineering Mechanics*. Engineering Physics and Engineering Mechanics have a single standard curriculum. Nanotechnology has two standard curricula, one emphasizing Physics and Materials Science and the other Chemistry and Bioengineering.

2.1 Engineering Physics Curriculum

The required courses in the Engineering Physics curriculum are summarized below.

Engineering Science Program Area of Concentration: Engineering Physics			
Course	**Title**	**Cr.**	**Pre/Co-Req**
Chem 0960	Gen. Chem. Eng. 1	3	
Chem 0970	Gen. Chem. Eng. 2	3	Chem 0960
Math 0220	Anal. Geo. & Calc. 1	4	
Math 0230	Anal. Geo. & Calc. 2	4	Math 0220
Math 0240	Anal. Geo. & Calc. 3	4	Math 0230
Math 0280	Mat. & Lin. Alg.	3	Math 0220
Math 0290	Diff. Eq.	3	Math 0230
Phys 0174	Phys. Sci. & Eng. 1	4	*Math 0220*
Phys 0175	Phys. Sci. & Eng. 2	4	Phys 0174, *Math 0230*
Phys 0219	Lab Phys. Sci. & Eng.	2	*Phys 0175*
Phys 0477	Thermal Phys, Rel.,&QM	4	Phys 0175, *Math 0240*
Phys 0481	Princ. Mod. Phys. 2	3	Phys 0477
(Phys 1351)	Upper Level Physics (Rec: Inter. Elect. & Mag.)	3	Phys 0175,Math 0240, *Math 0290*
Phys	Upper Level Physics	3	
Phys	Upper Level Physics	3	
Engr 0011	Int. Eng. Analysis	3	
Engr 0012	Eng. Computing	3	Engr 0011
Engr 0022	Mat. Str. & Prop.	3	Phys 0175, Math 0230
Engr 0135	Statics & Mech. Matls 1	3	Math 0230, Phys 0174
Ece 0101	Lin. Circ. & Sys.	4	Phys 0175, Engr 0012 *Math 0280, 0290*

Ece 0201	Digital Cir. & Systems	4	Ece 0101
Ece 0102	Micro Circuits & Lab	4	Ece 0101
Ece 0301	Problem Solving C++	3	Engr 0012
Ece 1212	El. Circ. Des. Lab	3	Ece 0102, 0402
Ece 1247	Semicond. Dev. Theory	3	Ece 0102 Math 0280, 0290
Ece 1266	Appl. Fields & Waves	3	Phys 1351 Ece 0301 Alt; Physics 1372
Ece 0402	Sig. Sys. & Prob.	3	Math 0280, 0290
Mems 0051	Intro. Thermodynamics	3	Phys 0174, Chem 0960,
Mems 1053	Struct. of Crystals	3	Engr 0022
Ece 1895[À]	Jr. Design Fund.	3	
Mems 1059	Phase Equilibria	3	Engr 0022, Mems 0051
	Program Elective (Rec: Math 1470 PDE)	3	Math 0240, Math 0290
	Program Elective	3	
	Senior Design 1[+]	3	
	Senior Design 2[++]	3	
	Hum. Elective*	3	
	Soc. Sci. Elective*	3	
	Hum./Soc. Sci. El.*	3	
	Hum./Soc. Sci. El.*	3	
	Hum./Soc. Sci. El.* [ÿ]	3	
	Hum./Soc. Sci. El.*	3	

Upper Level Physics: Physics courses with course numbers > 1000

[+] A senior design course offered by one of the other SSOE engineering programs is required.

[++] May be ENGR 1050 Product Realization, or with preapproval a senior design project arranged with a faculty mentor and taken as ENGSCI 1801. Students wishing to complete a two-term project with a faculty mentor may request approval for the second term to count as a program elective (ENGSCI 1802).

[ÿ]A University designated writing intensive course

*All humanities and Social Science electives must be from the SSOE approved list. Two courses need to be in single area (see SSOE guidelines).

Italicized courses indicate co-requisites; courses must be taken prior to or concurrently.

2.1.1 Engineering Physics Curriculum Program Electives

Upper level physics classes have course numbers > 1000. Possible choices (must meet prerequisite requirements) include the following

PHYS 1331: Mechanics
PHYS 1341: Thermo. And Statistical Mechanics
PHYS 1351: Intermed. Elect. And Magnetism (Same as ECE 1259)
PHYS 1361: Wave Motion and Optics (PHYS 0219)
PHYS 1370: Intro. to Quantum Mechanics 1 (Coreq. PHYS 1331 and 1351)
PHYS 1371: Intro. to Quantum Mechanics 2 (Prereq. PHYS 1370)
PHYS 1372: Electromagnetic Theory (Coreq. PHYS 1331 and 1351)
PHYS 1374: Solid State Physics (Prereq. PHYS 0477)
PHYS 1376: Intro. to Biophysics (Math 235 or Stat 1000)
PHYS 1378: Intro. to Nuc. And Part. Physics 1 (Prereq. PHYS 1370)

There are two program electives in the Engineering Physics curriculum. It is recommended that students planning to pursue graduate studies in physics take the honors quantum mechanics sequence in the Physics department:

PHYS 1370: Introduction to Quantum Physics 1
PHYS 1371: Introduction to Quantum Physics 2

Students can also satisfy the program elective requirement by choosing a two-course sequence that creates in-depth exposure to a topic area. Example sequences of courses include the following:

ECE 1232: Introduction to Lasers and Optical Electronics
ECE 1238: Digital Electronics

MEMS 1010: Experimental Methods in Materials Science and Engineering
MEMS 1101: Ferrous Physical Metallurgy
MEMS 1048: Analysis and char. at the Nanoscale
MEMS 1049: Mechatronics
MEMS 1111: Matls. For Energy Generation and Storage

MEMS 1057: Micro/Nano Manufacturing
MEMS 1082: Electromechanical Sensors and Actuators

ENGR 0240: Nanotechnology and Nano-Engineering
ENGR 0241: Fabrication and Design in Nanotechnology#
(# or PHYS 1375/CHEM 1630 Foundations of Nanoscience)

2.2 Nanotechnology Curriculum ï Physics/Materials Emphasis

The required courses in the Nanotechnology curriculum (Physics/Materials Emphasis) are summarized below.

Engineering Science Program Area of Concentration: Nanotechnology *Physics/Materials Emphasis*			
Course	**Title**	**Cr.**	**Pre/Co-Req**
Chem 0960	Gen. Chem. Eng. 1	3	
Chem 0970	Gen. Chem. Eng. 2	3	Chem 0960
Math 0220	Anal. Geo. & Calc. 1	4	
Math 0230	Anal. Geo. & Calc. 2	4	Math 0220
Math 0240	Anal. Geo. & Calc. 3	4	Math 0230
Math 0280	Mat. & Lin. Alg.	3	Math 0220
Math 0290	Diff. Eq.	3	Math 0230
Phys 0174	Phys. Sci. & Eng. 1	4	*Math 0220*
Phys 0175	Phys. Sci. & Eng. 2	4	Phys 0174, *Math 0230*
Phys 0477	Thermal Phys, Rel&QM	4	Phys 0175, *Math 0240*
Phys 0481	Princ. Mod. Phys. 2	3	Phys 0479
Phys 0219	Lab. Phys. Sci.& Eng.	2	*Phys 0175*
Phys	Upper Level Physics	3	
Phys	Upper Level Physics	3	Phys 0175, Math 0240, *Math 0290*
Engr 0011	Int. Eng. Analysis	3	
Engr 0012	Eng. Computing	3	Engr 0011
Engr 0020	Prob. & Statistics	4	Math 0230
Engr 0022	Mat. Str. & Prop.	3	Phys 0175, Math 0230
Engr 0135	Statics & Mech. Matls 1	3	Math 0230, Phys 0174
Engr 0240	Int. Nôtech. and Nôeng.	3	Math 0230, Phys 0175
Engr 0241 or Phys 1375 Chem 1630	Fab. & Des. In Nôtech. Found. of Nanosci	3	
Ece 0101	Lin. Circ. & Sys. 1	4	Phys 0175, Engr 0012 *Math 0280, Math 0290*
Ece 0102	Microelectronic Cir.	4	Ece 0101
Ece 0301	Problem Solving C++	3	Engr 0012
Mems 0051	Intro. Thermodynamics	3	Phys 0175, Chem 0960
Mems 1010	Exp. Meth. In MSE	3	Engr 0022

Mems 1053	Struct. of Crystals	3	Engr 0022
Mems 1057	Micro/Nano Manuf.	3	
Mems 1059	Phase Equilibria	3	Engr 0022, Mems 0051
Mems 1063	Phase Transformation.	3	Mems 1053, Mems 1059
	Nanotech Prog. Elect.	3	
	Nanotech Prog. Elect.	3	
	Nanotech Prog. Elect.	3	
	Senior Design 1[+]	3	
	Senior Design 2[++]	3	
	Hum. Elective*	3	
	Soc. Sci. Elective*	3	
	Hum./Soc. Sci. El.*	3	
	Hum./Soc. Sci. El.*	3	
	Hum./Soc. Sci. El.*[ÿ]	3	
	Hum./Soc. Sci. El.*	3	

Upper Level Physics: Physics courses with course numbers > 1000

[+] A senior design course offered by one of the other SSOE engineering programs is required.
[++] May be ENGR 1050 Product Realization, or with preapproval a senior design project arranged with a faculty mentor and taken as ENGSCI 1801. Students wishing to complete a two-term project with a faculty mentor may request approval for the second term to count as a program elective (ENGSCI 1802).
[ÿ]A University designated writing intensive course
*All humanities and Social Science electives must be from the SSOE approved list. Two courses need to be in single area (see SSOE guidelines).

2.2.1 Nanotechnology Curriculum Program Electives ï Physics/Materials

Approved Electives include:

CHEM 1450	Molecular Modeling and Graphics
CHEM 1410	Physical Chemistry 1
CHEM 1420	Physical Chemistry 2
CHEM 1480	Intermediate Physical Chemistry
CHEM 1130	Inorganic Chemistry
CHEM 1620	Atoms, Molecules & Materials ï óIntroduction to Nanomaterialsô
PHYS 0577	Modern Physical Measurements
PHYS 1370	Introduction to Quantum Physics
PHYS 1371	Introduction to Quantum Physics

PHYS 1375	Foundations of Nanoscience
BIOENG 1601	Principles and Properties of Complex Engineered Materials
BIOEG 1810	Biomaterals and Biocompatibility
ECE 1232	Introduction to Lasers and Optical Electronics
ECE 1238	Digital Electronics
ECE 1247	Semiconductor Device Theory
ECE 2295	Nanosensors
ENGR 1065	Nanomanufacturing and Nanomaterials for Photovoltaics
ENGR 1066	Introduction to Solar Cells and Nanotechnology
IE 1012	Manufacture of Structural Nano-Materials
MEMS 1011	Structure and Properties Lab
MEMS 1101	Ferrous Physical Metallurgy
MEMS 1048	Analysis and char. at the Nanoscale
MEMS 1082	Electromechanical Sensors and Actuators
MEMS 1101	Ferrous Physical Metallurgy
MEMS 1111	Matls. For Energy Generation and Storage
MEMS 1477	Thin Film Processes and Characterization

2.3 Nanotechnology Curriculum ï Chemistry/Bioengineering Emphasis

The required courses in the Nanotechnology curriculum (Chemistry/Bioengineering Emphasis) are summarized below.

Engineering Science Program Area of Concentration: Nanotechnology *Chemistry/Bioengineering Emphasis*			
Course	**Title**	**Cr.**	**Pre/Co-Req**
Phys 0174	Phys. Sci. & Eng. 1	4	*Math 0220*
Phys 0175	Phys. Sci. & Eng. 2	4	Phys 0174, *Math 0230*
Phys 0219	Basic Lab. Physics	2	Phys 0175
Math 0220	Anal. Geo. & Calc. 1	4	
Math 0230	Anal. Geo. & Calc. 2	4	Math 0220
Math 0240	Anal. Geo. & Calc. 3	4	Math 0230
Math 0280	Mat. & Lin. Alg.	3	Math 0220
Math 0290	Diff. Eq.	3	Math 0230
Chem 0960	Gen. Chem. Eng. 1	3	
Chem 0970	Gen. Chem. Eng. 2	3	Chem 0960
CHEM 1	Core Chem. Course (Chem 0310)	3	
CHEM 2	Core Chem. Course (Chem 0320)	3	
CHEM 3	Core Chem. Course (Chem 0330, Chem 0430, Chem 0440)	3	
LIFESCI 1	Basic Life Science (Biosc 0150)	3	
LIFESCI 2	Basic Life Science (Biosc 0160)	3	
Engr 0011	Int. Eng. Analysis	3	
Engr 0012	Eng. Computing	3	Engr 0011
Engr 0020	Prob. & Statistics	4	Math 0230
Engr 0022	Mat. Str. & Prop.	3	Phys 0175, Math 0230
Engr 0135	Statics & Mech. Matls 1	3	Math 0230, Phys 0174
Engr 0240	Int. Nôtech. & Nôeng.	3	
Ece 0101	Lin. Circ. & Sys.	4	Phys 0175, Engr 0012 *Math 0280, Math 0290*
Ece 0102	Microelectronic Cir.	4	Ece 0101
Ece 0301	Problem Solving C++	3	Engr 0012

BIOENG 1	Core Bioeng.	3	
BIOENG 2	Core Bioeng.	3	
Mems 0051	Intro. Thermodynamics	3	Phys 0175, Chem 0960
Mems 1010	Exp. Meth. In MSE	3	Engr 0022
Mems 1053	Struct. of Crystals	3	Engr 0022
Mems 1057	Micro/Nano Manuf.	3	
	Nano Prog. Elect.*	3	
	Nano Prog. Elect.	3	
	Nano Prog. Elect.	3	
	Senior Design 1+	3	
	Senior Design 2++	3	
	Hum. Electiveÿ	3	
	Soc. Sci. Electiveÿ	3	
	Hum./Soc. Sci. El. ÿ	3	
	Hum./Soc. Sci. El. ÿ	3	
	Hum./Soc. Sci. El. ÿÀ	3	
	Hum./Soc. Sci. El. ÿ	3	

+ A senior design course offered by one of the other SSOE engineering programs is required.
++ May be ENGR 1050 Product Realization, or with preapproval a senior design project arranged with a faculty mentor and taken as ENGSCI 1801. Students wishing to complete a two-term project with a faculty mentor may request approval for the second term to count as a program elective (ENGSCI 1802).
* One of the Nano. Prog. Electives must be a basic science course. Three credits of basic science lab courses can constitute a three credit Nano Prog. Elective.

ÿAll humanities and Social Science electives must be from the SSOE approved list. Two courses need to be in single area (see SSOE guidelines).
À Writing intensive course

Italicized courses indicate co-requisites; courses must be taken prior to or concurrently.

2.3.1 Nanotechnology Curriculum Program Electives and Core Chemistry, Life Science and Bioengineering Course Options ï Chemistry/Bioengineering

Approved Nanotechnology Electives include:

CHEM 0310 Organic Chemistry 1
CHEM 0320 Organic Chemistry 2

CHEM 1450	Molecular Modeling and Graphics
CHEM 1410	Physical Chemistry 1
CHEM 1420	Physical Chemistry 2
CHEM 1480	Intermediate Physical Chemistry
CHEM 1130	Inorganic Chemistry
CHEM 1620	Atoms, Molecules & Materials ï ðIntroduction to Nanomaterialsô
PHYS 0577	Modern Physical Measurements
PHYS 1370	Introduction to Quantum Physics 1
PHYS 1371	Introduction to Quantum Physics 2
PHYS 1363	Photonics 1
PHYS 1364	Photonics 2
PHYS/CHEM 1375	Foundations of Nanoscience
BIOSC 0050	Foundations of Bio. Lab 1 (1 cr.)
BIOSC 0060	Foundations of Bio. Lab 2 (1 cr.)
BIOENG 1005	RF Medical Devices and Applications of Electromag. in Medicine
BIOENG 1532	Bioseparation
BIOENG 1601	Principles and Properties of Complex Engineered Materials
BIOENG 1810	Biomaterals and Biocompatibility
ECE 1232	Introduction to Lasers and Optical Electronics (3 units)
ECE 1238	Digital Electronics (3 units)
ECE 1247	Semiconductor Device Theory
ECE 2295	Nanosensors
ENGR 1065	Nanomanufacturing and Nanomaterials for Photovoltaics
ENGR 1066	Introduction to Solar Cells and Nanotechnology
IE 1012	Manufacture of Structural Nano-Materials
MEMS 1011	Structure and Properties Lab
MEMS 1048	Analysis and char. at the Nanoscale
MEMS 1063	Phase Transformation
MEMS 1082	Electromechanical Sensors and Actuators
MEMS 1101	Ferrous Physical Metallurgy
MEMS 1111	Matls. For Energy Generation and Storage
MEMS 1477	Thin Film Processes and Characterization

CHEM 1, 2, and 3 must be selected from the following:

CHEM 0310	Organic Chemistry 1
CHEM 0320	Organic Chemistry 2
CHEM 0250	Analytic Chemistry
CHEM 1250	Instrument Analysis
CHEM 1410	Physical Chemistry 1
CHEM 1420	Physical Chemistry 2
CHEM 1130	Inorganic Chemistry
CHEM 1590	Molecular Biophysics
BIOSC 1000	Principles of Biochemistry
BIOSC 1810	Macromolecular Structure

LIFESCI 1 and 2 must be selected from the following:

BIOENG 1070	Cell Biology I
BIOENG 1071	Cell Biology II
BIOSC 0150	Foundations of Biology I
BIOSC 0160	Foundations of Biology II
BIOSC 1070	Human Physiology - UHC
BIOSC 1250	Introduction to Human Physiology
HRS 1020	Introduction to Anatomy and Physiology
HRS 1022	Human Anatomy
HRS 1023	Human Physiology
HRS 1024	Introduction to Neurosciences
NROSCI 1000	Intro to Neuroscience
NROSCI 1003	UHC Introduction to Neuroscience

BIOENG 1 and 2 must be selected from the following (prerequisites must be met):

BIOENG 1005	Radiofrequency Medical Devices
BIOENG 1061	Human Factors Engineering
BIOENG 1075	Introductory Cell and Molecular Biology Laboratory Techniques
BIOENG 1095	Special Projects
BIOENG 1150	Bioengineering Methods and Applications
BIOENG 1210	Bioengineering Thermodynamics
BIOENG 1220	Biotransport Phenomena
BIOENG 1241	Societal, Political, Ethical Issues in Biotechnology
BIOENG 1310	Linear Systems and Electronics I
BIOENG 1311	Hemodynamics and Biotransport
BIOENG 1320	Linear Systems and Electronics II
BIOENG 1330	Biomedical Imaging
BIOENG 1383	Biomedical Optical Microscopy
BIOENG 1384	Application of NMR Spectroscopy in Medicine
BIOENG 1531	Fundamentals of Biochemical Engineering
BIOENG 1601	Principles and Properties of Complex Engineered Materials
BIOENG 1620	Introduction to Tissue Engineering
BIOENG 1630	Biomechanics 1

2.4 Engineering Mechanics Curriculum

The required courses in the Engineering Mechanics curriculum are summarized below.

Engineering Science Program Area of Concentration: Engineering Mechanics			
Course	**Title**	**Cr.**	**Pre/Co-Req**
Chem 0960	Gen. Chem. Eng. 1	3	
Chem 0970	Gen. Chem. Eng. 2	3	Chem 0960
Math 0220	Anal. Geo. & Calc. 1	4	
Math 0230	Anal. Geo. & Calc. 2	4	Math 0220
Math 0240	Anal. Geo. & Calc. 3	4	Math 0230
Math 0280	Mat. & Lin. Alg.	3	Math 0220
Math 0290	Diff. Eq.	3	Math 0230
Stat 1000	Appl. Stat. Methods	4	
Math 1550	Vector Analysis	3	
Phys 0174	Phys. Sci. & Eng. 1	4	*Math 0220*
Phys 0175	Phys. Sci. & Eng. 2	4	Phys 0174, *Math 0230*
Phys 0477	Thermal Phys, Rel&QM	4	Phys 0175, *Math 0240*
Phys	Upper Level Physics	3	
Engr 0011	Int. Eng. Analysis	3	
Engr 0012	Eng. Computing	3	Engr 0011
Engr 0022	Mat. Str. & Prop.	3	Phys 0175, Math 0230
Engr 0135	Statics & Mech. Matls 1	3	Math 0230, PHYS 0174
Engr 0145	Statics & Mech. Matls 2	3	Engr 0135
Mems 0024	Intro to Design	3	Engr 0011
Mems 0031	Lin. Circ. & Sys. 1	3	Phys 0175, Math 0230
Mems 0051	Intro. Thermodynamics	3	Phys 0175, Chem 0960
Mems 1014	Dynamic Systems	3	Engr 0012, Mems 0031, Math 0280
Mems 1015	Rigid Body Dynamics	3	Engr 0135, Math 0240
Mems 1041	Mech. Measurements 1	3	Engr 0145, Mems 0031, Mems 1014 and Mems 1015
Mems 0071	Intro to Fluid Mech.	3	Phys 0175, Chem 0970, Math 0290
Mems 1028	Mech Design 1	3	Engr 0145
Mems 1047	Finite Element Anal	3	Mems 1028
Mems 1020	Vibrations	3	Mems 1014
Mems 1010	Exp. Meth. In MSE	3	Engr 0022
Mems 1053	Struct. of Crystals	3	Engr 0022
	Eng. Mech. Elect.	3	

	Eng. Mech. Elect.	3	
	Senior Design 1[+]	3	
	Senior Design 2[++]	3	
	Hum. Elective*	3	
	Soc. Sci. Elective*	3	
	Hum./Soc. Sci. El.*	3	
	Hum./Soc. Sci. El.*	3	
	Hum./Soc. Sci. El.* [ÿ]	3	
	Hum./Soc. Sci. El.*	3	
Total		127	

Upper Level Physics: Physics courses with course numbers > 1000

[+] A senior design course offered by one of the other SSOE engineering programs is required.
[++] May be ENGR 1050 Product Realization, or with preapproval a senior design project arranged with a faculty mentor and taken as ENGSCI 1801. Students wishing to complete a two-term project with a faculty mentor may request approval for the second term to count as a program elective (ENGSCI 1802)
*All humanities and Social Science electives must be from the SSOE approved list. Two courses need to be in single area (see SSOE guidelines).
[ÿ]A University designated writing intensive course

Italicized courses indicate co-requisites; courses must be taken prior to or concurrently.

2.4.1 Engineering Mechanics Program Electives

The Engineering Mechanics curriculum requires two program elective courses. It is suggested that the two courses be selected to form an area of specialization. Possible elective courses are given below:

Bioengineering

BIOE 1061 Human Factors Engineering
BIOE 1063 Intro to Orthopaedic BIomech
BIOE 1064 Biomech of Organs, Tissues and Cells
BIOE 1630 Biomech 1: Mechanical Principles Biological
BIOE 1631 Biomech 2: Intro to Biodyn and Biosolid Mech
BIOE 1632 Biomech 3: Biodynamics of Movement
BIOE 1633 Biomech 4: Biomech of Organs, Tissues and Cells

Civil Engineering

CEE 1801 Principles of Soil Mechanics
CEE 1821 Foundation Engineering

CEE 1412 Introduction to Hydrology
CEE 1401 Open Channel Hydraulics
CEE 1330 Intro. to Structural Analysis
CEE 1341Steel Structures

Physics

PHYS 1331 Mechanics
PHYS 1341 Thermo and Statistical Mechanics

Material Science

MEMS 0040 Materials and Manufacturing
MEMS 1011 Structure and Properties Lab
MEMS 1048 Analysis and Characterization at the Nano-Scale
MEMS 1053 Structures of Crystals
MEMS 1058 Electronic Properties of Materials
MEMS 1059 Phase Equilibria in Multi-Component Materials
MEMS 1063 Phase Transformations
MEMS 1070 Mechanical Behavior of Materials
MEMS 1111 Materials for Energy Generation and Storage

Mechanical Engineering

MEMS 1045 Automatic Controls
MEMS 1049 Mechatronics
MEMS 1051 Applied Thermodynamics
MEMS 1052 Heat and Mass Transfer
MEMS 1057 Micro/Nano Manufacturing
MEMS 1071 Applied Fluid Mechanics
MEMS 1072 Applied Fluid Dynamics
MEMS 1082 Electromechanical Sensors and Actuators

2.6 Humanities and Social Science Electives

Students must satisfactorily complete a minimum of six humanities and social science electives for a total of 18 units to satisfy the degree requirements for mechanical engineering. At least six credits of humanities and six credits for social science elements are required. All courses selected must be on the list of approved humanity/social science courses that has been prepared by the Office of the Associate Dean of the School of Engineering. External studies courses are not acceptable, nor are ENGCMP 0150 and ENGCMP 0200.

In order to satisfy School of Engineering and ABET accreditation requirements for breadth and depth, all Engineering Science students must fulfill the following requirements when choosing their six elective courses:

Depth Requirement
Students must satisfactorily 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 Science. 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 Science departments offers "W" - designated courses, which may or may not satisfy School of Engineering humanities or social science requirements.

Humanities and social science courses on the school's list of approved courses 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. The form must be submitted to the Associate Dean's office (147 Benedum Hall) for approval. Students can contact the undergraduate program office approximately one week later to see if the course was approved. It is helpful to include a copy of the course description with the form. 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 on acquiring a skill than on conveying intellectual knowledge) are also usually not approved.

2.7 Advanced Standing and Transfer Credit

Students transferring into the Engineering Science program 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 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 2.00 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. 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.

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

2.7.2 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 Program 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 Engineering Science program, he/she is not permitted to take courses at a community college or other two-year institution as part of his/her engineering education. Students residing in the Pittsburgh area are expected to take all of their courses at the University of Pittsburgh, unless there is a special course offered at one of the other area four-year colleges that is not available at the University of Pittsburgh. See Section 4.2 for more information on cross-registering at PCHE-member institutions. Students may take courses at the Greensburg and Johnstown campuses of the University of Pittsburgh.

Engineering and engineering science courses must have been taken from an ABET-approved engineering program.

Only the 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 2.00 on a 4.00 scale. It is the studentôs responsibility to have their transcript sent to the Undergraduate Program Office, 636 Benedum Hall, at the completion of the class.

2.8 Academic Advising

Å The Program Director is the academic advisor for students in the Engineering Science program. The Undergraduate Administrator will assist you with your initial registration.

Å If you decide to enroll in the co-op program, notify the MEMS Department Undergraduate Administrator in Room 636 Benedum (see Section 5.6).

Å Students must make an appointment for registration with the Program Director at least one week before the registration period begins.

2 .8.1 Undergraduate Resources Web Page

A broad range of information for undergraduates is available at:

http://www.engineering.pitt.edu/MEMS/Undergraduate/Resources/

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 courses taken to fulfill the requirements for a B.S. in Engineering Science must be taken with the Letter Grade Optionð the H/S/U and S/NC Grade Options are not allowed.

3.1.1 Letter Grades

The Universityôs letter grade system described below will be followed without exception.

Grade	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 studentôs completion of a course, one of the grades listed below may appear on the studentôs transcript in lieu of the letter grades discussed above.

G - The ñGò grade signifies unfinished course work due to extenuating circumstances.

Students assigned ñGò 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 ñGò grade is not removed within one year, the instructor may change it to an ñFò grade for the course.

I - The ñIò 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 ñRò grade signifies that a student resigned from the University.

W - The ñWò grade signifies that a student has withdrawn from a course (see Withdrawal below).

Z - The ñZò 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 termÕs add/drop period. This is done by processing an Enrollment form, signed by the studentÕs 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, 151 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 deanÕs office. A ñWò 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 studentÕs degree is awarded grade points as shown in the grading system table. A studentÕs term grade point average (term GPA) is the total grade points earned for the term divided by the total units assigned letter grades.

A studentÕs 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 studentÕs 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 studentÕs 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 studentõs 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 ñD+òor worse was awarded and earning a grade of ñCòor 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 course requirements specified in the Engineering Science curricula. Only units approved by the Engineering Science Program Director count toward 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 ñFòor a non-letter grade was received can be used to satisfy the 128-unit requirement. A minimum ñD-òletter 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 on-line at www.engineering.pitt.edu/mems/undergraduate/resources.html. After completing the form, students turn it in to the Office of Administration, 151 Benedum Hall.

   Students should 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 the Program Director 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 studentsô responsibility to meet all of the programõs requirements for graduation.

8. In the term that the student is graduating, he/she must make an appointment to see the Program Director before the add/drop period ends. The Program 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 Program 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

Useful information and many of the necessary forms associated with registration can be found on the MEMS Undergraduate Resources Web Page:
www.engineering.pitt.edu/mems/undergraduate/resources.html

These and other forms are also available in the Undergraduate Program Office, 636 Benedum Hall.

4.1 Self-Enrollment

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

Å 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 (first seniors, then juniors, etc.).

Å All students will initially have an ñAcademic Advisement Requiredò 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 studentõs hold. Ideally a studentõs 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 Program Director and approval by the Associate Dean for Academic Affairs. Such permission is given selectively and only after a review of the studentõs 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:

Å Cross-registration is available only during the Fall and Spring Terms.

Å Undergraduates and post-baccalaureate students must be registered for a total of at least 12 units (including the cross-registration units).

Å Students may not cross-register for courses available at the home institution.

Å Students cannot use cross-registration to repeat courses taken at the University of Pittsburgh.

Å Once a student is enrolled in the Engineering Science program, 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.

Å Students may not use cross-registration to take courses that are not acceptable for an Engineering degree.

Å 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, 151 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 Engineering Science 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 Program Director must initial the form, and the student then returns the form to the Office of Administration, 151 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 2.5 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 Engineering Science program are given below. More information, including links to specific web sites for each of the degree options listed below, is available online at www.engineering.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, 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 Engineering
- International Engineering Studies
- Product Realization
- Sustainable Engineering
- Mining Engineering
- Engineering for Humanity

- Supply Chain Management

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).

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.

Engineering 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, 636 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 152D Benedum Hall or call (412) 624-9882 or 9883.

5.7 School of Engineering Minors

Undergraduate students in the Engineering Science 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 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:

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

5.10 International Education

The School of Engineering is making a concerted effort to expand studentsô 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 schoolôs 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 studentôs 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 Mechanical 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, 152 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, then the classes most likely will not transfer.

APPENDICES

Appendix A ï Engineering Science Program Curriculum Checklists

Engineering Physics Curriculum Checklist **Student:**

Engineering Science Program Area of Concentration: Engineering Physics					
Course	**Title**	**Cr.**	**Grade**	**Term**	**Pre/Co-Req**
Chem 0960	Gen. Chem. Eng. 1	3			
Chem 0970	Gen. Chem. Eng. 2	3			Chem 0960
Math 0220	Anal. Geo. & Calc. 1	4			
Math 0230	Anal. Geo. & Calc. 2	4			Math 0220
Math 0240	Anal. Geo. & Calc. 3	4			Math 0230
Math 0280	Mat. & Lin. Alg.	3			Math 0220
Math 0290	Diff. Eq.	3			Math 0230
Phys 0174	Phys. Sci. & Eng. 1	4			*Math 0220*
Phys 0175	Phys. Sci. & Eng. 2	4			Phys 0174, *Math 0230*
Phys 0219	Lab Phys. Sci. & Eng.	2			*Phys 0175*
Phys 0477	Thermal Phys, Rel.,&QM	4			Phys 0175, *Math 0240*
Phys 0481	Princ. Mod. Phys. 2	3			Phys 0477
(Phys 1351)	Upper Level Physics (Rec: Inter. Elect. & Mag.)	3			Phys 0175,Math 0240, *Math 0290*
Phys	Upper Level Physics	3			
Phys	Upper Level Physics	3			
Engr 0011	Int. Eng. Analysis	3			
Engr 0012	Eng. Computing	3			Engr 0011
Engr 0022	Mat. Str. & Prop.	3			Phys 0175, Math 0230
Engr 0135	Statics & Mech. Matls 1	3			Math 0230, Phys 0174
Ece 0101	Lin. Circ. & Sys.	4			Phys 0175, Engr 0012 *Math 0280, 0290*
Ece 0201	Digital Cir. & Systems	4			Phys 0175
Ece 0102	Micro Circuits & Lab	4			Ece 0101
Ece 0301	Problem Solving C++	3			Engr 0012

Ece 1212	El. Circ. Des. Lab	3			Ece 0102, 0402
Ece 1247	Semicond. Dev. Theory	3			Ece 0102 Math 0280, 0290
Ece 1266	Appl. Fields & Waves	3			Phys 1351 Ece 0301 Alt; Physics 1372
Ece 0402	Sig. Sys. & Prob.	3			Math 0280, 0290
Mems 0051	Intro. Thermodynamics	3			Phys 0174, Chem 0960,
Mems 1053	Struct. of Crystals	3			Engr 0022
Ece 1895À	Jr. Design Fund.	3			
Mems 1059	Phase Equilibria	3			Engr 0022, Mems 0051
	Program Elective (Rec: Math 1470 PDE)	3			Math 0240, Math 0290
	Program Elective	3			
	Senior Design 1+	3			
	Senior Design 2++	3			
	Hum. Electiveÿ	3			
	Soc. Sci. Electiveÿ	3			
	Hum./Soc. Sci. El. ÿ	3			
	Hum./Soc. Sci. El. ÿ	3			
	Hum./Soc. Sci. El. ÿ À	3			
	Hum./Soc. Sci. El. ÿ	3			

Upper Level Physics: Physics courses with course numbers > 1000

+ A senior design course offered by one of the other SSOE engineering programs is required.

++ May be ENGR 1050 Product Realization, or with preapproval a senior design project arranged with a faculty mentor and taken as ENGSCI 1801. Students wishing to complete a two-term project with a faculty mentor may request approval for the second term to count as a program elective (ENGSCI 1802).

ÿAll humanities and Social Science electives must be from the SSOE approved list. Two courses need to be in single area (see SSOE guidelines).

À Writing intensive course

Italicized courses indicate co-requisites; courses must be taken prior to or concurrently.

* or MEMS 1010, MEMS 1057
Upper Level Physics: Physics courses with course numbers > 1000

[+] A senior design course offered by one of the other SSOE engineering programs is required.

[++] May be ENGR 1050 Product Realization, or with preapproval a senior design project arranged with a faculty mentor and taken as ENGSCI 1801. Students wishing to complete a two-term project with a faculty mentor may request approval for the second term to count as a program elective (ENGSCI 1802).

Italicized courses indicate co-requisites; courses must be taken prior to or concurrently.

Engineering Physics Curriculum Program Electives

There are two program electives in the Engineering Physics curriculum. It is recommended that students planning to pursue graduate studies in physics take the honors quantum mechanics sequence in the Physics department:

PHYS 1370: Introduction to Quantum Physics 1
PHYS 1371: Introduction to Quantum Physics 2

Students can also satisfy the program elective requirement by choosing a two-course sequence that creates in-depth exposure to a topic area. The Program Director can approve appropriate two-course sequences. Example sequences of courses include the following:

ECE 1232: Introduction to Lasers and Optical Electronics
ECE 1238: Digital Electronics

MEMS 1010: Experimental Methods in Materials Science and Engineering
MEMS 1101: Ferrous Physical Metallurgy

ENGR 0240 Nanotechnology and Nano-Engineering
ENGR 0241 Fabrication and Design in Nanotechnology#
(# or PHYS 1375/CHEM 1630 Foundations of Nanoscience)

Nanotechnology Curriculum Checklist **Student:**

Physics/Materials Emphasis

Course	Title	Credits	Grade	Term	Pre/Co-Req
Chem 0960	Gen. Chem. Eng. 1	3			
Chem 0970	Gen. Chem. Eng. 2	3			Chem 0960
Math 0220	Anal. Geo. & Calc. 1	4			
Math 0230	Anal. Geo. & Calc. 2	4			Math 0220
Math 0240	Anal. Geo. & Calc. 3	4			Math 0230
Math 0280	Mat. & Lin. Alg.	3			Math 0220
Math 0290	Diff. Eq.	3			Math 0230
Phys 0174	Phys. Sci. & Eng. 1	4			*Math 0220*
Phys 0175	Phys. Sci. & Eng. 2	4			Phys 0174, *Math 0230*
Phys 0477	Thermal Phys,Rel.&QM	4			Phys 0175, *Math 0240*
Phys 0481	Princ. Mod. Phys. 2	3			Phys 0479
Phys 0219	Lab Phys. Sci. & Eng.	2			Phys 0175
Phys	Upper Level Physics	3			
Phys	Upper Level Physics	3			Phys 0175, Math 0240, *Math 0290*
Engr 0011	Int. Eng. Analysis	3			
Engr 0012	Eng. Computing	3			Engr 0011
Engr 0020	Prob. & Statistics	3			
Engr 0022	Mat. Str. & Prop.	3			Phys 0175, Math 0230
Engr 0135	Statics & Mech. Matls 1	3			Math 0230, PHYS 0174
Engr 0240	Int. Nâtech. and Nâeng.	3			
Engr 0241 or Phys 1375 Chem 1630	Fab. & Des. In Nâtech. Found. of Nanosci	3			
ECE 0101	Lin. Circ. & Sys. 1	4			Phys 0175, Engr 0012 *Math 0280, Math 0290*
ECE 0102	Microelectronic Cir.	4			ECE 0101
ECE 0310	Problem Solving C++	3			ENGR 0012
MEMS 0051	Intro. Thermodynamics	3			PHYS 0175, CHEM 0960
MEMS 1010	Exp. Meth. In MSE	3			
MEMS 1053	Struct. of Crystals	3			ENGR 0022
MEMS 1057	Micro/Nano Manuf.	3			
MEMS 1059	Phase Equilibria	3			ENGR 0022, MEMS 1051
MEMS 1063	Phase Transformation.	3			MEMS 1053, MEMS 1059
	Nanotech Prog. Elect.	3			
	Nanotech Prog. Elect.	3			
	Nanotech Prog. Elect.	3			
	Senior Design 1⁺	3			
	Senior Design 2⁺⁺	3			

	Hum. Elective[ÿ]	3			
	Soc. Sci. Elective[ÿ]	3			
	Hum./Soc. Sci. El. [ÿ]	3			
	Hum./Soc. Sci. El. [ÿ]	3			
	Hum./Soc. Sci. El. [ÿ À]	3			
	Hum./Soc. Sci. El. [ÿ]	3			

Upper Level Physics: Physics courses with course numbers > 1000

[+] A senior design course offered by one of the other SSOE engineering programs is required.

[++] May be ENGR 1050 Product Realization, or with preapproval a senior design project arranged with a faculty mentor and taken as ENGSCI 1801. Students wishing to complete a two-term project with a faculty mentor may request approval for the second term to count as a program elective (ENGSCI 1802)

[ÿ]All humanities and Social Science electives must be from the SSOE approved list. Two courses need to be in single area (see SSOE guidelines).

[À] Writing intensive course

Italicized courses indicate co-requisites; courses must be taken prior to or concurrently.

Nanotechnology Curriculum Program Electives ï Physics/Materials

Approved Nanotechnology Electives include:

CHEM 1130	Inorganic Chemistry
CHEM 1410	Physical Chemistry 1
CHEM 1420	Physical Chemistry 2
CHEM 1450	Molecular Modeling and Graphics
CHEM 1480	Intermediate Physical Chemistry
CHEM 1620	Atoms, Molecules & Materials
PHYS 0577	Modern Physical Measurements
PHYS 1370	Introduction to Quantum Physics 1
PHYS 1371	Introduction to Quantum Physics 2
PHYS 1375/CHEM 1630	Foundations of Nanoscience
BIOENG 1601	Principles and Properties of Complex Engineered Materials
BIOENG 1810	Biomaterals and Biocompatibility
ECE 1232	Introduction to Lasers and Optical Electronics
ECE 1238	Digital Electronics
ECE 1247	Semiconductor Device Theory
ECE 2295	Nanosensors
ENGR 1065	Nanomanufacturing and Nanomaterials for Photovoltaics
ENGR 1066	Introduction to Solar Cells and Nanotechnology

IE 1012	Manufacture of Structural Nano-Materials
MEMS 1447	Nanocharacterization
MEMS 1469	Materials Science of Nanostructures
MEMS 1477	Thin Film Processes and Characterization
MEMS 1480	Introduction to Microelectromechanical Systems
MEMS 1101	Ferrous Physical Metallurgy

Other appropriate courses may be approved as Nanotechnology Electives by the Program Director

Nanotechnology Curriculum Checklist **Student:**

Chemistry/Bioengineering Emphasis

Course	**Title**	**Credits**	**Grade**	**Term**	**Pre/Co-Req**
Phys 0174	Phys. Sci. & Eng. 1	4			*Math 0220*
Phys 0175	Phys. Sci. & Eng. 2	4			Phys 0174, *Math 0230*
Phys 0219	Basic Lab Physics	2			Phys 0175
Math 0220	Anal. Geo. & Calc. 1	4			
Math 0230	Anal. Geo. & Calc. 2	4			Math 0220
Math 0240	Anal. Geo. & Calc. 3	4			Math 0230
Math 0280	Mat. & Lin. Alg.	3			Math 0220
Math 0290	Diff. Eq.	3			Math 0230
Chem 0960	Gen. Chem. Eng. 1	3			
Chem 0970	Gen. Chem. Eng. 2	3			Chem 0960
CHEM 1	Core Chem. Course	3			
CHEM 2	Core Chem. Course	3			
CHEM 3	Core Chem. Course	3			
LIFESCI 1	Basic Life Science	3			
LIFESCI 2	Basic Life Science	3			
Engr 0011	Int. Eng. Analysis	3			
Engr 0012	Eng. Computing	3			Engr 0011
Engr 0020	Prob. & Statistics	4			
Engr 0022	Mat. Str. & Prop.	3			Phys 0175, Math 0230
Engr 0135	Statics & Mech. Matls	3			Math 0230, Phys 0174
Engr 0240	Int. Nôtech. & Nôeng.	3			
ECE 0101	Lin. Circ. & Sys. 1	4			Phys 0175, Engr 0012 *Math 0280, Math 0290*
ECE 0102	Microelectronic Cir.	4			Ece 0101
ECE 0301	Prob. Solving C++	3			Engr 0012
BIOENG 1	Core Bioeng.	3			
BIOENG 2	Core Bioeng.	3			
MEMS 0051	Intro. Thermodynamics	3			Phys 0175, Chem 0960
MEMS 1010	Exp. Meth. In MSE	3			
MEMS 1053	Struct. of Crystals	3			Engr 0022
MEMS 1057	Micro/Nano Manuf.	3			
	Nano Prog. Elect.*	3			
	Nano Prog. Elect.	3			
	Nano Prog. Elect.	3			
	Senior Design 1[+]	3			
	Senior Design 2[++]	3			
	Hum. Elective[ÿ]	3			

ττ

	Soc. Sci. Elective[ÿ]	3			
	Hum./Soc. Sci. El. [ÿ]	3			
	Hum./Soc. Sci. El. [ÿ]	3			
	Hum./Soc. Sci. El. [Àÿ]	3			
	Hum./Soc. Sci. El. [ÿ]	3			

[+] A senior design course offered by one of the other SSOE engineering programs is required.

[++] May be ENGR 1050 Product Realization, or with preapproval a senior design project arranged with a faculty mentor and taken as ENGSCI 1801. Students wishing to complete a two-term project with a faculty mentor may request approval for the second term to count as a program elective (ENGSCI 1802).

* One of the Nano. Prog. Electives must be a basic science course* Three credits of basic science lab courses can constitute a three credit Nano Prog. Elective.

[ÿ]All humanities and Social Science electives must be from the SSOE approved list. Two courses need to be in single area (see SSOE guidelines).

[À] Writing intensive course

Italicized courses indicate co-requisites; courses must be taken prior to or concurrently.

Nanotechnology Curriculum Program Electives and Core Chemistry, Life Science and Bioengineering Course Options ï Chemistry/Bioengineerin

Approved Nanotechnology Electives include:

CHEM 0310	Organic Chemistry 1
CHEM 0320	Organic Chemistry 2
CHEM 1130	Inorganic Chemistry
CHEM 1410	Physical Chemistry 1
CHEM 1420	Physical Chemistry 2
CHEM 1450	Molecular Modeling and Graphics
CHEM 1480	Intermediate Physical Chemistry
CHEM 1620	Atoms, Molecules & Materials
PHYS 0577	Modern Physical Measurements
PHYS 1370	Introduction to Quantum Physics
PHYS 1371	Introduction to Quantum Physics
PHYS 1375/CHEM 1630	Foundations of Nanoscience
BIOSC 0050	Foundations of Bio. Lab 1 (1 cr.)
BIOSC 0060	Foundations of Bio. Lab 2 (1 cr.)
BIOENG 1005	RF Medical Devices and Applications
BIOENG 1532	Bioseparation
BIOENG 1601	Principles and Properties of Complex Engineered Materials
BIOENG 1810	Biomaterals and Biocompatibility

ECE 1232	Introduction to Lasers and Optical Electronics (3 units)
ECE 1238	Digital Electronics (3 units)
ECE 1247	Semiconductor Device Theory
ECE 2295	Nanosensors
ENGR 1065	Nanomanufacturing and Nanomaterials for Photovoltaics
ENGR 1066	Introduction to Solar Cells and Nanotechnology
IE 1012	Manufacture of Structural Nano-Materials
MEMS 1059	Phase Equilibria
MEMS 1063	Phase Transformation
MEMS 1447	Nanocharacterization
MEMS 1469	Materials Science of Nanostructures
MEMS 1477	Thin Film Processes and Characterization
MEMS 1480	Introduction to Microelectromechanical Systems
MEMS 1101	Ferrous Physical Metallurgy

Other appropriate courses may be approved as Nanotechnology Electives by the Program Director

CHEM 1, 2, and 3 must be selected from the following:

CHEM 0310	Organic Chemistry 1
CHEM 0320	Organic Chemistry 2
CHEM 0250	Analytic Chemistry
CHEM 1250	Instrument Analysis
CHEM 1410	Physical Chemistry 1
CHEM 1420	Physical Chemistry 2
CHEM 1130	Inorganic Chemistry
CHEM 1590	Molecular Biophysics
BIOSC 1000	Principles of Biochemistry
BIOSC 1810	Macromolecular Structure

Other appropriate courses may be approved as CHEM 1, 2, and 3 by the Program Director

LIFESCI 1 and 2 must be selected from the following:

BIOENG 1070	Cell Biology I
BIOENG 1071	Cell Biology II
BIOSC 0150	Foundations of Biology I
BIOSC 0160	Foundations of Biology II
BIOSC 1070	Human Physiology - UHC
BIOSC 1250	Introduction to Human Physiology
HRS 1020	Introduction to Anatomy and Physiology
HRS 1022	Human Anatomy
HRS 1023	Human Physiology
HRS 1024	Introduction to Neurosciences

NROSCI 1000	Intro to Neuroscience
NROSCI 1003	UHC Introduction to Neuroscience

Other appropriate courses may be approved as LIFESCI 1 and 2 by the Program Director

BIOENG 1 and 2 must be selected from the following (prerequisites must be met):

BIOENG 1005 Radiofrequency Medical Devices

BIOENG 1061	Human Factors Engineering
BIOENG 1075	Introductory Cell and Molecular Biology Lab Techniques
BIOENG 1095	Special Projects
BIOENG 1150	Bioengineering Methods and Applications
BIOENG 1210	Bioengineering Thermodynamics
BIOENG 1220	Biotransport Phenomena
BIOENG 1241	Societal, Political, Ethical Issues in Biotechnology
BIOENG 1310	Linear Systems and Electronics I
BIOENG 1311	Hemodynamics and Biotransport
BIOENG 1320	Linear Systems and Electronics II
BIOENG 1330	Biomedical Imaging
BIOENG 1383	Biomedical Optical Microscopy
BIOENG 1384	Application of NMR Spectroscopy in Medicine
BIOENG 1531	Fundamentals of Biochemical Engineering
BIOENG 1601	Principles and Properties of Complex Engineered Materials
BIOENG 1620	Introduction to Tissue Engineering
BIOENG 1630	Biomechanics 1

Other appropriate courses may be approved as BIOENG 1 and 2 by the Program Director

Engineering Mechanics Curriculum Checklist **Student:**

The required courses in the Engineering Mechanics curriculum are summarized below.

Course	Title	Cr.	Grade	Term	Pre/Co-Req
Chem 0960	Gen. Chem. Eng. 1	3			
Chem 0970	Gen. Chem. Eng. 2	3			Chem 0960
Math 0220	Anal. Geo. & Calc. 1	4			
Math 0230	Anal. Geo. & Calc. 2	4			Math 0220
Math 0240	Anal. Geo. & Calc. 3	4			Math 0230
Math 0280	Mat. & Lin. Alg.	3			Math 0220
Math 0290	Diff. Eq.	3			Math 0230
Stat 1000	Appl. Stat. Methods	4			
Math 1550	Vector Analysis	3			
Phys 0174	Phys. Sci. & Eng. 1	4			*Math 0220*
Phys 0175	Phys. Sci. & Eng. 2	4			Phys 0174, *Math 0230*
Phys 0477	Thermal Phys, Rel&QM	4			Phys 0175, *Math 0240*
Phys	Upper Level Physics	3			
Engr 0011	Int. Eng. Analysis	3			
Engr 0012	Eng. Computing	3			Engr 0011
Engr 0022	Mat. Str. & Prop.	3			Phys 0175, Math 0230
Engr 0135	Statics & Mech. Matls 1	3			Math 0230, PHYS 0174
Engr 0145	Statics & Mech. Matls 2	3			Engr 0135
MEMS 0024	Intro to Design	3			
MEMS 0031	Lin. Circ. & Sys. 1	3			Phys 0175, Math 0230
MEMS 0051	Intro to Thermo	3			PHYS 0175, CHEM 0960
MEMS 1014	Dynamic Systems	3			Mems 1015
MEMS 1015	Rigid Body Dyn.	3			Ece 0031
MEMS 1041	Mech. Measure. 1	3			
MEMS 0071	Intro. Fluid Mechanics	3			
MEMS 1028	Mech Design 1	3			
MEMS 1047	Finite Element Anal	3			
MEMS 1020	Vibrations	3			
MEMS 1010	Exp. Meth. In MSE	3			
MEMS 1053	Struct. Of Crystals	3			
	Eng. Mech. Elect.	3			
	Eng. Mech. Elect.	3			
	Senior Design 1+	3			

τψ

	Senior Design 2[++]	3			
	Hum. Elective[ÿ]	3			
	Soc. Sci. Elective[ÿ]	3			
	Hum./Soc. Sci. El.[ÿ]	3			
	Hum./Soc. Sci. El.[ÿ]	3			
	Hum./Soc. Sci. El. [ÿÀ]	3			
	Hum./Soc. Sci. El. [ÿ]	3			
Total		127			

Upper Level Physics: Physics courses with course numbers > 1000

[+] A senior design course offered by one of the other SSOE engineering programs is required.
[++] May be ENGR 1050 Product Realization, or with preapproval a senior design project arranged with a faculty mentor and taken as ENGSCI 1801. Students wishing to complete a two-term project with a faculty mentor may request approval for the second term to count as a program elective (ENGSCI 1802).
Note: All humanities and Social Science electives must be from the SSOE approved list. Two courses need to be in single area (see SSOE guidelines).
[À] Writing intensive course
[ÿ]All humanities and Social Science electives must be from the SSOE approved list. Two courses need to be in single area (see SSOE guidelines).

Italicized courses indicate co-requisites; courses must be taken prior to or concurrently.

Engineering Mechanics Program Electives

<u>Bioengineering</u>

BIOE 1061 Human Factors EngineeringMEMS
BIOE 1063 Intro to Orthopaedic BIomech
BIOE 1064 Biomech of Organs, Tissues and Cells
BIOE 1630 Biomech 1: Mechanical Principles Biological
BIOE 1631 Biomech 2: Intro to Biodyn and Biosolid Mech
BIOE 1632 Biomech 3: Biodynamics of Movement
BIOE 1633 Biomech 4: Biomech of Organs, Tissues and Cells

<u>Civil Engineering</u>

CEE 1801 Principles of Soil Mechanics
CEE 1821 Foundation Engineering
CEE 1412 Introduction to Hydrology
CEE 1401 Open Channel Hydraulics
CEE 1330 Intro. to Structural Analysis
CEE 1341Steel Structures

<u>Physics</u>

PHYS 1331 Mechanics

PHYS 1341 Thermo and Statistical Mechanics

Material Science

MEMS 0040 Materials and Manufacturing
MEMS 1011 Structure and Properties Lab (2cr)
MEMS 1030 Materials Selection
MEMS 1053 Structures of Crystals
MEMS 1058 Electronic Properties of Materials
MEMS 1059 Phase Equilibria in Multi-Component Materials
MEMS 1063 Phase Transformations

Mechanical Engineering

A number of mechanical engineering course can be used as program electives. Consult with the program

Appendix B ï Engineering Science Program Sample Schedules

Engineering Science Program
Area of Concentration: Engineering Physics

First Term			**Second Term**		
		Units			Units
CHEM 0960	Gen. Chem. For Engr.1	3	CHEM 0970	Gen. Chem. For Engr.2	3
MATH 0220	Anal. Geometry & Calc. 1	4	MATH 0230	Anal. Geometry & Calc. 2	4
PHYS 0174	Phys. For Sci. & Engr. 1	4	PHYS 0175	Phys. For Sci. & Engr. 2	4
ENGR 0011	Intr. Engr. Analysis	3	ENGR 0012	Engr. Computing	3
	H/SS Elective 1	3		H/SS Elective 2	3
ENGR 0081	Freshman Seminar	0	ENGR 0082	Freshman Seminar	0
		17			17
Third Term			**Fourth Term**		
MATH 0290	Differential Equations	3	MATH 0240	Anal. Geom. & Calc. 3	4
MATH 0280	Matrices and Lin. Algebra	3	ENGR 0022	Matl. Structure & Prop.	3
ECE 0301	Prob. Solving with C++	3	ECE 0402	Sig. Sys. & Probability	3
ECE 0101	Linear Circ. & Systems	4	MEMS 0051	Intro. To Thermo	3
ECE 0201	Digital Circ.& Systems	4		.H/SS Elective 3	3
MEMS 1085	Departmental Seminar	0	MEMS 1085	Departmental Seminar	
		17			16
Fifth Term			**Sixth Term**		
PHYS 0477	Thermal Phys, Rel., & QM	4	PHYS 0219	Lab. Phys. for Sci. & Engr.	2
ECE 1212	Elect. Circ. Design Lab	3	ECE 0102	Micro. Elect. Circ. & Lab	4
	Upper level Physics 1 (Rec: PHYS 1351)	3	ENGR 0135	Statics 1	3
MEMS 1053	Struct. of Crystals & Diff.	3	ECE 1895	Jr. Design Fund.	3
	Program Elective 1 (Rec: MATH1470)	3		H/SS Elective 4À	3
MEMS 1085	Departmental Seminar	0	MEMS 1085	Departmental Seminar	0
		16			15
Seventh Term			**Eighth Term**		
ECE 1247	Semicon. Device Theory	3		Upper Level Physics	3
ECE 1266	Appl. Fields & Waves	3	PHYS 0481	Prin. Modern Physics 3	3
MEMS 1059	Phase Equilibria	3		Senior Design*	3
ECE 1896	Senior Design*	3		Program Elect. 2	3
	Upper Level Physics3	3		H/SS Elective 6	3
	H/SS Elective 5	3	MEMS 1085	Departmental Seminar	0
MEMS 1085	Departmental Seminar	0			
		18			15

* at least one senior design course offered by one of the other SSOE engineering programs is required; the second course may be a senior project arranged with a faculty mentor and taken as ENGSCI 1801. Students wishing to complete a two-term project with a faculty mentor may request approval for the second term to count as a program elective (ENGSCI 1802).
Upper Level Physics: Physics courses with course numbers > 1000
À Writing intensive course
Note: All humanities and Social Science electives must be from the SSOE approved list. Two courses need to be in single area (see SSOE guidelines).
Courses in red constitute a minor in Physics
131 total credits; 51 credits minimum of Engineering, 50 credits minimum of Math/Science

Program Electives

There are two program electives in the Engineering Physics curriculum. It is recommended that students planning to pursue graduate studies in physics take the honors quantum mechanics sequence in the Physics department:

PHYS 1370: Introduction to Quantum Physics 1
PHYS 1371: Introduction to Quantum Physics 2

Note: PHYS 1331 and 1351 are prerequisites for PHYS 1370.

Students can also satisfy the program elective requirement by choosing a two-course sequence that creates in-depth exposure to a topic area. The Program Director can approve appropriate two-course sequences. Example include the following:

ECE 1232: Introduction to Lasers and Optical Electronics
ECE 1238: Digital Electronics

MEMS 1010: Experimental Methods in Materials Science and Engineering
MEMS 1101: Ferrous Physical Metallurgy

ENGR 0240 Nanotechnology and Nano-Engineering
ENGR 0241 Fabrication and Design in Nanotechnology#
(# or PHYS 1375/CHEM 1630 Foundations of Nanoscience)

Engineering Science Program
Area of Concentration: Nanotechnology
Physics/Materials Emphasis

First Term			**Second Term**		
		Units			Units
CHEM 0960	Gen. Chem. For Engr.1	3	CHEM 0970	Gen. Chem. For Engr.2	3
MATH 0220	Anal. Geometry & Calc. 1	4	MATH 0230	Anal. Geometry & Calc. 2	4
PHYS 0174	Phys. For Sci. & Engr. 1	4	PHYS 0175	Phys. For Sci. & Engr. 2	4
ENGR 0011	Intr. Engr. Analysis	3	ENGR 0012	Engr. Computing	3
	H/SS Elective 1	3		H/SS Elective 2	3
ENGR 0081	Freshman Seminar	0	ENGR 0082	Freshman Seminar	0
		17			17
Third Term			**Fourth Term**		
MATH 0290	Differential Equations	3	MATH 0240	Anal. Geom. & Calc. 3	4
MATH 0280	Matrices and Lin. Algebra	3	ENG 0135	Statics & Mech 1	3
ECE 0101	Linear Circ. & Systems	4	MEMS 0051	Intro. to Thermo.	3
PHYS 0477	Thermal Phys, Rel., & QM	4	PHYS 0219	Lab. Phys. for Sci. & Eng.	2
ECE 0301	Problem Solving w/C++	3	ENGR 0022	Mat. Structure & Prop.	3
MEMS 1085	Departmental Seminar	0	MEMS 1085	Departmental Seminar	0
		17			15
Fifth Term			**Sixth Term**		
	H/SS Elective 3	3			
	Nanotech Elective 1	3	ENGR 0241#	Fab. & Des. In Nanotech.	3
ENGR 0240	Int. Nanotech. & Nanoeng.	3	MEMS 1063	Ph. Transf. & Micro. Evol.	3
MEMS 1010	Exp. Methods in MSE	3		Nanotech. Elective 2	3
MEMS 1053	Struct. of Crystals & Diff.	3	ECE 0102	Microelectonic Cir.	4
MEMS 1059	Ph. Eq. Multi-Comp. Syst.	3	PHYS	Upper Level Physics 1	3
MEMS 1085	Departmental Seminar	0	MEMS 1085	Departmental Seminar	0
		18			16
Seventh Term			**Eighth Term**		
MEMS 1057	Micro/Nano Manufacturing	3	PHYS 0481	Prin. Modern Physics 2	3
	Nanotech. Elective[À] 3	3		HSS Elective 5	3
	H/SS Elective 4	3	ENGR 0020	Probability & Statistics	4
PHYS	Upper Level Physics 2	3		H/SS Elective 6	3
MEMS 1085	Departmental Seminar	0	MEMS 1085	Departmental Seminar	0
		15			16

or PHYS 1375/CHEM 1630
Upper Level Physics: Physics courses with course numbers > 1000
* at least one senior design course offered by one of the other SSOE engineering programs is required; the second course may be a senior project arranged with a faculty mentor and taken as ENGSCI 1801. Students wishing to complete a two-term project with a faculty mentor may request approval for the second term to count as a program elective (ENGSCI 1802).
[À]Writing intensive course
Note: All humanities and Social Science electives must be from the SSOE approved list. Two courses need to be in single area (see SSOE guidelines).

courses in red constitute a minor in Physics
131 total credits; 50 credits minimum of Engineering, 45 credits minimum of Math/Science

Approved Nanotechnology Electives include:

CHEM 1130	Inorganic Chemistry
CHEM 1410	Physical Chemistry 1
CHEM 1420	Physical Chemistry 2
CHEM 1450	Molecular Modeling and Graphics
CHEM 1480	Intermediate Physical Chemistry
CHEM 1620	Atoms, Molecules & Materials
PHYS 0577	Modern Physical Measurements
PHYS 1370	Introduction to Quantum Physics
PHYS 1371	Introduction to Quantum Physics
PHYS 1375/CHEM 1630	Foundations of Nanoscience
BIOENG 1601	Principles and Properties of Complex Engineered Materials
BIOENG 1810	Biomaterals and Biocompatibility
ECE 1232	Introduction to Lasers and Optical Electronics
ECE 1238	Digital Electronics
ECE 1247	Semiconductor Device Theory
ECE 2295	Nanosensors
ENGR 1065	Nanomanufacturing and Nanomaterials for Photovoltaics
ENGR 1066	Introduction to Solar Cells and Nanotechnology
IE 1012	Manufacture of Structural Nano-Materials
MEMS 1447	Nanocharacterization
MEMS 1469	Materials Science of Nanostructures
MEMS 1477	Thin Film Processes and Characterization
MEMS 1480	Introduction to Microelectromechanical Systems
MEMS 1101	Ferrous Physical Metallurgy

Other appropriate courses may be approved as Nanotechnology Electives by the Program Director

Engineering Science Program
Area of Concentration: Nanotechnology
Chemistry/Bioengineering Emphasis

First Term			**Second Term**		
		Units			Units
CHEM 0960	Gen. Chem. For Engr.1	3	CHEM 0970	Gen. Chem. For Engr.2	3
MATH 0220	Anal. Geometry & Calc. 1	4	MATH 0230	Anal. Geometry & Calc. 2	4
PHYS 0174	Phys. For Sci. & Engr. 1	4	PHYS 0175	Phys. For Sci. & Engr. 2	4
ENGR 0011	Intr. Engr. Analysis	3	ENGR 0012	Engr. Computing	3
	H/SS Elective 1	3		H/SS Elective 2	3
ENGR 0081	Freshman Seminar	0	ENGR 0082	Freshman Seminar	0
		17			17
Third Term			**Fourth Term**		
MATH 0290	Differential Equations Anal.	3	MATH 0290	Differential Equations	3
MATH 0280	Matrices and Lin. Algebra	3	CHEM 2	Core chemistry course	3
CHEM 1	Core chemistry course	3	MEMS 0051	Intro. to Thermo.	3
ECE 0101	Lin Cir & Systems 1	4	LIFESCI 1	Basic Life Science	3
ECE 0301	Problem Solving w/C++	3	ENGR 0022	Mat. Structure & Prop	3
MEMS 1085	Departmental Seminar	0	MEMS 1085	Departmental Seminar	0
		16			15
Fifth Term			**Sixth Term**		
ENGR 0240	Int. Nanotech. & Nanoeng.	3	ENGR 0135	Statics & Mechanics1	3
LIFESCI 2	Basic Life Science	3		H/SS Elective 4	3
MEMS 1010	Exp. Methods in MSE	3	CHEM 3	Core chemistry course	3
MEMS 1053	Struct. of Crystals & Diff.	3	BIOENG 2	Core BIOENG Course	3
	H/SS Elective[À] 3	3		Nanotech Elective[ÿ] 1	3
BIOENG 1	Core BIOENG Course	3	MEMS 1085	Departmental Seminar	0
MEMS 1085	Departmental Seminar	0			
		18			15
Seventh Term			**Eighth Term**		
ENGR 0020 ECE 0201	Probability & Statistics Digital Circ. & Systems	4		Senior Design 2*	3
MEMS 1059	Ph. Eq. Multi-Comp. Syst.	3		Nano Elective 2	3
	Senior Design 1*	3		Nano Elective 3	3
MEMS 1057	Micro/Nano Manufacturing	3	MATH 0240	Anal. Geom. & Calc. 3	4
	H/SS Elective 5	3		H/SS Elective 6	3
MEMS 1085	Departmental Seminar	0	MEMS 1085	Departmental Seminar	0
	.	16			15

* at least one senior design course offered by one of the other SSOE engineering programs is required; the second course may be a senior project arranged with a faculty mentor and taken as ENGSCI 1801. Students wishing to complete a two-term project with a faculty mentor may request approval for the second term to count as a program elective (ENGSCI 1802).

[ÿ] One of the Nano. Prog. Electives must be a basic science course. Three credits of basic science lab courses can constitute a three credit Nano Prog. Elective.

[À]Writing intensive course

Note: All humanities and Social Science electives must be from the SSOE approved list. Two courses need to be in single area (see SSOE guidelines).

classes in red constitute a minor in Bioengineering if the student also takes BIOENG 1085 Seminar
classes in green constitute a minor in Chemistry if students add two 1-cr Chemistry Lab courses
131 total credits; 49 credits minimum of Engineering, 50 credits minimum of Math/Science

Approved Nanotechnology Electives include:

CHEM 0310	Organic Chemistry 1
CHEM 0320	Organic Chemistry 2
CHEM 1130	Inorganic Chemistry
CHEM 1410	Physical Chemistry 1
CHEM 1420	Physical Chemistry 2
CHEM 1450	Molecular Modeling and Graphics
CHEM 1480	Intermediate Physical Chemistry
CHEM 1620	Atoms, Molecules & Materials
PHYS 0577	Modern Physical Measurements
PHYS 1370	Introduction to Quantum Physics
PHYS 1371	Introduction to Quantum Physics
PHYS 1375/CHEM 1630	Foundations of Nanoscience
BIOSC 0050	Foundations of Bio. Lab 1 (1 cr.)
BIOSC 0060	Foundations of Bio. Lab 2 (1 cr.)
BIOENG 1005	RF Medical Devices and Applications é
BIOENG 1532	Bioseparation
BIOENG 1601	Principles and Properties of Complex Engineered Materials
BIOENG 1810	Biomaterals and Biocompatibility
ECE 1232	Introduction to Lasers and Optical Electronics (3 units)
ECE 1238	Digital Electronics (3 units)
ECE 1247	Semiconductor Device Theory
ECE 2295	Nanosensors
ENGR 1065	Nanomanufacturing and Nanomaterials for Photovoltaics
ENGR 1066	Introduction to Solar Cells and Nanotechnology
IE 1012	Manufacture of Structural Nano-Materials
MEMS 1447	Nanocharacterization
MEMS 1469	Materials Science of Nanostructures
MEMS 1477	Thin Film Processes and Characterization
MEMS 1480	Introduction to Microelectromechanical Systems
MEMS 1101	Ferrous Physical Metallurgy

Other appropriate courses may be approved as Nanotechnology Electives by the Program Director

CHEM 1, 2, and 3 must be selected from the following:

CHEM 0250	Analytic Chemistry
CHEM 0310	Organic Chemistry 1
CHEM 0320	Organic Chemistry 2
CHEM 1130	Inorganic Chemistry
CHEM 1250	Instrument Analysis
CHEM 1410	Physical Chemistry 1
CHEM 1420	Physical Chemistry 2
CHEM 1590	Molecular Biophysics

BIOSCI 1000	Principles of Biochemistry
BIOSCI 1810	Macromolecular Structure

Other appropriate courses may be approved as CHEM 1, 2, and 3 by the Program Director

LIFESCI 1 and 2 must be selected from the following:

BIOENG 1070	Cell Biology I
BIOENG 1071	Cell Biology II
BIOSCI 0150	Foundations of Biology I
BIOSCI 0160	Foundations of Biology II
BIOSCI 1070	Human Physiology - UHC
BIOSCI 1250	Introduction to Human Physiology
HRS 1020	Introduction to Anatomy and Physiology
HRS 1022	Human Anatomy
HRS 1023	Human Physiology
HRS 1024	Introduction to Neurosciences
NROSCI 1000	Intro to Neuroscience
NROSCI 1003	UHC Introduction to Neuroscience

Other appropriate courses may be approved as LIFESCI 1 and 2 by the Program Director

BIOENG 1 and 2 must be selected from the following (prerequisites must be met):

BIOENG 1005	Radiofrequency Medical Devices
BIOENG 1061	Human Factors Engineering
BIOENG 1075	Introductory Cell and Molecular Biology Lab Techniques
BIOENG 1095	Special Projects
BIOENG 1150	Bioengineering Methods and Applications
BIOENG 1210	Bioengineering Thermodynamics
BIOENG 1220	Biotransport Phenomena
BIOENG 1241	Societal, Political, Ethical Issues in Biotechnology
BIOENG 1310	Linear Systems and Electronics I
BIOENG 1311	Hemodynamics and Biotransport
BIOENG 1320	Linear Systems and Electronics II
BIOENG 1330	Biomedical Imaging
BIOENG 1383	Biomedical Optical Microscopy
BIOENG 1384	Application of NMR Spectroscopy in Medicine
BIOENG 1531	Fundamentals of Biochemical Engineering
BIOENG 1601	Principles and Properties of Complex Engineered Materials
BIOENG 1620	Introduction to Tissue Engineering
BIOENG 1630	Biomechanics 1

Other appropriate courses may be approved as BIOENG 1 and 2 by Program Director

Engineering Science Program
Area of Concentration: Engineering Mechanics

Note: Completing this curriculum qualifies the student for an Undergraduate Certificate in Engineering Mechanics.

FIRST TERM			SECOND TERM		
Subject		**Units**	**Subject**		**Units**
CHEM 0960	Gen. Chem. For Engr. 1	3	CHEM 0970	Gen. Chem. For Engr. 2	3
MATH 0220	Anal. Geo. & Calc. 1	4	MATH 0230	Anal. Geo. & Calc. 2	4
PHYS 0174	Phys. For Sci. & Engr. 1	4	PHYS 0175	Phys. For Sci. & Engr. 2	4
ENGR 0011	Intro. To Engr. Analysis	3	ENGR 0012	Engr. Computing	3
	Hum/Soc. Sci. Elec. 1	3		Hum/Soc. Sci. Elec. 2	3
ENGR 0081	Freshman Seminar	0	ENGR 0082	Freshman Seminar	0
	Total	17		Total	17

THIRD TERM			FOURTH TERM		
Subject		**Units**	**Subject**		**Units**
MATH 0240	Anal. Geo. & Calc. 3	4	MATH 0290	Differential Equations	3
MATH 0280	Matrices & Linear Alg.	3	ENGR 0145	Statics & Mech. Mater. 2	3
MEMS 0024	Intro to Design	3	MEMS 0031	Linear Circ. & Systems 1	3
ENGR 0135	Statics & Mech. Mater.	3	MEMS 0051	Intro. to	3
MEMS 1085	1	0	ENRG 0022	Thermodynamics	3
	Departmental Seminar	3		Mater. Struct. & Prop.	0
	Hum./Soc. Sci. Elec. À 3	16	MEMS 1085	Departmental Seminar	
	Total			Total	15

FIFTH TERM			SIXTH TERM		
Subject		**Units**	**Subject**		**Units**
MATH 1055	Vector Analysis	3	STAT 1000	Statistics	4
MEMS 1010	Exp. Methods in MSE	3	MEMS 1020	Vibrations	3
PHYS 0477	Thermal Phys, Rel., &	4	MEMS 1028	Mech. Design 1	3
MEMS 0071	Intro Fluid Mech.	3	MEMS 1014	Dynamic Systems	3
MEMS 1015	Rigid Body Dyn.	3		Hum./Soc. Sci. Elec. 4	3
MEMS 1085	Departmental Seminar	0	MEMS 1085	Departmental Seminar	0
	Total	16		Total	16

SEVENTH TERM			EIGHT TERM		
Subject		**Units**	**Subject**		**Units**
	Senior Design 1*	3		Senior Design 2*	3
MEMS 1041	Mech. Measure. 1	3	MEMS 1053	Struct. of Crystals	3
	Program Elective 1	3	PHYS	Upper Level Physics	3
MEMS 1047	Finite El. Method	3		Program Elective 2	3
	Hum./Soc. Sci. Elec. 5	3		Hum./Soc. Sci. Elec. 6	3
MEMS 1085	Departmental Seminar	0		Departmental Seminar	3
	Total	15	MEMS 1085	Total	15

* at least one senior design course offered by one of the other SSOE engineering programs is required; the second course may be a senior project arranged with a faculty mentor and taken as ENGSCI 1801. Students wishing to complete a two-term project with a faculty mentor may request approval for the second term to count as a program elective (ENGSCI 1802).

Upper Level Math: Math courses with course numbers > 1000

ÀWriting intensive course

Note: All humanities and Social Science electives must be from the SSOE approved list. Two courses need to be in single area (see SSOE guidelines).

127 total credits

Engineering Mechanics Program Electives

Bioengineering

BIOE 1061 Human Factors EngineeringMEMS
BIOE 1063 Intro to Orthopaedic BIomech
BIOE 1064 Biomech of Organs, Tissues and Cells
BIOE 1630 Biomech 1: Mechanical Principles Biological
BIOE 1631 Biomech 2: Intro to Biodyn and Biosolid Mech
BIOE 1632 Biomech 3: Biodynamics of Movement
BIOE 1633 Biomech 4: Biomech of Organs, Tissues and Cells

Civil Engineering

CEE 1801 Principles of Soil Mechanics
CEE 1821 Foundation Engineering
CEE 1412 Introduction to Hydrology
CEE 1401 Open Channel Hydraulics
CEE 1330 Intro. to Structural Analysis
CEE 1341Steel Structures

Physics

PHYS 1331 Mechanics
PHYS 1341 Thermo and Statistical Mechanics

Material Science

MEMS 0040 Materials and Manufacturing
MEMS 1011 Structure and Properties Lab (2cr)
MEMS 1053 Structures of Crystals
MEMS 1058 Electronic Properties of Materials
MEMS 1059 Phase Equilibria in Multi-Component Materials
MEMS 1063 Phase Transformations

Appendix C ï Key Engineering Science Program Course Offerings by Term

A tentative term-by-term listing of course offerings for key required courses in the Engineering Science curricula is provided below. Note that upper level CHEM, LIFESCI, and BIOENG courses in the Chemistry/Bioengineering Nanotechnology curriculum are selected from a menu of courses in each of these areas - they are not listed below. Students are responsible for confirming the availability of courses they need for their course of study.

Course Number	Fall	Spring	Summer
Phys 0477	x		
Phys 0481		X	
Engr 0020	x	X	x
Engr 0022	x	X	x
Engr 0240	x		
Engr 0241 or Phys 1375		X	
ECE 0031	x	X	
ECE 0257	x	X	x
ECE 1201	x	X	
ECE 1212		X	x
ECE 1247	x		
ECE 1266	x		
ECE 1552	x	X	
MEMS 0051		X	x
MEMS 1010	x		
MEMS 1053	x		
MEMS 1057	x		
MEMS 1058	x		
MEMS 1059	x		
MEMS 1063		X	
MEMS 0071	x	X	
MEMS 1071		X	x

Appendix D ï Engineering Science Program Co-op Schedule Form

The interdisciplinary nature of the Engineering Science program requires in-depth exposure to science combined with in-depth exposure to multiple engineering disciplines. Students have several standard curricula to choose from and considerable flexibility within each curriculum. Therefore it is difficult to design a one-size-fits-all Co-op schedule. Engineering Science students interested in the Co-op program should consult with the Program Director as early as possible so that an appropriate schedule can be developed.

Co-op Schedule for the Engineering Science Program

Student Name:

Anticipated Co-op Start Date:

Current Status (circle one): Soph. 2 Jun. 1 Jun. 2 Senior 1

Year	Fall	Spring	Summer
1			
2			
3			
4			
5			

Co-op Advisorõs Signature: ______________________________ Date: ______________

Studentõs Signature: ____________________________________Date: ______________

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