UNIVERSITY OF PITTSBURGH | SWANSON SCHOOL OF ENGINEERING

ENGINEERING SCIENCE

UNDERGRADUATE PROGRAM MANUAL

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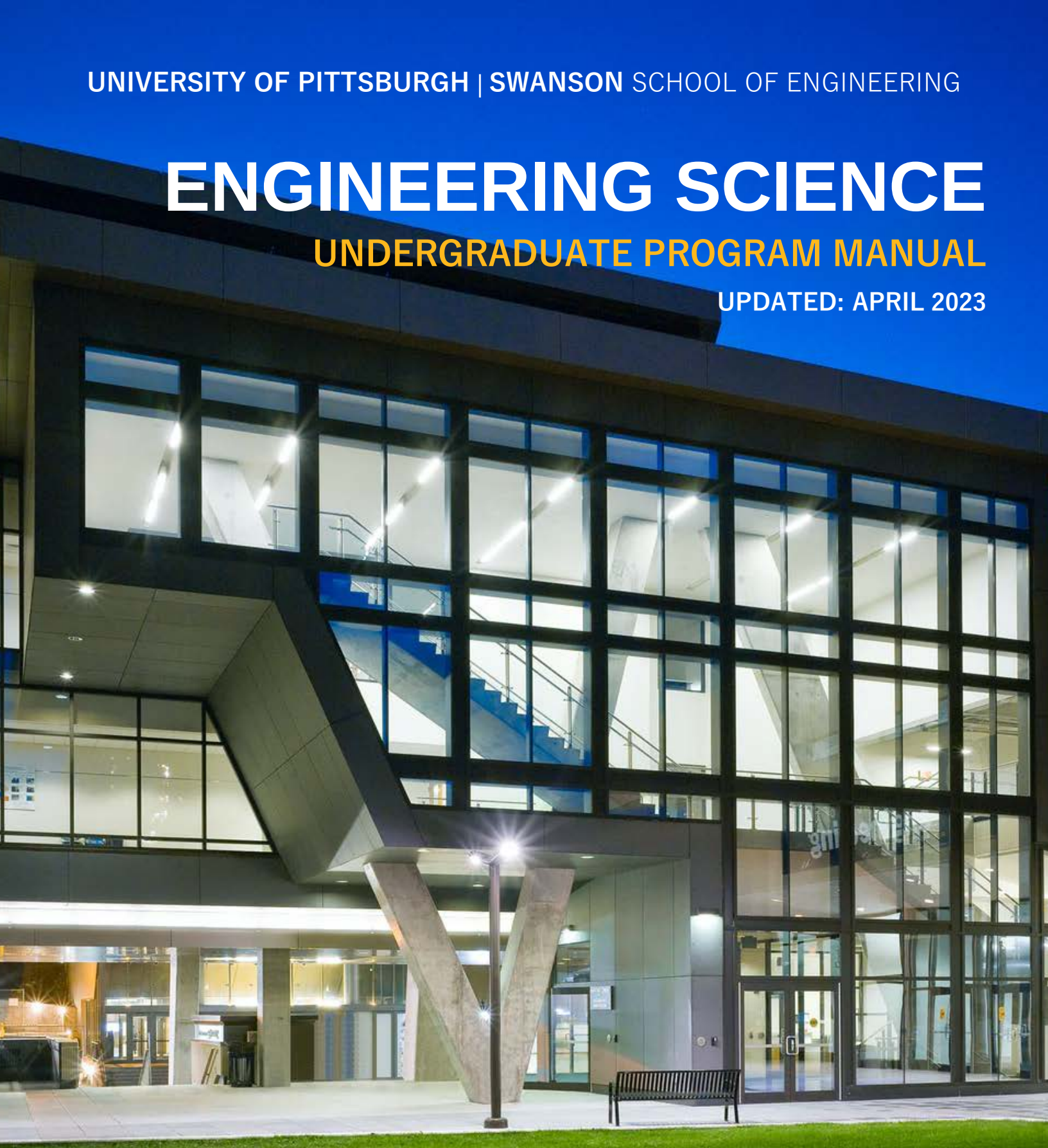

University of Pittsburgh | Swanson School of Engineering

PREFACE

This Engineering Science Undergraduate Academic Program Manual is a supplement to the information provided on the University of Pittsburgh Swanson School of Engineering (SSOE) website, which is the official source of information about the school's academic programs and degree requirements. This supplemental manual provides specific information on departmental policies, procedures, and programs not included in the SSOE website, in addition to some relevant information from the website. 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.

Dr. Brian Gleeson
Chairman

Dr. Paul Ohodnicki
Program Director

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

Admissions and Financial Aid Information

Note: If there are any discrepancies between the Engineering Science Undergraduate Academic Program Manual and the SSOE website then the ultimate authority is the SSOE website.

April 2023

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Chapter 1: About Engineering Science

Prospective students often ask, “What is Engineering Science?”

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 Electrical 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 student’s 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 higher-level science and mathematics courses making this a challenging major. All areas of concentration offer a one-term capstone design experience and a one-term research 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 – 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 application of 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:

1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.

2. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.

3. An ability to communicate effectively with a range of audiences.

4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgements, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.

5. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.

6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgement to draw conclusions.

7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

1.2 Curriculum Overview

Engineering Science curricula are constructed as follows:

During the first two terms, students are part of the common First-Year Engineering Program, acquiring knowledge of the fundamentals of mathematics (calculus), as well as the fundamental principles and methods of physics,

chemistry, and engineering (for more details on the First-Year Engineering Program, visit https://www.engineering.pitt.edu/firstyear).

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:

- Minimum 48 hours Engineering
- Minimum 44 hours Science + Math (minimum 18 hours of Math)
- Minimum 15 hours concentrated in a single Engineering program
- Minimum 101 hours total 'STEM' classes (Science + Engineering + Math)
- 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 four areas of concentration: *Engineering Physics*, *Nanotechnology Physics/Materials*, *Nanotechnology Chemistry/Bioengineering*, 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 one design-oriented course and one research experience in the senior year. The design and research projects build on the knowledge gained in coursework and they emphasize independent and team problem solving under the guidance of faculty mentorship.

Nanotechnology Physics/Materials 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 (nano characterization and nanometrology), as well as knowledge of processes used to fabricate useful nanoscale materials, systems, and devices (nanomanufacturing). Students take courses in modern physics, materials science, electrical engineering, nanotechnology and nanoscience and the materials science of nanostructures. The curriculum culminates with program electives and one design-oriented course and one research experience in the senior year. The design and research projects build on the knowledge gained in coursework and they emphasize independent and team problem solving under the guidance of faculty mentorship.

Nanotechnology Chemistry/Bioengineering 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 (nano characterization and nanometrology), as well as knowledge of processes used to fabricate useful nanoscale materials, systems, and devices (nanomanufacturing) with a focus on the chemistry, bioengineering, and life sciences applications. Students take courses in modern physics, chemistry, biology, electrical engineering, bioengineering, nanotechnology and nanoscience. The curriculum culminates with program electives and one design-oriented course and one research experience in the senior year. The design and research projects build on the knowledge gained in coursework and they emphasize independent and team problem solving under the guidance of faculty mentorship.

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, 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 for specialization in a certain area such as structural analysis, biomechanics or the mechanics of material science. The curriculum culminates with program electives and one design-oriented course and one research experience in the senior year. The design and research projects build on the knowledge gained in coursework and they emphasize independent and team problem solving under the guidance of faculty mentorship.

Course work in the humanities and social sciences is included for the enhancement of the student's awareness of the importance of social, political, and economic problems in the practice of engineering. Where appropriate, 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 department 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. Other minors in addition to engineering minors are listed in Chapter 2 following the curriculum of each concentration. 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 four areas of concentration: *Engineering Physics*, *Nanotechnology Physics/Materials, Nanotechnology Chemistry/Bioengineering,* and *Engineering Mechanics*.

2.1 Engineering Physics Curriculum

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

Engineering Physics Curriculum Checklist					
Title	**Course**	**Cr.**	**Pre/Co-Requisites**	**Term**	**Grade**
Chemistry					
General Chemistry for Engineering 1	CHEM 0960	3			
General Chemistry for Engineering 2	CHEM 0970	3	CHEM 0960		
Electrical & Computer Engineering					
Linear Circuits & Systems	ECE 0101	4	PHYS 0175, ENGR 0012 *Math 0280, 0290*		
Digital Circuits & Systems	ECE 0201	4	PHYS 0175, ENGR 0012		
Microelectronic Circuits & Lab	ECE 0102	4	ECE 0101		
Problem Solving in C++	ECE 0301	3	ENGR 0012		
Electrical Circuits Design Lab	ECE 1212	3	ECE 0102, 0402		
Semiconductor Device Theory	ECE 1247	3	ECE 0402 or ENGR 0020		
Applied Fields & Waves	ECE 1266	3	PHYS 1351, ECE 0301		
Signals Systems & Probabilities	ECE 0402	3	MATH 0280, 0290		
Junior Design Fundamentals	ECE 1895	3	ECE 0102, ECE 0202, ECE 0302, ECE 0402		
General Engineering					
Introduction to Engineering Analysis	ENGR 0011	3			
Engineering Computing	ENGR 0012	3	ENGR 0011		
Materials Structures & Properties	ENGR 0022	3	PHYS 0175, MATH 0230		
Statics & Mechanics of Materials 1	ENGR 0135	3	MATH 0230, PHYS 0174		
Humanities & Social Sciences					
Humanities Elective*		3			
Social Sciences Elective*		3			
Humanities/Social Sciences Elective*		3			
Humanities/Social Sciences Elective*		3			
Humanities/Social Sciences Elective*		3			
Humanities/Social Sciences Elective * ‡		3			
Mathematics					

Analytical Geometry & Calculus 1	MATH 0220	4			
Analytical Geometry & Calculus 2	MATH 0230	4	MATH 0220		
Analytical Geometry & Calculus 3	MATH 0240	4	MATH 0230		
Matrices & Linear Algebra	MATH 0280	3	MATH 0220		
Differential Equations	MATH 0290	3	MATH 0230		
Mechanical Engineering					
Introduction Thermodynamics	MEMS 0051	3	PHYS 0175, CHEM 0960		
Structures of Crystals	MEMS 1053	3	ENGR 0022		
Phase Equilibria	MEMS 1059	3	ENGR 0022, MEMS 0051		
Physics					
Physics for Science & Engineering 1	PHYS 0174	4	*MATH 0220*		
Physics for Science & Engineering 2	PHYS 0175	4	PHYS 0174, *MATH 0230*		
Lab Physics for Science & Engineering	PHYS 0219	2	*PHYS 0175*		
Principles of Modern Physics 1	PHYS 0477	4	PHYS 0175, *MATH 0240*		
Principles of Modern Physics 2	PHYS 0481	3	PHYS 0477		
Upper-Level Physics (Recommended: Intermediate Electricity & Magnetism)	PHYS (1351)	3	PHYS 0175, MATH 0240, *MATH 0290*		
Upper-Level Physics	PHYS	3			
Upper-Level Physics	PHYS	3			
Program Specific					
Program Elective (Recommended: Partial Differential Equations [MATH 1470])	(MATH 1470)	3	MATH 0240, MATH 0290		
Program Elective		3			
Senior Design					
Senior Design 1[+]		3			
Senior Design 2[++]		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. Alternatively, may be ENGR 1050 Product Realization, or with preapproval, a senior design project arranged with a faculty mentor and taken as ENGSCI 1801.

[++] A semester-long research experience under the supervision of a faculty advisor at Pitt, not necessarily within the Swanson School of Engineering. Note that this requirement may also be fulfilled by participation in an undergraduate research program like the MCSI URP or the SURI during the summer semester.

‡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 possible choices (must meet prerequisite requirements) include the following:

PHYS 1331: Mechanics
PHYS 1341: Thermodynamics. & Statistical Mechanics
PHYS 1351: Intermediate Electricity & Magnetism (Same as ECE 1259)
PHYS 1361: Wave Motion and Optics (PHYS 0219)
PHYS 1370: Introduction to Quantum Mechanics 1 (Corequisite: PHYS 1331 and 1351)
PHYS 1371: Introduction to Quantum Mechanics 2 (Prerequisite: PHYS 1370)
PHYS 1372: Electromagnetic Theory (Corequisite: PHYS 1331 and 1351)
PHYS 1374: Solid State Physics (Prerequisite: PHYS 0477)
PHYS 1376: Introduction to Biological Physics (Math 235 or Statistics 1000)
PHYS 1378: Introduction to Nuclear & Particle Physics 1 (Prerequisite: 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 standard quantum mechanics sequence in the Physics department:

PHYS 1370: Introduction to Quantum Mechanics 1
PHYS 1371: Introduction to Quantum Mechanics 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 1250: Introduction to Nanotechnology & Nanoengineering
ECE 1251: Fabrication & Design in Nanotechnology

Other Elective Options Include:

Electrical & Computer Engineering
ECE 1232: Introduction to Lasers & Optical Electronics
ECE 1238: Digital Electronics

Mechanical Engineering
MEMS 1010: Experimental Methods in Materials Science & Engineering
MEMS 1048: Analysis & Characteristics at the Nanoscale
MEMS 1049: Mechatronics
MEMS 1057: Micro/Nano Manufacturing
MEMS 1082: Electromechanical Sensors & Actuators
MEMS 1111: Materials for Energy Generation & Storage

2.1.2 Engineering Physics Minors and Certificates

Below are minors and certificates that pair well with the Engineering Physics curriculum. Italicized courses are already satisfied by the Engineering Physics course requirements and courses marked with * can be satisfied with electives.

Physics Minor: All requirements for the Physics minor are satisfied by the Engineering Physics curriculum. Students interested in receiving the minor should contact the Physics department to declare the minor.

PHYS 0174: Physics for Scientists & Engineers 1
PHYS 0175: Physics for Scientists & Engineers 2
PHYS 0477: Principles of Modern Physics 1
PHYS 0219: Basic Laboratory Physics for Science and Engineering
PHYS: Pick one: *PHYS 0481*, PHYS 1374, PHYS 1375, PHYS 1376 or PHYS 1378

Math Minor: Can be completed with 2 extra courses (6 extra credits) and using one program elective towards 1 course (3 credits).

MATH: 0250 or higher
MATH: 0250 or higher
MATH: 0250 or higher
MATH: 1000 or higher (Recommended: Partial Differential Equations [MATH 1470])
MATH: 1000 or higher

Electrical Engineering Minor: Can be completed with no additional courses, through the completion of the Engineering Physics degree. The minor requirements are fully encompassed in the track curriculum.

ECE 0101: Linear Circuits & Systems
ECE 0102: Microelectronic Circuits
ECE 0142: Signals, Systems, & Probabilities
ECE: Pick one: *ECE 0201*, *ECE 1212*, *ECE 1247*, ECE 1259, ECE 1560, ECE 1673, ECE 1701

Materials Science and Engineering Minor: Can be completed with 2 extra courses (6 extra credits). The rest of the minor is covered by courses within the Engineering Physics Curriculum. Students must complete these classes with a GPA of at least 2.0 to be eligible for the minor. Students interested in receiving the minor should apply by following the link at this website.

ENGR 0022: Materials Structure and Properties
MEMS 0040: Materials and Manufacturing
MEMS 1053: Structure of Crystals and Diffraction
MEMS 1059: Phase Equilibria in Multi-Component Materials
MEMS 1063: Phase Transformations and Microstructure Evolution

Sustainability Certificate: Requires 3 extra engineering courses (9 credits) and 3 non engineering courses (9 credits), many of which can count towards the humanities and social sciences electives. Students interested in receiving the certificate should apply by following the link at this website.

ENGR 1905: Current Issues in Sustainability
ENGR 1907: Sustainability Capstone Experience
CEE 1610: Engineering & Sustainable Development
Elective
Elective
Elective
(Recommended Electives: HIST 1695, 1019, GSWS 1450, ECON 0530, 0360, SA 1340, PS 1542, ENGLIT 1005, 0710)

Photonics Certificate: Can be completed with 0 extra courses using electives in the Engineering Physics Curriculum

***All of the following*:**

MATH 0220 : Analytical Geometry & Calculus 1
MATH 0230 : Analytical Geometry & Calculus 2
MATH 0240 : Analytical Geometry & Calculus 3
MATH 0280 : Matrices & Linear Algebra
MATH 0290 : Differential Equations
PHYS 0174: Basic Physics for Scientists & Engineers 1 (integrated)
PHYS 0175: Basic Physics for Scientists & Engineers 2 (integrated)
CHEM 0960: General Chem for Engineers 1
CHEM 0970: General Chem for Engineers 2

Laboratory Requirement 1: Choose one of the following or pairs:

MEMS 1010: Experimental Methods in MSE

PHYS 0219: Basic Lab Physics for Science & Engineering

PHYS 0520: Modern Physical Measurements

CHEM 0250: Introduction to Analytical Chemistry **and**
CHEM 0260: Introduction to Analytical Chemistry Lab

***Laboratory Requirement 2: Choose one of the following or pairs**:*

PHYS 0525: Analog and Digital Electronics

ECE 1212: Electronic Circuit Design Lab

CHEM 1430: Physical Chemistry Laboratory 1 **and**
CHEM 1255: Instrumental Analysis Lab

All of the following:

*PHYS 1361: Wave Motion and Optics

ECE 1247: Semiconductor Device Theory **or**
PHYS 1374: Solid State Physics

*ECE 1232: Introduction to Lasers & Optical Electronics

One of the following

CHEM 1410: Physical Chemistry 1

PHYS 0477: Principles of Modern Physics 1

PHYS 1370: Intro to Quantum Mechanics 1

One of the following

MEMS 1058: Electromagnetic Properties of Materials

PHYS 1351: Intermediate Electricity/Magnetism

ECE 1259: Electromagnetics 1

ECE 1266: Applications of Fields & Waves

2.2 Nanotechnology Curriculum – Physics/Materials Emphasis

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

Nanotechnology Curriculum Checklist
Physics/Materials Emphasis

Title	Course	Cr.	Pre/Co-Requisites	Term	Grade
Chemistry					
General Chemistry for Engineering 1	CHEM 0960	3			
General Chemistry for Engineering 2	CHEM 0970	3	CHEM 0960		
Electrical & Computer Engineering					
Linear Circuits & Systems	ECE 0101	4	PHYS 0175, ENGR 0012 *Math 0280, 0290*		
Microelectronic Circuits & Lab	ECE 0102	4	ECE 0101		
Problem Solving in C++	ECE 0301	3	ENGR 0012		
Fabrication & Design in Nanotechnology	ECE 1251	3	ENGR 0240/ECE 1250		
General Engineering					
Introduction to Engineering Analysis	ENGR 0011	3			
Engineering Computing	ENGR 0012	3	ENGR 0011		
Materials Structures & Properties	ENGR 0022	3	PHYS 0175, MATH 0230		
Statics & Mechanics of Materials 1	ENGR 0135	3	MATH 0230, PHYS 0174		
Probability & Statistics	ENGR 0021	3	MATH 0230		
Introduction to Nanotechnology & Nanoengineering	ENGR 0240/ ECE 1250	3	MATH 0230, PHYS 0175		
Fabrication & Design in Nanotechnology	ECE 1251	3			
Humanities & Social Sciences					
Humanities Elective*		3			
Social Sciences Elective*		3			
Humanities/Social Sciences Elective*		3			
Humanities/Social Sciences Elective*		3			
Humanities/Social Sciences Elective*		3			
Humanities/Social Sciences Elective * ‡		3			
Mathematics					
Analytical Geometry & Calculus 1	MATH 0220	4			
Analytical Geometry & Calculus 2	MATH 0230	4	MATH 0220		
Analytical Geometry & Calculus 3	MATH 0240	4	MATH 0230		

Matrices & Linear Algebra	MATH 0280	3	MATH 0220		
Differential Equations	MATH 0290	3	MATH 0230		
Mechanical Engineering					
Thermodynamics of Materials	MEMS 0048	3	PHYS 0175, CHEM 0960		
Structures of Crystals	MEMS 1053	3	ENGR 0022		
Experimental Methods in MSE	MEMS 1010	3	ENGR 0022		
Micro/Nano Manufacturing	MEMS 1057	3			
Phase Equilibria	MEMS 1059	3	ENGR 0022, MEMS 0051		
Phase Transformations	MEMS 1063	3	MEMS 1053, MEMS 1059		
Physics					
Physics for Science & Engineering 1	PHYS 0174	4	*MATH 0220*		
Physics for Science & Engineering 2	PHYS 0175	4	PHYS 0174, *MATH 0230*		
Lab Physics for Science & Engineering	PHYS 0219	2	*PHYS 0175*		
Principles of Modern Physics 1	PHYS 0477	4	PHYS 0175, *MATH 0240*		
Principles of Modern Physics 2	PHYS 0481	3	PHYS 0477		
Upper-Level Physics	PHYS	3			
Upper-Level Physics	PHYS	3			
Program Specific					
Nanotechnology Program Elective		3			
Nanotechnology Program Elective		3			
Nanotechnology Program Elective		3			
Senior Design					
Senior Design 1[+]		3			
Senior Design 2[++]		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. Alternatively, may be ENGR 1050 Product Realization, or with preapproval, a senior design project arranged with a faculty mentor and taken as ENGSCI 1801.

[++] A semester-long research experience under the supervision of a faculty advisor at Pitt, not necessarily within the Swanson School of Engineering. Note that this requirement may also be fulfilled by participation in an undergraduate research program like the MCSI URP or the SURI during the summer semester.

[‡]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.

2.2.1 Nanotechnology Curriculum Program Electives – Physics/Materials

Approved Electives include:

Bioengineering
BIOENG 1810 Biomaterials and Biocompatibility

Chemistry
CHEM 1410 Physical Chemistry 1
CHEM 1420 Physical Chemistry 2
CHEM 1480 Intermediate Physical Chemistry
CHEM 1130 Inorganic Chemistry
CHEM 1620 Atoms, Molecules & Materials – 'Introduction to Nanomaterials'

Electrical & Computer Engineering
ECE 1232 Introduction to Lasers and Optical Electronics
ECE 1238 Digital Electronics
ECE 1247 Semiconductor Device Theory

General Engineering
ENGR 1066 Introduction to Solar Cells and Nanotechnology

Industrial Engineering
IE 1012 Manufacture of Structural Nano-Materials

Mechanical Engineering
MEMS 1011 Structure and Properties Lab
MEMS 1048 Analysis and characterization at the Nano-scale
MEMS 1082 Electromechanical Sensors and Actuators
MEMS 1111 Materials for Energy Generation and Storage

Materials Science
MSE 2012 Computational Material Science

Physics
PHYS 0520 Modern Physical Measurements
PHYS 1370 Introduction to Quantum Mechanics
PHYS 1371 Introduction to Quantum Mechanics
PHYS 1375 Foundations of Nanoscience

2.2.2 Nanotechnology Physics/Materials Minors and Certificates

Below are minors and certificates that pair well with the Nanotechnology Physics/Materials curriculum. Italicized courses are already satisfied by the Engineering Physics course requirements and courses marked with * can be satisfied with electives.

Physics Minor: All requirements for the Physics minor are satisfied by the Nanotechnology Physics/Materials curriculum. Students interested in receiving the minor should contact the Physics department to declare the minor.

PHYS 0174: Physics for Science & Engineering 1
PHYS 0175: Physics for Science & Engineering 2
PHYS 0219: Basic Laboratory Physics for Science and Engineering
PHYS 0477: Principles of Modern Physics 1
PHYS: Pick one: *PHYS 0481*, 1374, 1375, 1376 or 1378

Materials Science and Engineering Minor: Can be completed with 1 extra course (3 extra credits). The rest of the minor is covered by courses by the Nanotechnology Physics/Materials curriculum. Students must complete these classes with a GPA of at least 2.0 to be eligible for the minor. Students interested in receiving the minor should apply by following the link at this website.

ENGR 0022: Materials Structure and Properties
MEMS 0040: Materials and Manufacturing
MEMS 1053: Structure of Crystals and Diffraction
MEMS 1059: Phase Equilibria in Multi-Component Materials
MEMS 1063: Phase Transformations and Microstructure Evolution

Sustainability Certificate: Requires 3 extra engineering courses (9 credits) and 3 non engineering courses (9 credits), many of which can count towards the humanities and social sciences electives. Students interested in receiving the certificate should apply by following the link at this website.

ENGR 1905: Current Issues in Sustainability
ENGR 1907: Sustainability Capstone Experience
CEE 1610: Engineering & Sustainable Development
Elective
Elective
Elective
(Recommended Electives: HIST 1695, 1019, GSWS 1450, ECON 0530, 0360, SA 1340, PS 1542, ENGLIT 1005, 0710)

Photonics Certificate: Can be completed with 1 extra course and 1-2 labs using program electives.

***All of the following*:**

MATH 0220 : Analytical Geometry & Calculus 1
MATH 0230 : Analytical Geometry & Calculus 2
MATH 0240 : Analytical Geometry & Calculus 3
MATH 0280 : Matrices & Linear Algebra
MATH 0290 : Differential Equations
PHYS 0174: Basic Physics for Scientists & Engineers 1 (integrated)
PHYS 0175: Basic Physics for Scientists & Engineers 2 (integrated)
CHEM 0960: General Chem for Engineers 1
CHEM 0970: General Chem for Engineers 2

Laboratory Requirement 1: Choose one of the following or pairs:

MEMS 1010: Experimental Methods in MSE

PHYS 0219: Basic Lab Physics for Science & Engineering

PHYS 0520: Modern Physical Measurements

CHEM 0250: Introduction to Analytical Chemistry **and**
CHEM 0260: Introduction to Analytical Chemistry Lab

***Laboratory Requirement 2: Choose one of the following or pairs**:*

PHYS 0525: Analog and Digital Electronics

ECE 1212: Electronic Circuit Design Lab

CHEM 1430: Physical Chemistry Laboratory 1 **and**
CHEM 1255: Instrumental Analysis Lab

All of the following:

*PHYS 1361: Wave Motion and Optics

*ECE 1247: Semiconductor Device Theory **or**
PHYS 1374: Solid State Physics

*ECE 1232: Introduction to Lasers & Optical Electronics

One of the following

CHEM 1410: Physical Chemistry 1

PHYS 0477: Principles of Modern Physics 1

PHYS 1370: Intro to Quantum Mechanics 1

One of the following

MEMS 1058: Electromagnetic Properties of Materials

PHYS 1351: Intermediate Electricity/Magnetism

ECE 1259: Electromagnetics 1

ECE 1266: Applications of Fields & Waves

2.3 Nanotechnology Curriculum – Chemistry/Bioengineering Emphasis

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

Nanotechnology Curriculum Checklist
Chemistry/Bioengineering Emphasis

Title	Course	Cr.	Pre/Co-Requisites	Term	Grade
Bioengineering					
Bioengineering Elective	BIOENG	3			
Bioengineering Elective	BIOENG	3			
Chemistry					
General Chemistry for Engineering 1	CHEM 0960	3			
General Chemistry for Engineering 2	CHEM 0970	3	CHEM 0960		
Core Chemistry Course	CHEM	3			
Core Chemistry Course	CHEM	3			
Core Chemistry Course	CHEM	3			
Electrical & Computer Engineering					
Linear Circuits & Systems	ECE 0101	4	PHYS 0175, ENGR 0012 *Math 0280, 0290*		
Microelectronic Circuits & Lab	ECE 0102	4	ECE 0101		
Problem Solving in C++	ECE 0301	3	ENGR 0012		
General Engineering					
Introduction to Engineering Analysis	ENGR 0011	3			
Engineering Computing	ENGR 0012	3	ENGR 0011		
Materials Structures & Properties	ENGR 0022	3	PHYS 0175, MATH 0230		
Statics & Mechanics of Materials 1	ENGR 0135	3	MATH 0230, PHYS 0174		
Probability & Statistics	ENGR 0021	3	MATH 0230		
Introduction to Nanotechnology & Nanoengineering	ENGR 0240	3	MATH 0230, PHYS 0175		
Humanities & Social Sciences					
Humanities Elective*		3			
Social Sciences Elective*		3			
Humanities/Social Sciences Elective*		3			
Humanities/Social Sciences Elective*		3			
Humanities/Social Sciences Elective*		3			

Humanities/Social Sciences Elective * ‡		3			
Life Sciences					
Basic Life Science	LIFESCI	3			
Basic Life Science	LIFESCI	3			
Mathematics					
Analytical Geometry & Calculus 1	MATH 0220	4			
Analytical Geometry & Calculus 2	MATH 0230	4	MATH 0220		
Analytical Geometry & Calculus 3	MATH 0240	4	MATH 0230		
Matrices & Linear Algebra	MATH 0280	3	MATH 0220		
Differential Equations	MATH 0290	3	MATH 0230		
Mechanical Engineering					
Introduction to Thermodynamics	MEMS 0051	3	PHYS 0175, CHEM 0960		
Structures of Crystals	MEMS 1053	3	ENGR 0022		
Experimental Methods in MSE	MEMS 1010	3	ENGR 0022		
Micro/Nano Manufacturing	MEMS 1057	3			
Physics					
Physics for Science & Engineering 1	PHYS 0174	4	*MATH 0220*		
Physics for Science & Engineering 2	PHYS 0175	4	PHYS 0174, *MATH 0230*		
Lab Physics for Science & Engineering	PHYS 0219	2	*PHYS 0175*		
Program Specific					
Nanotechnology Program Elective		3			
Nanotechnology Program Elective		3			
Nanotechnology Program Elective		3			
Senior Design					
Senior Design 1[+]		3			
Senior Design 2[++]		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. Alternatively, may be ENGR 1050 Product Realization, or with preapproval, a senior design project arranged with a faculty mentor and taken as ENGSCI 1801.

[++] A semester-long research experience under the supervision of a faculty advisor at Pitt, not necessarily within the Swanson School of Engineering. Note that this requirement may also be fulfilled by participation in an undergraduate research program like the MCSI URP or the SURI during the summer semester.

‡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.

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

Approved Nanotechnology Electives include:

Bioengineering

BIOENG 1005	RF Medical Devices and Applications of Electromagnetism in Medicine
BIOENG 1810	Biomaterials and Biocompatibility

Biological Sciences

BIOSC 0057	Foundations of Biology Research Lab 1 (1 cr.)
BIOSC 0067	Foundations of Biology Research Lab 2 (1 cr.)

Chemistry

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 1480	Intermediate Physical Chemistry
CHEM 1620	Atoms, Molecules & Materials – ‘Introduction to Nanomaterials’

Electrical & Computer Engineering

ECE 1232	Introduction to Lasers and Optical Electronics (3 units)
ECE 1238	Digital Electronics (3 units)
ECE 1247	Semiconductor Device Theory

General Engineering

ENGR 1066	Introduction to Solar Cells and Nanotechnology

Industrial Engineering

IE 1012	Manufacture of Structural Nanomaterials

Mechanical Engineering

MEMS 1011	Structure and Properties Lab
MEMS 1048	Analysis and Characterization at the Nanoscale
MEMS 1063	Phase Transformation
MEMS 1082	Electromechanical Sensors and Actuators
MEMS 1101	Ferrous Physical Metallurgy
MEMS 1111	Materials for Energy Generation and Storage

Materials Science

MSE 2012	Computational Material Science

Physics

PHYS 0520	Modern Physical Measurements
PHYS 1370	Introduction to Quantum Mechanics 1
PHYS 1371	Introduction to Quantum Mechanics 2

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

BIOSC 1000	Biochemistry
BIOSC 1810	Macromolecular Structure & Function
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

LIFESCI 1 and 2 must be selected from the following:

Bioengineering

BIOENG 1070	Introduction to Cell Biology I
BIOENG 1071	Introduction to Cell Biology II

Biological Sciences

BIOSC 0150	Foundations of Biology I
BIOSC 0160	Foundations of Biology II
BIOSC 1070	Human Physiology - UHC
BIOSC 1250	Introduction to Human Physiology

Health & Rehabilitation Sciences

HRS 1023	Human Physiology

Neuroscience

NROSCI 1000	Introduction 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 1075	Introductory Cell and Molecular Biology Laboratory Techniques
BIOENG 1095	Special Projects
BIOENG 1150	Bioengineering Methods and Applications
BIOENG 1210	Bioengineering Thermodynamics – OR MEMS 0051 (Thermodynamics)
BIOENG 1220	Biotransport Phenomena
BIOENG 1310	Linear Systems and Electronics I – OR MEMS 0031 (Linear Circuits & Systems)
BIOENG 1320	Biological Signals and Systems
BIOENG 1330	Biomedical Imaging

BIOENG 1383 Biomedical Optical Microscopy
BIOENG 1620 Introduction to Tissue Engineering
BIOENG 1630 Biomechanics 1

2.3.2 Nanotechnology Bioengineering/Chemistry Minors and Certificates

Below are minors and certificates that pair well with the Nanotechnology Bioengineering/Chemistry curriculum. Italicized courses are already satisfied by the Engineering Physics course requirements and courses marked with * can be satisfied with electives.

Physics Minor: Most requirements are satisfied by the Nanotechnology Bioengineering/Chemistry curriculum and electives. Students interested in receiving the minor should contact the Physics department to declare the minor.

PHYS 0174: Physics for Science & Engineering 1
PHYS 0175: Phys. Science & Engineering 2
PHYS 0219: Basic Laboratory Physics for Science and Engineering
PHYS 0477: Properties of Modern Physics 1
PHYS Elective: Pick one: PHYS 0481, 1374, 1375, 1376 or 1378

Materials Science and Engineering Minor: Can be completed with 1 extra course (3 extra credits), the rest can be covered by program electives. Students must complete these classes with a GPA of at least 2.0 to be eligible for the minor. Students interested in receiving the minor should apply by following the link at this website.

ENGR 0022: Materials Structure and Properties
MEMS 0040: Materials and Manufacturing
MEMS 1053: Structure of Crystals and Diffraction
*MEMS 1059: Phase Equilibria in Multi-Component Materials
*MEMS 1063: Phase Transformations and Microstructure Evolution

Bioengineering Minor: Can be completed using program electives and 1 extra seminar. Students interested in a Bioengineering Minor are required to submit a completed BioE Minor Checklist to the Bioengineering Undergraduate Administrator for course approvals prior to enrolling in BIOENG courses in order to ensure that the requirements for the minor are fulfilled. Approval to use substitute courses to meet minor requirements must be obtained in advance from the Bioengineering Undergraduate Program Director.

BIOENG 1086: Bioengineering Seminar for Minors – must attend a minimum of 6 seminar presentations
ENGR 0021: Probability and Statistics for Engineers

Choose 1 Basic Life Science Course
*BIOENG 1070: Cell Biology 1
*BIOENG 1071: Cell Biology 2
*BIOSCI 0150: Foundations of Biology 1
*BIOSCI 0160: Foundations of Biology 2
BIOSCI 1000: Principles of Biochemistry
BIOSCI 1810: Macromolecular Structure and Function
CHEM 1810: Chemical Biology

CHEM 1880: Chemical Biology for Engineers
*BIOSCI 1250: Introduction to Human Physiology
*HRS 1023: Human Physiology

Choose 3 Bioengineering Electives
*BIOENG Elective
*BIOENG Elective
*BIOENG Elective

Sustainability Certificate: Requires 3 extra engineering courses (9 credits) and 3 non engineering courses (9 credits), many of which can count towards the humanities and social sciences electives. Students interested in receiving the certificate should apply by following the link at this website.

ENGR 1905: Current Issues in Sustainability
ENGR 1907: Sustainability Capstone Experience
CEE 1610: Engineering & Sustainable Development
Elective
Elective
Elective
(Recommended Electives: HIST 1695, 1019, GSWS 1450, ECON 0530, 0360, SA 1340, PS 1542, ENGLIT 1005, 0710)

Photonics Certificate: Can be completed with 2 extra courses and 1-2 labs.

***All of the following*:**

MATH 0220 : Analytical Geometry & Calculus 1
MATH 0230 : Analytical Geometry & Calculus 2
MATH 0240 : Analytical Geometry & Calculus 3
MATH 0280 : Matrices & Linear Algebra
MATH 0290 : Differential Equations
PHYS 0174: Basic Physics for Scientists & Engineers 1 (integrated)
PHYS 0175: Basic Physics for Scientists & Engineers 2 (integrated)
CHEM 0960: General Chem for Engineers 1
CHEM 0970: General Chem for Engineers 2

Laboratory Requirement 1: Choose one of the following or pairs:

MEMS 1010: Experimental Methods in MSE

PHYS 0219: Basic Lab Physics for Science & Engineering

PHYS 0520: Modern Physical Measurements

CHEM 0250: Introduction to Analytical Chemistry **and**
CHEM 0260: Introduction to Analytical Chemistry Lab

***Laboratory Requirement 2: Choose one of the following or pairs**:*

PHYS 0525: Analog and Digital Electronics

ECE 1212: Electronic Circuit Design Lab

CHEM 1430: Physical Chemistry Laboratory 1 **and**
CHEM 1255: Instrumental Analysis Lab

All of the following:

PHYS 1361: Wave Motion and Optics

*ECE 1247: Semiconductor Device *Theory* **or**
PHYS 1374: Solid State Physics

*ECE 1232: Introduction to Lasers & Optical Electronics

One of the following

*CHEM 1410: Physical Chemistry 1

PHYS 0477: Principles of Modern Physics 1

*PHYS 1370: Intro to Quantum Mechanics 1

One of the following

MEMS 1058: Electromagnetic Properties of Materials

PHYS 1351: Intermediate Electricity/Magnetism

ECE 1259: Electromagnetics 1

ECE 1266: Applications of Fields & Waves

2.4 Engineering Mechanics Curriculum

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

Engineering Mechanics Curriculum Checklist					
Title	**Course**	**Cr.**	**Pre/Co-Requisites**	**Term**	**Grade**
Chemistry					
General Chemistry for Engineering 1	CHEM 0960	3			
General Chemistry for Engineering 2	CHEM 0970	3	CHEM 0960		
General Engineering					
Introduction to Engineering Analysis	ENGR 0011	3			
Engineering Computing	ENGR 0012	3	ENGR 0011		
Materials Structures & Properties	ENGR 0022	3	PHYS 0175, MATH 0230		
Statics & Mechanics of Materials 1	ENGR 0135	3	MATH 0230, PHYS 0174		
Statics & Mechanics of Materials 2	ENGR 0145	3	ENGR 0135		
Humanities & Social Sciences					
Humanities Elective*		3			
Social Sciences Elective*		3			
Humanities/Social Sciences Elective*		3			
Humanities/Social Sciences Elective*		3			
Humanities/Social Sciences Elective*		3			
Humanities/Social Sciences Elective * ‡		3			
Mathematics					
Analytical Geometry & Calculus 1	MATH 0220	4			
Analytical Geometry & Calculus 2	MATH 0230	4	MATH 0220		
Analytical Geometry & Calculus 3	MATH 0240	4	MATH 0230		
Matrices & Linear Algebra	MATH 0280	3	MATH 0220		
Differential Equations	MATH 0290	3	MATH 0230		
Vector Analysis & Applications	MATH 1550	3	MATH 0240, MATH 0280		
Mechanical Engineering					
Introduction to Design	MEMS 0024	3	ENGR 0011		
Linear Circuits & Systems 1	MEMS 0031	3	PHYS 0175, MATH 0230		
Introduction to Thermodynamics	MEMS 0051	3	PHYS 0175, CHEM 0960		

Introduction to Fluid Mechanics	MEMS 0071	3	PHYS 0175, CHEM 0970, MATH 0290		
Experimental Methods in MSE	MEMS 1010	3	ENGR 0022		
Dynamic Systems	MEMS 1014	3	ENGR 0012, MEMS 0031, MATH 0280		
Rigid Body Dynamics	MEMS 1015	3	ENGR 0135, MATH 0240		
Vibrations	MEMS 1020	3	MEMS 1014		
Mechanical Design 1	MEMS 1028	3	ENGR 0145, MEMS 0031, MEMS 1014/1015		
Mechanical Measurements 1	MEMS 1041	3	ENGR 0145		
Finite Element Analysis	MEMS 1047	3	MEMS 1028		
Structures of Crystals	MEMS 1053	3	ENGR 0022		
Physics					
Physics for Science & Engineering 1	PHYS 0174	4	*MATH 0220*		
Physics for Science & Engineering 2	PHYS 0175	4	PHYS 0174, *MATH 0230*		
Principles of Modern Physics 1	PHYS 0477	4	PHYS 0175, *MATH 0240*		
Upper-Level Physics	PHYS	3			
Program Specific					
Engineering Mechanics Elective		3			
Engineering Mechanics Elective		3			
Senior Design					
Senior Design 1[+]		3			
Senior Design 2[++]		3			
Statistics					
Applied Statistical Methods	STAT 1000	4			

Upper-Level Physics: Physics courses with course numbers > 1000

[+] A senior design course offered by one of the other SSOE engineering programs is required. Alternatively, may be ENGR 1050 Product Realization, or with preapproval, a senior design project arranged with a faculty mentor and taken as ENGSCI 1801.

[++] A semester-long research experience under the supervision of a faculty advisor at Pitt, not necessarily within the Swanson School of Engineering. Note that this requirement may also be fulfilled by participation in an undergraduate research program like the MCSI URP or the SURI during the summer semester.

[‡]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.

2.4.1 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:

Health & Rehabilitation Sciences
HRS 1701 Introduction to Prosthetics and Orthotics

Bioengineering
BIOENG 1630 Biomechanics 1: Mechanical Principles of Biological Systems
BIOENG 1631 Biomechanics 2: Introduction to Biodynamics and Biosolid Mechanics
BIOENG 1632 Biomechanics 3: Biodynamics of Movement
BIOENG 1633 Biomechanics 4: Biomechanics of Organs, Tissues, and Cells

Civil Engineering
CEE 1330 Introduction to Structural Analysis
CEE 1341 Design of Steel Structures
CEE 1401 Open Channel Hydraulics
CEE 1412 Introduction to Water Resources Engineering
CEE 1811 Principles of Soil Mechanics
CEE 1821 Foundation Engineering

Material Science
MEMS 0040 Materials and Manufacturing
MEMS 1011 Structure and Properties Lab
MEMS 1048 Analysis and Characterization at the Nanoscale
MEMS 1053 Structures of Crystals and Diffraction
MEMS 1058 Electromagnetic Properties of Materials
MEMS 1059 Phase Equilibria in Multi-Component Materials
MEMS 1063 Phase Transformation & Microstructure Evolution
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 1082 Electromechanical Sensors and Actuators

Physics
PHYS 1331 Mechanics
PHYS 1341 Thermodynamics and Statistical Mechanics

2.4.2 Engineering Mechanics Minors and Certificates

Below are minors and certificates that pair well with the Engineering Mechanics curriculum. Italicized courses are already satisfied by the Engineering Physics course requirements and courses marked with * can be satisfied with electives.

Physics Minor: Most requirements are satisfied by the Engineering Mechanics curriculum and electives. Students interested in receiving the minor should contact the Physics department to declare the minor.

PHYS 0174: Physics for Science & Engineering 1
PHYS 0175: Physics for Science & Engineering 2
PHYS 0219: Basic Laboratory Physics for Science and Engineering
PHYS 0477: Principles of Modern Physics 1
PHYS Elective: Pick one: Phys 0481, 1374, 1375, 1376 or 1378

Math Minor: Can be completed with 2 extra courses (6 extra credits). The rest is covered by the Engineering Mechanics Curriculum.

MATH: 0250 or higher
MATH: 0250 or higher
MATH: 0250 or higher
MATH: 1000 or higher
MATH: 1000 or higher

Materials Science and Engineering Minor: Can be completed with 1 extra course (3 extra credits). Students must complete these classes with a GPA of at least 2.0 to be eligible for the minor. Students interested in receiving the minor should apply by following the link at this website.

ENGR 0022: Materials Structure and Properties
*MEMS 0040: Materials and Manufacturing
MEMS 1053: Structure of Crystals and Diffraction
*MEMS 1059: Phase Equilibria in Multi-Component Materials
*MEMS 1063: Phase Transformations and Microstructure Evolution

Mechanical Engineering Minor: Can be completed with 0 extra courses using Engineering Mechanics Electives.

MEMS 0024: Introduction to Mechanical Engineering Design
MEMS 1028: Mechanical Design 1

Choose one of the Following Options
Thermal Fluids Option
MEMS 0051: Introduction to Thermodynamics
MEMS 0071: Introduction to Fluid Dynamics
One of the Following
*MEMS 1051: Applied Thermodynamics
*MEMS 1071: Applied Fluid Mechanics
Dynamic Systems Option

MEMS 1014: Dynamic Systems
MEMS 1015: Rigid-Body Dynamics
*MEMS 1045: Automatic Controls or ECE controls course
Mechanical Design Option
*MEMS 1029: Mechanical Design 2
*MEMS 1033: Fracture Mechanics for Product Design & Manufacturing
MEMS 1047: Finite Element Analysis
Mechanical Measurements Option
MEMS 1014: Dynamic Systems
MEMS 1041: Mechanical Measurements 1
*MEMS 1042: Mechanical Measurements 2

Nuclear Engineering Certificate: Can be completed with 3 extra courses (9 extra credits) using program electives.

ENGR 1700: Introduction to Nuclear Engineering
ENGR 1701: Fundamentals of Nuclear Reactors
ENGR 1702: Nuclear Plant Technology

Select two of the following eight courses
*MEMS 1030: Material Selection
*MEMS 1033: Fracture Mechanics for Product Design & Manufacturing
*MEMS 1045: Automatic Controls
MEMS 1047: Finite Element Analysis
*MEMS 1052: Heat and Mass Transfer
MEMS 1063: Phase Transformation & Microstructure Evolution
*MEMS 1065: Thermal Systems Design
MEMS 1070: Mechanical Behavior of Materials
*MEMS 1071: Applied Fluid Mechanics

Sustainability Certificate: Requires 3 extra engineering courses (9 credits) and 3 non engineering courses (9 credits), many of which can count towards the humanities and social sciences electives. Students interested in receiving the certificate should apply by following the link at this website.

ENGR 1905: Current Issues in Sustainability
ENGR 1907: Sustainability Capstone Experience
CEE 1610: Engineering & Sustainable Development
Elective
Elective
Elective
(Recommended Electives: HIST 1695, 1019, GSWS 1450, ECON 0530, 0360, SA 1340, PS 1542, ENGLIT 1005, 0710)

Photonics Certificate: Can be completed with 3 extra courses and 1 lab course.

***All of the following*:**

MATH 0220 : Analytical Geometry & Calculus 1
MATH 0230 : Analytical Geometry & Calculus 2
MATH 0240 : Analytical Geometry & Calculus 3
MATH 0280 : Matrices & Linear Algebra
MATH 0290 : Differential Equations
PHYS 0174: Basic Physics for Scientists & Engineers 1 (integrated)
PHYS 0175: Basic Physics for Scientists & Engineers 2 (integrated)
CHEM 0960: General Chem for Engineers 1
CHEM 0970: General Chem for Engineers 2

Laboratory Requirement 1: Choose one of the following or pairs:

MEMS 1010: Experimental Methods in MSE

PHYS 0219: Basic Lab Physics for Science & Engineering

PHYS 0520: Modern Physical Measurements

CHEM 0250: Introduction to Analytical Chemistry **and**
CHEM 0260: Introduction to Analytical Chemistry Lab

Laboratory Requirement 2: Choose one of the following or pairs*:*

PHYS 0525: Analog and Digital Electronics

ECE 1212: Electronic Circuit Design Lab

CHEM 1430: Physical Chemistry Laboratory 1 **and**
CHEM 1255: Instrumental Analysis Lab

All of the following:

*PHYS 1361: Wave Motion and Optics

ECE 1247: Semiconductor Device Theory **or**
PHYS 1374: Solid State Physics

*ECE 1232: Introduction to Lasers & Optical Electronics

One of the following

CHEM 1410: Physical Chemistry 1

PHYS 0477: Principles of Modern Physics 1

PHYS 1370: Intro to Quantum Mechanics 1

One of the following

*MEMS 1058: Electromagnetic Properties of Materials

PHYS 1351: Intermediate Electricity/Magnetism

ECE 1259: Electromagnetics 1

ECE 1266: Applications of Fields & Waves

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 credits to satisfy the SSOE and ABET accreditation requirements. 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. The list can be found here: www.engineering.pitt.edu/approvedelectives. 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 from one of the departments or programs within the School of Arts and Sciences. Only one of these courses can be an introductory course below the 0200 level except in Psychology, Linguistics, and languages.

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.

Most students will satisfy the writing requirement through ENGCMP 0412 as part of the First-Year Engineering program. However, if a student took the honors First-Year Engineering courses, they will not have taken ENGCMP 0412 and will have the satisfy the writing requirement with another "W" – designated course.

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 SSOE from another college or university). Only the credits 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 the SSOE 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/academics/undergraduate-admissions/ap-courses/ for the current SSOE policy relating AP scores with advanced standing credit.

2.7.2 Transfer Credit for Courses Taken After Enrollment

Students enrolled in the SSOE 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, they are not permitted to take courses at a community college or other two-year institution as part of their engineering education. Students residing in the Pittsburgh area are expected to take all of their courses

at the University of Pittsburgh, unless there is a special course offered at one of the other area four-year colleges that is not available at the University of Pittsburgh. See Section 4.2 for more information on cross-registering at PCHE-member institutions. Students may take courses at the Greensburg and Johnstown campuses of the University of Pittsburgh. Engineering and Engineering Science courses must have been taken from an ABET-approved engineering program.

Only the credits will transfer for the equivalent class, not the grade or grade point average, and credit will only be given if the student receives at least 2.00 on a 4.00 scale. It is the student's responsibility to have their transcript sent to the Undergraduate Program Office, 636 Benedum Hall, at the completion of the class.

2.8 Academic Advising

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

• 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:

www.engineering.pitt.edu/departments/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 Option—the H/S/U and S/NC Grade Options are not allowed.

3.1.1 Letter Grades

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

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

Students assigned "G" grades are required to complete course requirements within the next term of registration or within the time specified by the instructor. The instructor of the course will complete a grade change authorization form and send it to the School of Engineering Office of Administration for processing. If a "G" grade is not removed within one year, the instructor may change it to an "F" grade for the course.

I - The "I" grade signifies incomplete course work due to the nature of the course, clinical work, or incomplete research work in individual guidance courses or seminars. It is not typically used for undergraduates.

R - The "R" grade signifies that a student resigned from the University.

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

Z - The "Z" grade indicates that an instructor has issued an invalid grade.

3.2 Withdrawal

To receive a refund, a student must officially drop a course during the term's add/drop period. This is done by processing an Enrollment form, signed by the student's academic advisor, through the Undergraduate Program Office, 636 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, 636 Benedum Hall. The course instructor must sign the form. Withdrawal forms for courses offered by the School of Engineering must be processed through the SSOE 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 dean's office. A "W" grade will then be assigned for the course.

Withdrawal from a School of Engineering course after the ninth week of the term is permitted only for extremely extenuating circumstances. It requires the approval of the Associate Dean for Academic Affairs.

3.3 Calculation of the Grade Point Average

Each unit carried for a letter grade towards a student's degree is awarded grade points as shown in the grading system table. A student's term grade point average (term GPA) is the total grade points earned for the term divided by the total units assigned letter grades.

A student's cumulative grade point average (cumulative GPA) is determined by dividing the total number of grade points by the total number of units assigned letter grades. Only credits taken at the University of Pittsburgh and count towards a student's degree are used in the calculation of the grade point averages. In particular, preparatory writing, preparatory mathematics, PEDC, and AFROTC units are not included in the calculation of a student's GPA.

3.3.1 Course Repeats

A course resulting in a grade of "C–" or lower may be retaken within one calendar year.

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

3.4 Academic Honors

At the end of each term, the academic records of all undergraduate degree students in the SSOE 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 their 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 they are 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 their 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 SSOE Office of Administration. Students returning from academic suspension are reinstated on academic probation and their academic performance will be reviewed after each subsequent term. If the student's cumulative GPA remains below 2.00 for two consecutive terms, they 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 credits required by the department in which the student is enrolled. The student must also have obtained a minimum cumulative GPA of 2.00 for (a) all courses completed at the University of Pittsburgh and (b) all departmental courses.

2. Students who have a cumulative GPA of 2.00, but have not obtained the minimum 2.00 departmental GPA, can only be certified for graduation by the department by repeating all departmental courses in which a grade of "D+" or worse was awarded and earning a grade of "C" or better for each repeated course. Such students must maintain a cumulative GPA of 2.00 for all courses taken at the University.

3. Students must complete the 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 credits earned in such courses are not included in the GPA calculations.

5. No course in which an "F" or a non-letter grade was received can be used to satisfy the 128-unit requirement. A minimum "D−" letter grade is required.

6. Students must complete an Application for Graduation form in the term that they are graduating. These forms are available in the Undergraduate Program Office and online at www.engineering.pitt.edu/departments/mems/undergraduate/resources/. After completing the form, students turn it in to the SSOE 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 to make sure everything is in order. It is the student's responsibility to meet all of the program's requirements for graduation.

8. In the term that the student is graduating, they 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 SSOE, 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 credits 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/departments/mems/undergraduate/resources/

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

4.1 Self-Enrollment

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

- Prior to each term, students will be provided with an Enrollment Appointment, which is the date and time at which they may begin registering for courses. The Enrollment Appointments are based on seniority (first seniors, then juniors, etc.).
- All students will initially have an "Academic Advisement Required" hold on their account, which will prevent them from self-enrolling. Students should meet with their advisors to resolve questions regarding their curricular schedules. After it has been documented that a student has been advised, we are authorized to manually remove the student's hold. Ideally a student's hold should be removed before their 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 student's record and planned course work suggests that such an overload is academically justifiable. All units over 18 will be billed over and above the full-time tuition rate at the prevailing per-unit tuition charge.

4.2 PCHE Cross-Registration

Cross-college and cross-university registration is a program designed to provide for enriched educational opportunities for undergraduates at any of the eleven institutions that comprise the Pittsburgh Council on Higher Education (PCHE): Carnegie Mellon University, Carlow University, Chatham University, Community College of Allegheny County, Duquesne University, Point Park University, LaRoche College, Robert Morris University, Pittsburgh Technical College, Pittsburgh Theological Seminary, and the University of Pittsburgh. Under the terms of this program, full-time students at any one of these institutions are granted the opportunity to enroll for a maximum of six units per term at any of the other institutions. Each institution provides the others with lists of those courses approved by department chairpersons as being open to cross-registration. Such courses must be selected from those regularly accredited toward baccalaureate programs, and a student registering for them must

meet all prerequisites. Priority in registration goes to the students of the host college. Units and grades are transferred.

The following limitations apply:

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

Cross-registration takes place during the add/drop period, ending the last day of the University of Pittsburgh's add/drop period. Interested students should go to the Office of Administration, 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 from another college or university should indicate on their application to the University of Pittsburgh that they wish to apply for admission to the Swanson School of Engineering. If the student has fewer than 24 credits, the Swanson School of Engineering may also evaluate his or her high school record, including SAT or ACT scores in making the admissions decision. If the student is transferring through an established articulation agreement, this should be noted in the comments section of the electronic application and a letter of recommendation from the students 3/2 Program Advisor should be part of the application materials. All decisions are subject to space available in the academic program of choice. For more information about transferring in to the Swanson School of Engineering, please inquire with Christopher Kirchhof at chk63@pitt.edu.

Applicants for the Spring Term should apply by December 1 (October 1 for International Students); for the Summer Term by April 1 (February 15 for International Students); and for the Fall Term by August 1 (May 1 for International Students). A transfer applicant will typically not be admitted to the School of Engineering without 24 or more transferrable credits and a grade point average of 3.0 (3.25 for a two-year college) on a 4.0 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. For further information about transfer credits please refer to the Swanson School of Engineering Transfer Policies website at Swanson School of Engineering Transfer Policies (pitt.edu).

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 3.0 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 websites for each of the degree options listed below, is available online at www.engineering.pitt.edu/departments/mems/undergraduate/engineering-science/

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 eight certificates at the undergraduate level.

- Engineering for Humanity
- Engineering Simulation in Design
- Health Systems Engineering
- Innovation, Product Design, and Entrepreneurship
- International Engineering Studies
- Photonics

- Supply Chain Management
- Sustainable Engineering

5.4 The David C. Frederick Honors College

The David C. Frederick 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.

Curricular requirements: Engineering Science Program overlaps well with the mission of Honors College to provide students with knowledge in several disciplines. Therefore, for students majoring in Engineering Science who want to pursue Honors degree/Honors Distinction, the Curricular requirements (total of 18 credits for Honors degree/9 credits for Honors distinction) are waived.

For more information please see https://honors.pitt.edu/H-degree.

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 (412) 624-9883.

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

Seventy-four departmental minors are available in programs offered by A&S. The minors are listed here. 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 Panther Leadership Academy (previously the Emerging Leaders Program)

The Panther Leadership Academy (formerly known as Emerging Leaders and Leadership in Action) is a 20-week leadership development program that helps students discover and develop their personal capacity to lead effectively and inclusively. The foundation of the Panther Leadership Academy is based on the Social Change Model of Leadership which highlights on 8 key principles: consciousness of self, congruence, commitment, collaboration, common purpose, controversy with Civility, citizenship, change. For more information, see this webpage.

5.10 International Education

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

5.11 EAGR Program - Receiving Graduate Credit

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

5.12 Combined Liberal Arts & Engineering 3/2 Programs

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 Swanson School of Engineering.

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 – Curriculum Checklists

Engineering Physics Curriculum Checklist					
Title	**Course**	**Cr.**	**Pre/Co-Requisites**	**Term**	**Grade**
Chemistry					
General Chemistry for Engineering 1	CHEM 0960	3			
General Chemistry for Engineering 2	CHEM 0970	3	CHEM 0960		
Electrical & Computer Engineering					
Linear Circuits & Systems	ECE 0101	4	PHYS 0175, ENGR 0012 *Math 0280, 0290*		
Digital Circuits & Systems	ECE 0201	4	PHYS 0175, ENGR 0012		
Microelectronic Circuits & Lab	ECE 0102	4	ECE 0101		
Problem Solving in C++	ECE 0301	3	ENGR 0012		
Electrical Circuits Design Lab	ECE 1212	3	ECE 0102, 0402		
Semiconductor Device Theory	ECE 1247	3	ECE 0402 or ENGR 0020		
Applied Fields & Waves	ECE 1266	3	PHYS 1351, ECE 0301		
Signals Systems & Probabilities	ECE 0402	3	MATH 0280, 0290		
Junior Design Fundamentals	ECE 1895	3	ECE 0102, ECE 0202, ECE 0302, ECE 0402		
General Engineering					
Introduction to Engineering Analysis	ENGR 0011	3			
Engineering Computing	ENGR 0012	3	ENGR 0011		
Materials Structures & Properties	ENGR 0022	3	PHYS 0175, MATH 0230		
Statics & Mechanics of Materials 1	ENGR 0135	3	MATH 0230, PHYS 0174		
Humanities & Social Sciences					
Humanities Elective*		3			
Social Sciences Elective*		3			
Humanities/Social Sciences Elective*		3			
Humanities/Social Sciences Elective*		3			
Humanities/Social Sciences Elective*		3			

Humanities/Social Sciences Elective * ‡		3			
Mathematics					
Analytical Geometry & Calculus 1	MATH 0220	4			
Analytical Geometry & Calculus 2	MATH 0230	4	MATH 0220		
Analytical Geometry & Calculus 3	MATH 0240	4	MATH 0230		
Matrices & Linear Algebra	MATH 0280	3	MATH 0220		
Differential Equations	MATH 0290	3	MATH 0230		
Mechanical Engineering					
Introduction Thermodynamics	MEMS 0051	3	PHYS 0175, CHEM 0960		
Structures of Crystals	MEMS 1053	3	ENGR 0022		
Phase Equilibria	MEMS 1059	3	ENGR 0022, MEMS 0051		
Physics					
Physics for Science & Engineering 1	PHYS 0174	4	*MATH 0220*		
Physics for Science & Engineering 2	PHYS 0175	4	PHYS 0174, *MATH 0230*		
Lab Physics for Science & Engineering	PHYS 0219	2	*PHYS 0175*		
Principles of Modern Physics 1	PHYS 0477	4	PHYS 0175, *MATH 0240*		
Principles of Modern Physics 2	PHYS 0481	3	PHYS 0477		
Upper-Level Physics (Recommended: Intermediate Electricity & Magnetism)	PHYS (1351)	3	PHYS 0175, MATH 0240, *MATH 0290*		
Upper-Level Physics	PHYS	3			
Upper-Level Physics	PHYS	3			
Program Specific					
Program Elective (Recommended: Partial Differential Equations [MATH 1470])	(MATH 1470)	3	MATH 0240, MATH 0290		
Program Elective		3			
Senior Design					
Senior Design 1[+]		3			
Senior Design 2[++]		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. Alternatively, may be ENGR 1050 Product Realization, or with preapproval, a senior design project arranged with a faculty mentor and taken as ENGSCI 1801.

[++] A semester-long research experience under the supervision of a faculty advisor at Pitt, not necessarily within

the Swanson School of Engineering. Note that this requirement may also be fulfilled by participation in an undergraduate research program like the MCSI URP or the SURI during the summer semester.

‡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.

Engineering Physics Curriculum Program Electives

Upper-level physics possible choices (must meet prerequisite requirements) include the following:

PHYS 1331: Mechanics
PHYS 1341: Thermodynamics. & Statistical Mechanics
PHYS 1351: Intermediate Electricity & Magnetism (Same as ECE 1259)
PHYS 1361: Wave Motion and Optics (PHYS 0219)
PHYS 1370: Introduction to Quantum Mechanics 1 (Corequisite: PHYS 1331 and 1351)
PHYS 1371: Introduction to Quantum Mechanics 2 (Prerequisite: PHYS 1370)
PHYS 1372: Electromagnetic Theory (Corequisite: PHYS 1331 and 1351)
PHYS 1374: Solid State Physics (Prerequisite: PHYS 0477)
PHYS 1376: Introduction to Biological Physics (Math 235 or Statistics 1000)
PHYS 1378: Introduction to Nuclear & Particle Physics 1 (Prerequisite: 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 standard quantum mechanics sequence in the Physics department:

PHYS 1370: Introduction to Quantum Mechanics 1
PHYS 1371: Introduction to Quantum Mechanics 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 1250: Introduction to Nanotechnology & Nanoengineering
ECE 1251: Fabrication & Design in Nanotechnology

Other Elective Options Include:

Electrical & Computer Engineering
ECE 1232: Introduction to Lasers & Optical Electronics
ECE 1238: Digital Electronics

Mechanical Engineering
MEMS 1010: Experimental Methods in Materials Science & Engineering
MEMS 1048: Analysis & Characteristics at the Nanoscale
MEMS 1049: Mechatronics
MEMS 1057: Micro/Nano Manufacturing
MEMS 1082: Electromechanical Sensors & Actuators
MEMS 1111: Materials for Energy Generation & Storage

Nanotechnology Curriculum Checklist
Physics/Materials Emphasis

Title	Course	Cr.	Pre/Co-Requisites	Term	Grade
Chemistry					
General Chemistry for Engineering 1	CHEM 0960	3			
General Chemistry for Engineering 2	CHEM 0970	3	CHEM 0960		
Electrical & Computer Engineering					
Linear Circuits & Systems	ECE 0101	4	PHYS 0175, ENGR 0012 *Math 0280, 0290*		
Microelectronic Circuits & Lab	ECE 0102	4	ECE 0101		
Problem Solving in C++	ECE 0301	3	ENGR 0012		
Fabrication & Design in Nanotechnology	ECE 1251	3	ENGR 0240/ECE 1250		
General Engineering					
Introduction to Engineering Analysis	ENGR 0011	3			
Engineering Computing	ENGR 0012	3	ENGR 0011		
Materials Structures & Properties	ENGR 0022	3	PHYS 0175, MATH 0230		
Statics & Mechanics of Materials 1	ENGR 0135	3	MATH 0230, PHYS 0174		
Probability & Statistics	ENGR 0021	3	MATH 0230		
Introduction to Nanotechnology & Nanoengineering	ENGR 0240/ ECE 1250	3	MATH 0230, PHYS 0175		
Fabrication & Design in Nanotechnology	ECE 1251	3			
Humanities & Social Sciences					
Humanities Elective*		3			
Social Sciences Elective*		3			
Humanities/Social Sciences Elective*		3			
Humanities/Social Sciences Elective*		3			
Humanities/Social Sciences Elective*		3			
Humanities/Social Sciences Elective * ‡		3			
Mathematics					
Analytical Geometry & Calculus 1	MATH 0220	4			
Analytical Geometry & Calculus 2	MATH 0230	4	MATH 0220		
Analytical Geometry & Calculus 3	MATH 0240	4	MATH 0230		
Matrices & Linear Algebra	MATH 0280	3	MATH 0220		
Differential Equations	MATH 0290	3	MATH 0230		

Mechanical Engineering					
Thermodynamics of Materials	MEMS 0048	3	PHYS 0175, CHEM 0960		
Structures of Crystals	MEMS 1053	3	ENGR 0022		
Experimental Methods in MSE	MEMS 1010	3	ENGR 0022		
Micro/Nano Manufacturing	MEMS 1057	3			
Phase Equilibria	MEMS 1059	3	ENGR 0022, MEMS 0051		
Phase Transformations	MEMS 1063	3	MEMS 1053, MEMS 1059		
Physics					
Physics for Science & Engineering 1	PHYS 0174	4	*MATH 0220*		
Physics for Science & Engineering 2	PHYS 0175	4	PHYS 0174, *MATH 0230*		
Lab Physics for Science & Engineering	PHYS 0219	2	*PHYS 0175*		
Principles of Modern Physics 1	PHYS 0477	4	PHYS 0175, *MATH 0240*		
Principles of Modern Physics 2	PHYS 0481	3	PHYS 0477		
Upper-Level Physics	PHYS	3			
Upper-Level Physics	PHYS	3			
Program Specific					
Nanotechnology Program Elective		3			
Nanotechnology Program Elective		3			
Nanotechnology Program Elective		3			
Senior Design					
Senior Design 1[+]		3			
Senior Design 2[++]		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. Alternatively, may be ENGR 1050 Product Realization, or with preapproval, a senior design project arranged with a faculty mentor and taken as ENGSCI 1801.

[++] A semester-long research experience under the supervision of a faculty advisor at Pitt, not necessarily within the Swanson School of Engineering. Note that this requirement may also be fulfilled by participation in an undergraduate research program like the MCSI URP or the SURI during the summer semester.

[‡]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.

Nanotechnology Curriculum Program Electives – Physics/Materials

Approved Electives include:

Bioengineering

BIOENG 1810	Biomaterials and Biocompatibility

Chemistry

CHEM 1410	Physical Chemistry 1
CHEM 1420	Physical Chemistry 2
CHEM 1480	Intermediate Physical Chemistry
CHEM 1130	Inorganic Chemistry
CHEM 1620	Atoms, Molecules & Materials – 'Introduction to Nanomaterials'

Electrical & Computer Engineering

ECE 1232	Introduction to Lasers and Optical Electronics
ECE 1238	Digital Electronics
ECE 1247	Semiconductor Device Theory

General Engineering

ENGR 1066	Introduction to Solar Cells and Nanotechnology

Industrial Engineering

IE 1012	Manufacture of Structural Nano-Materials

Mechanical Engineering

MEMS 1011	Structure and Properties Lab
MEMS 1048	Analysis and characterization at the Nano-scale
MEMS 1082	Electromechanical Sensors and Actuators
MEMS 1111	Materials for Energy Generation and Storage

Materials Science

MSE 2012	Computational Material Science

Physics

PHYS 0520	Modern Physical Measurements
PHYS 1370	Introduction to Quantum Mechanics
PHYS 1371	Introduction to Quantum Mechanics
PHYS 1375	Foundations of Nanoscience

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

Nanotechnology Curriculum Checklist
Chemistry/Bioengineering Emphasis

Title	Course	Cr.	Pre/Co-Requisites	Term	Grade
Bioengineering					
Bioengineering Elective	BIOENG	3			
Bioengineering Elective	BIOENG	3			
Chemistry					
General Chemistry for Engineering 1	CHEM 0960	3			
General Chemistry for Engineering 2	CHEM 0970	3	CHEM 0960		
Core Chemistry Course	CHEM	3			
Core Chemistry Course	CHEM	3			
Core Chemistry Course	CHEM	3			
Electrical & Computer Engineering					
Linear Circuits & Systems	ECE 0101	4	PHYS 0175, ENGR 0012 *Math 0280, 0290*		
Microelectronic Circuits & Lab	ECE 0102	4	ECE 0101		
Problem Solving in C++	ECE 0301	3	ENGR 0012		
General Engineering					
Introduction to Engineering Analysis	ENGR 0011	3			
Engineering Computing	ENGR 0012	3	ENGR 0011		
Materials Structures & Properties	ENGR 0022	3	PHYS 0175, MATH 0230		
Statics & Mechanics of Materials 1	ENGR 0135	3	MATH 0230, PHYS 0174		
Probability & Statistics	ENGR 0021	3	MATH 0230		
Introduction to Nanotechnology & Nanoengineering	ENGR 0240	3	MATH 0230, PHYS 0175		
Humanities & Social Sciences					
Humanities Elective*		3			
Social Sciences Elective*		3			
Humanities/Social Sciences Elective*		3			
Humanities/Social Sciences Elective*		3			
Humanities/Social Sciences Elective*		3			
Humanities/Social Sciences Elective * ‡		3			

Life Sciences					
Basic Life Science	LIFESCI	3			
Basic Life Science	LIFESCI	3			
Mathematics					
Analytical Geometry & Calculus 1	MATH 0220	4			
Analytical Geometry & Calculus 2	MATH 0230	4	MATH 0220		
Analytical Geometry & Calculus 3	MATH 0240	4	MATH 0230		
Matrices & Linear Algebra	MATH 0280	3	MATH 0220		
Differential Equations	MATH 0290	3	MATH 0230		
Mechanical Engineering					
Introduction to Thermodynamics	MEMS 0051	3	PHYS 0175, CHEM 0960		
Structures of Crystals	MEMS 1053	3	ENGR 0022		
Experimental Methods in MSE	MEMS 1010	3	ENGR 0022		
Micro/Nano Manufacturing	MEMS 1057	3			
Physics					
Physics for Science & Engineering 1	PHYS 0174	4	*MATH 0220*		
Physics for Science & Engineering 2	PHYS 0175	4	PHYS 0174, *MATH 0230*		
Lab Physics for Science & Engineering	PHYS 0219	2	*PHYS 0175*		
Program Specific					
Nanotechnology Program Elective		3			
Nanotechnology Program Elective		3			
Nanotechnology Program Elective		3			
Senior Design					
Senior Design 1[+]		3			
Senior Design 2[++]		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. Alternatively, may be ENGR 1050 Product Realization, or with preapproval, a senior design project arranged with a faculty mentor and taken as ENGSCI 1801.

[++] A semester-long research experience under the supervision of a faculty advisor at Pitt, not necessarily within the Swanson School of Engineering. Note that this requirement may also be fulfilled by participation in an undergraduate research program like the MCSI URP or the SURI during the summer semester.

[‡]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.

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

Approved Nanotechnology Electives include:

Bioengineering

BIOENG 1005	RF Medical Devices and Applications of Electromagnetism in Medicine
BIOENG 1810	Biomaterials and Biocompatibility

Biological Sciences

BIOSC 0057	Foundations of Biology Research Lab 1 (1 cr.)
BIOSC 0067	Foundations of Biology Research Lab 2 (1 cr.)

Chemistry

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 1480	Intermediate Physical Chemistry
CHEM 1620	Atoms, Molecules & Materials – ‘Introduction to Nanomaterials’

Electrical & Computer Engineering

ECE 1232	Introduction to Lasers and Optical Electronics (3 units)
ECE 1238	Digital Electronics (3 units)
ECE 1247	Semiconductor Device Theory

General Engineering

ENGR 1066	Introduction to Solar Cells and Nanotechnology

Industrial Engineering

IE 1012	Manufacture of Structural Nanomaterials

Mechanical Engineering

MEMS 1011	Structure and Properties Lab
MEMS 1048	Analysis and Characterization at the Nanoscale
MEMS 1063	Phase Transformation
MEMS 1082	Electromechanical Sensors and Actuators
MEMS 1101	Ferrous Physical Metallurgy
MEMS 1111	Materials for Energy Generation and Storage

Materials Science

MSE 2012	Computational Material Science

Physics

PHYS 0520	Modern Physical Measurements
PHYS 1370	Introduction to Quantum Mechanics 1
PHYS 1371	Introduction to Quantum Mechanics 2

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

BIOSC 1000	Biochemistry
BIOSC 1810	Macromolecular Structure & Function
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

LIFESCI 1 and 2 must be selected from the following:

Bioengineering

BIOENG 1070	Introduction to Cell Biology I
BIOENG 1071	Introduction to Cell Biology II

Biological Sciences

BIOSC 0150	Foundations of Biology I
BIOSC 0160	Foundations of Biology II
BIOSC 1070	Human Physiology - UHC
BIOSC 1250	Introduction to Human Physiology

Health & Rehabilitation Sciences

HRS 1023	Human Physiology

Neuroscience

NROSCI 1000	Introduction 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 1075	Introductory Cell and Molecular Biology Laboratory Techniques
BIOENG 1095	Special Projects
BIOENG 1150	Bioengineering Methods and Applications
BIOENG 1210	Bioengineering Thermodynamics – OR MEMS 0051 (Thermodynamics)
BIOENG 1220	Biotransport Phenomena
BIOENG 1310	Linear Systems and Electronics I – OR MEMS 0031 (Linear Circuits & Systems)
BIOENG 1320	Biological Signals and Systems
BIOENG 1330	Biomedical Imaging
BIOENG 1383	Biomedical Optical Microscopy

BIOENG 1620 Introduction to Tissue Engineering
BIOENG 1630 Biomechanics 1

Other appropriate courses may be approved by the Program Director

Engineering Mechanics Curriculum Checklist

Title	Course	Cr.	Pre/Co-Requisites	Term	Grade
Chemistry					
General Chemistry for Engineering 1	CHEM 0960	3			
General Chemistry for Engineering 2	CHEM 0970	3	CHEM 0960		
General Engineering					
Introduction to Engineering Analysis	ENGR 0011	3			
Engineering Computing	ENGR 0012	3	ENGR 0011		
Materials Structures & Properties	ENGR 0022	3	PHYS 0175, MATH 0230		
Statics & Mechanics of Materials 1	ENGR 0135	3	MATH 0230, PHYS 0174		
Statics & Mechanics of Materials 2	ENGR 0145	3	ENGR 0135		
Humanities & Social Sciences					
Humanities Elective*		3			
Social Sciences Elective*		3			
Humanities/Social Sciences Elective*		3			
Humanities/Social Sciences Elective*		3			
Humanities/Social Sciences Elective*		3			
Humanities/Social Sciences Elective * ‡		3			
Mathematics					
Analytical Geometry & Calculus 1	MATH 0220	4			
Analytical Geometry & Calculus 2	MATH 0230	4	MATH 0220		
Analytical Geometry & Calculus 3	MATH 0240	4	MATH 0230		
Matrices & Linear Algebra	MATH 0280	3	MATH 0220		
Differential Equations	MATH 0290	3	MATH 0230		
Vector Analysis & Applications	MATH 1550	3	MATH 0240, MATH 0280		
Mechanical Engineering					
Introduction to Design	MEMS 0024	3	ENGR 0011		
Linear Circuits & Systems 1	MEMS 0031	3	PHYS 0175, MATH 0230		
Introduction to Thermodynamics	MEMS 0051	3	PHYS 0175, CHEM 0960		
Introduction to Fluid Mechanics	MEMS 0071	3	PHYS 0175, CHEM 0970, MATH 0290		
Experimental Methods in MSE	MEMS 1010	3	ENGR 0022		
Dynamic Systems	MEMS 1014	3	ENGR 0012, MEMS 0031, MATH 0280		

Rigid Body Dynamics	MEMS 1015	3	ENGR 0135, MATH 0240		
Vibrations	MEMS 1020	3	MEMS 1014		
Mechanical Design 1	MEMS 1028	3	ENGR 0145, MEMS 0031, MEMS 1014/1015		
Mechanical Measurements 1	MEMS 1041	3	ENGR 0145		
Finite Element Analysis	MEMS 1047	3	MEMS 1028		
Structures of Crystals	MEMS 1053	3	ENGR 0022		
Physics					
Physics for Science & Engineering 1	PHYS 0174	4	*MATH 0220*		
Physics for Science & Engineering 2	PHYS 0175	4	PHYS 0174, *MATH 0230*		
Principles of Modern Physics 1	PHYS 0477	4	PHYS 0175, *MATH 0240*		
Upper-Level Physics	PHYS	3			
Program Specific					
Engineering Mechanics Elective		3			
Engineering Mechanics Elective		3			
Senior Design					
Senior Design 1[+]		3			
Senior Design 2[++]		3			
Statistics					
Applied Statistical Methods	STAT 1000	4			

Upper-Level Physics: Physics courses with course numbers > 1000

[+] A senior design course offered by one of the other SSOE engineering programs is required. Alternatively, may be ENGR 1050 Product Realization, or with preapproval, a senior design project arranged with a faculty mentor and taken as ENGSCI 1801.

[++] A semester-long research experience under the supervision of a faculty advisor at Pitt, not necessarily within the Swanson School of Engineering. Note that this requirement may also be fulfilled by participation in an undergraduate research program like the MCSI URP or the SURI during the summer semester.

[‡]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.

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:

Health & Rehabilitation Sciences
HRS 1701 Introduction to Prosthetics and Orthotics

Bioengineering
BIOENG 1630 Biomechanics 1: Mechanical Principles of Biological Systems
BIOENG 1631 Biomechanics 2: Introduction to Biodynamics and Biosolid Mechanics
BIOENG 1632 Biomechanics 3: Biodynamics of Movement
BIOENG 1633 Biomechanics 4: Biomechanics of Organs, Tissues, and Cells

Civil Engineering
CEE 1330 Introduction to Structural Analysis
CEE 1341 Design of Steel Structures
CEE 1401 Open Channel Hydraulics
CEE 1412 Introduction to Water Resources Engineering
CEE 1811 Principles of Soil Mechanics
CEE 1821 Foundation Engineering

Material Science
MEMS 0040 Materials and Manufacturing
MEMS 1011 Structure and Properties Lab
MEMS 1048 Analysis and Characterization at the Nanoscale
MEMS 1053 Structures of Crystals and Diffraction
MEMS 1058 Electromagnetic Properties of Materials
MEMS 1059 Phase Equilibria in Multi-Component Materials
MEMS 1063 Phase Transformation & Microstructure Evolution
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 1082 Electromechanical Sensors and Actuators

Physics
PHYS 1331 Mechanics
PHYS 1341 Thermodynamics and Statistical Mechanics

Appendix B – Sample Schedules

Engineering Physics Sample Schedule		
Title	**Course**	**Units**
First Term		
General Chemistry for Engineering 1	CHEM 0960	3
Introduction to Engineering Analysis	ENGR 0011	3
Analytical Geometry & Calculus 1	MATH 0220	4
Physics for Science & Engineering 1	PHYS 0174	4
*Humanities/Social Sciences Elective**	*H/SS Elective 1*	3
Freshman Seminar	ENGR 0081	0
Term Units		17
Second Term		
General Chemistry for Engineering 2	CHEM 0970	3
Engineering Computing	ENGR 0012	3
Analytical Geometry & Calculus 2	MATH 0230	4
Physics for Science & Engineering 2	PHYS 0175	4
*Humanities/Social Sciences Elective**	*H/SS Elective 2*	3
Freshman Seminar	ENGR 0082	0
Term Units		17
Third Term		
Linear Circuits & Systems	ECE 0101	4
Digital Circuits & Systems	ECE 0201	4
Problem Solving in C++	ECE 0301	3
Statics & Mechanics of Materials 1	ENGR 0135	3
Differential Equations	MATH 0290	3
Engineering Science Seminar	ENGSCI 1085	0
Term Units		17
Fourth Term		
Microelectronic Circuits & Lab	ECE 0102	4
Signals Systems & Probabilities	ECE 0402	3
Materials Structures & Properties	ENGR 0022	3
Analytical Geometry & Calculus 3	MATH 0240	4
Matrices & Linear Algebra	MATH 0280	3
Engineering Science Seminar	ENGSCI 1085	0
Term Units		17

Fifth Term		
Electrical Circuits Design Lab	ECE 1212	3
Structures of Crystals	MEMS 1053	3
Principles of Modern Physics 1	PHYS 0477	4
Physics Elective 1	*PHYS*	3
Program Elective (Recommended: Partial Differential Equations)	*(MATH 1470)*	3
Engineering Science Seminar	ENGSCI 1085	0
Term Units		16
Sixth Term		
Junior Design Fundamentals	ECE 1895	3
Introduction Thermodynamics	MEMS 0051	3
Lab Physics for Science & Engineering	PHYS 0219	2
Principles of Modern Physics 2	PHYS 0481	3
*Humanities/Social Sciences Elective**	*H/SS Elective 3*	3
*Social Sciences Elective**	*H/SS Elective 4*	3
Engineering Science Seminar	ENGSCI 1085	0
Term Units		17
Seventh Term		
Semiconductor Device Theory	ECE 1247	3
Applied Fields & Waves	ECE 1266	3
Phase Equilibria	MEMS 1059	3
Physics Elective 2	*PHYS*	3
Senior Design 1		3
Engineering Science Seminar	ENGSCI 1085	0
Term Units		15
Eighth Term		
*Humanities/Social Sciences Elective * [‡]*	*H/SS Elective 5*	3
*Humanities Elective**	*H/SS Elective 6*	3
Physics Elective 3	*PHYS*	3
Program Elective 2		3
Senior Design 2		3
Engineering Science Seminar	ENGSCI 1085	0
Term Units		15
Total Units		131
51 Minimum Engineering Units, 50 Minimum Math/Science Units		

Upper-Level Physics: Physics courses with course numbers > 1000

[+] A senior design course offered by one of the other SSOE engineering programs is required. Alternatively, may be ENGR 1050 Product Realization, or with preapproval, a senior design project arranged with a faculty mentor and taken as ENGSCI 1801.

[++] A semester-long research experience under the supervision of a faculty advisor at Pitt, not necessarily within the Swanson School of Engineering. Note that this requirement may also be fulfilled by participation in an undergraduate research program like the MCSI URP or the SURI during the summer semester.

[‡]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).

Engineering Physics 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 standard quantum mechanics sequence in the Physics department:

PHYS 1370: Introduction to Quantum Mechanics 1
PHYS 1371: Introduction to Quantum Mechanics 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 1250: Introduction to Nanotechnology & Nanoengineering
ECE 1251: Fabrication & Design in Nanotechnology

Other Elective Options Include:

Electrical & Computer Engineering
ECE 1232: Introduction to Lasers & Optical Electronics
ECE 1238: Digital Electronics

Mechanical Engineering
MEMS 1010: Experimental Methods in Materials Science & Engineering
MEMS 1048: Analysis & Characteristics at the Nanoscale
MEMS 1049: Mechatronics
MEMS 1057: Micro/Nano Manufacturing
MEMS 1082: Electromechanical Sensors & Actuators
MEMS 1111: Materials for Energy Generation & Storage

Nanotechnology Sample Schedule
Physics/Materials Emphasis

Title	Course	Units
First Term		
General Chemistry for Engineering 1	CHEM 0960	3
Introduction to Engineering Analysis	ENGR 0011	3
Analytical Geometry & Calculus 1	MATH 0220	4
Physics for Science & Engineering 1	PHYS 0174	4
*Humanities/Social Sciences Elective**	*H/SS Elective 1*	3
Freshman Seminar	ENGR 0081	0
Term Units		17
Second Term		
General Chemistry for Engineering 2	CHEM 0970	3
Engineering Computing	ENGR 0012	3
Analytical Geometry & Calculus 2	MATH 0230	4
Physics for Science & Engineering 2	PHYS 0175	4
*Humanities/Social Sciences Elective**	*H/SS Elective 2*	3
Freshman Seminar	ENGR 0082	0
Term Units		17
Third Term		
Linear Circuits & Systems	ECE 0101	4
Problem Solving in C++	ECE 0301	3
Statics & Mechanics of Materials 1	ENGR 0135	3
Matrices & Linear Algebra	MATH 0280	3
Principles of Modern Physics 1	PHYS 0477	4
Engineering Science Seminar	ENGSCI 1085	0
Term Units		17
Fourth Term		
Materials Structures & Properties	ENGR 0022	3
Analytical Geometry & Calculus 3	MATH 0240	4
Differential Equations	MATH 0290	3
Introduction Thermodynamics	MEMS 0051	3
Lab Physics for Science &	PHYS 0219	2
Engineering Science Seminar	ENGSCI 1085	0
Term Units		15
Fifth Term		
Introduction to Nanotechnology & Nanoengineering	ENGR 0240	3
Experimental Methods in MSE	MEMS 1010	3

Structures of Crystals	MEMS 1053	3
Phase Equilibria	MEMS 1059	3
*Humanities/Social Sciences Elective**	*H/SS Elective 3*	3
Program Elective 1		3
Engineering Science Seminar	ENGSCI 1085	0
Term Units		18
Sixth Term		
Engineering Microelectronic Circuits & Lab	ECE 0102	4
Fabrication & Design in Nanotechnology or Foundations of Nanoscience	PHYS 1375 or CHEM 1630 or ECE 1251	3
Phase Transformations	MEMS 1063	3
Principles of Modern Physics 2	PHYS 0481	3
Program Elective 2		3
Engineering Science Seminar	ENGSCI 1085	0
Term Units		16
Seventh Term		
Micro/Nano Manufacturing	MEMS 1057	3
Physics Elective 1	*PHYS*	3
Program Elective 3		3
Senior Design 1		3
*Social Sciences Elective**	*H/SS Elective 4*	3
Engineering Science Seminar	ENGSCI 1085	0
Term Units		15
Eighth Term		
Probability & Statistics	ENGR 0021	3
Physics Elective 2	*PHYS*	3
Senior Design 2		3
*Humanities/Social Sciences Elective * ‡*	*H/SS Elective 5*	3
*Humanities Elective**	*H/SS Elective 6*	3
Engineering Science Seminar	ENGSCI 1085	0
Term Units		15
Total Units		130
50 Minimum Engineering Units, 45 Minimum Math/Science Units		

Upper-Level Physics: Physics courses with course numbers > 1000

[+] A senior design course offered by one of the other SSOE engineering programs is required. Alternatively, may be ENGR 1050 Product Realization, or with preapproval, a senior design project arranged with a faculty mentor and taken as ENGSCI 1801.

[++] A semester-long research experience under the supervision of a faculty advisor at Pitt, not necessarily within the Swanson School of Engineering. Note that this requirement may also be fulfilled by participation in an undergraduate research program like the MCSI URP or the SURI during the summer semester.

‡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).

Nanotechnology Electives

Approved Electives include:

Bioengineering
BIOENG 1810 Biomaterials and Biocompatibility

Chemistry
CHEM 1410 Physical Chemistry 1
CHEM 1420 Physical Chemistry 2
CHEM 1480 Intermediate Physical Chemistry
CHEM 1130 Inorganic Chemistry
CHEM 1620 Atoms, Molecules & Materials – 'Introduction to Nanomaterials'

Electrical & Computer Engineering
ECE 1232 Introduction to Lasers and Optical Electronics
ECE 1238 Digital Electronics
ECE 1247 Semiconductor Device Theory

General Engineering
ENGR 1066 Introduction to Solar Cells and Nanotechnology

Industrial Engineering
IE 1012 Manufacture of Structural Nano-Materials

Mechanical Engineering
MEMS 1011 Structure and Properties Lab
MEMS 1048 Analysis and characterization at the Nano-scale
MEMS 1082 Electromechanical Sensors and Actuators
MEMS 1111 Materials for Energy Generation and Storage

Materials Science
MSE 2012 Computational Material Science

Physics
PHYS 0520 Modern Physical Measurements
PHYS 1370 Introduction to Quantum Mechanics
PHYS 1371 Introduction to Quantum Mechanics
PHYS 1375 Foundations of Nanoscience

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

Nanotechnology Sample Schedule
Chemistry/Bioengineering Emphasis

Title	Course	Units
First Term		
General Chemistry for Engineering 1	CHEM 0960	3
Introduction to Engineering Analysis	ENGR 0011	3
Analytical Geometry & Calculus 1	MATH 0220	4
Physics for Science & Engineering 1	PHYS 0174	4
*Humanities/Social Sciences Elective**	*H/SS Elective 1*	3
Freshman Seminar	ENGR 0081	0
Term Units		17
Second Term		
General Chemistry for Engineering 2	CHEM 0970	3
Engineering Computing	ENGR 0012	3
Analytical Geometry & Calculus 2	MATH 0230	4
Physics for Science & Engineering 2	PHYS 0175	4
*Humanities/Social Sciences Elective**	*H/SS Elective 2*	3
Freshman Seminar	ENGR 0082	0
Term Units		17
Third Term		
Linear Circuits & Systems	ECE 0101	4
Problem Solving in C++	ECE 0301	3
Statics & Mechanics of Materials 1	ENGR 0135	3
Matrices & Linear Algebra	MATH 0280	3
Core Chemistry Course 1	*CHEM*	3
Engineering Science Seminar	ENGSCI 1085	0
Term Units		16
Fourth Term		
Materials Structures & Properties	ENGR 0022	3
Analytical Geometry & Calculus 3	MATH 0240	4
Differential Equations	MATH 0290	3
Introduction Thermodynamics	MEMS 0051	3
Lab Physics for Science &	PHYS 0219	2
Core Chemistry Course 2	*CHEM*	3
Engineering Science Seminar	ENGSCI 1085	0
Term Units		18
Fifth Term		
Introduction to Nanotechnology & Nanoengineering	ENGR 0240	3

Experimental Methods in MSE	MEMS 1010	3
Structures of Crystals	MEMS 1053	3
Basic Life Science 1		3
Bioengineering Elective 1	*BIOENG*	3
Engineering Science Seminar	ENGSCI 1085	0
Term Units		15
Sixth Term		
Engineering Microelectronic Circuits & Lab	ECE 0102	4
Bioengineering Elective 2	*BIOENG*	3
Core Chemistry Course 2	*CHEM*	3
*Humanities/Social Sciences Elective**	*H/SS Elective 3*	3
Program Elective 1		3
Engineering Science Seminar	ENGSCI 1085	0
Term Units		16
Seventh Term		
Micro/Nano Manufacturing	MEMS 1057	3
Basic Life Science 2		3
Program Elective 2		3
Senior Design 1		3
*Social Sciences Elective**	*H/SS Elective 4*	3
Engineering Science Seminar	ENGSCI 1085	0
Term Units		15
Eighth Term		
Probability & Statistics	ENGR 0021	3
*Humanities Elective**	*H/SS Elective 6*	3
*Humanities/Social Sciences Elective * [‡]*	*H/SS Elective 5*	3
Program Elective 3		3
Senior Design 2		3
Engineering Science Seminar	ENGSCI 1085	0
Term Units		15
Total Units		129
49 Minimum Engineering Units, 50 Minimum Math/Science Units		

Upper-Level Physics: Physics courses with course numbers > 1000

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

[+] A senior design course offered by one of the other SSOE engineering programs is required. Alternatively, may be ENGR 1050 Product Realization, or with preapproval, a senior design project arranged with a faculty mentor and taken as ENGSCI 1801.

[++] A semester-long research experience under the supervision of a faculty advisor at Pitt, not necessarily within

the Swanson School of Engineering. Note that this requirement may also be fulfilled by participation in an undergraduate research program like the MCSI URP or the SURI during the summer semester.

‡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).

Nanotechnology Electives

Approved Nanotechnology Electives include:

Bioengineering

BIOENG 1005	RF Medical Devices and Applications of Electromagnetism in Medicine
BIOENG 1810	Biomaterials and Biocompatibility

Biological Sciences

BIOSC 0057	Foundations of Biology Research Lab 1 (1 cr.)
BIOSC 0067	Foundations of Biology Research Lab 2 (1 cr.)

Chemistry

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 1480	Intermediate Physical Chemistry
CHEM 1620	Atoms, Molecules & Materials – ‘Introduction to Nanomaterials’

Electrical & Computer Engineering

ECE 1232	Introduction to Lasers and Optical Electronics (3 units)
ECE 1238	Digital Electronics (3 units)
ECE 1247	Semiconductor Device Theory

General Engineering

ENGR 1066	Introduction to Solar Cells and Nanotechnology

Industrial Engineering

IE 1012	Manufacture of Structural Nanomaterials

Mechanical Engineering

MEMS 1011	Structure and Properties Lab
MEMS 1048	Analysis and Characterization at the Nanoscale
MEMS 1063	Phase Transformation
MEMS 1082	Electromechanical Sensors and Actuators
MEMS 1101	Ferrous Physical Metallurgy
MEMS 1111	Materials for Energy Generation and Storage

Materials Science

MSE 2012	Computational Material Science

Physics

PHYS 0520	Modern Physical Measurements
PHYS 1370	Introduction to Quantum Mechanics 1
PHYS 1371	Introduction to Quantum Mechanics 2

Engineering Mechanics Sample Schedule

Title	Course	Units
First Term		
General Chemistry for Engineering 1	CHEM 0960	3
Introduction to Engineering Analysis	ENGR 0011	3
Analytical Geometry & Calculus 1	MATH 0220	4
Physics for Science & Engineering 1	PHYS 0174	4
*Humanities/Social Sciences Elective**	*H/SS Elective 1*	3
Freshman Seminar	ENGR 0081	0
Term Units		17
Second Term		
General Chemistry for Engineering 2	CHEM 0970	3
Engineering Computing	ENGR 0012	3
Analytical Geometry & Calculus 2	MATH 0230	4
Physics for Science & Engineering 2	PHYS 0175	4
*Humanities/Social Sciences Elective**	*H/SS Elective 2*	3
Freshman Seminar	ENGR 0082	0
Term Units		17
Third Term		
Statics & Mechanics of Materials 1	ENGR 0135	3
Matrices & Linear Algebra	MATH 0280	3
Introduction to Design	MEMS 0024	4
Linear Circuits & Systems 1	MEMS 0031	4
Principles of Modern Physics 1	PHYS 0477	4
Engineering Science Seminar	ENGSCI 1085	0
Term Units		16
Fourth Term		
Materials Structures & Properties	ENGR 0022	3
Statics & Mechanics of Materials 2	ENGR 0145	3
Analytical Geometry & Calculus 3	MATH 0240	4
Differential Equations	MATH 0290	3
Introduction Thermodynamics	MEMS 0051	3
Engineering Science Seminar	ENGSCI 1085	0
Term Units		16
Fifth Term		
Vector Analysis & Applications	MATH 1550	3
Introduction to Fluid Mechanics	MEMS 0071	3

Experimental Methods in MSE	MEMS 1010	3
Rigid Body Dynamics	MEMS 1015	3
Structures of Crystals	MEMS 1053	3
Engineering Science Seminar	ENGSCI 1085	0
Term Units		15
Sixth Term		
Dynamic Systems	MEMS 1014	3
Vibrations	MEMS 1020	3
Mechanical Design 1	MEMS 1028	3
Applied Statistical Methods	STAT 1000	4
*Humanities/Social Sciences Elective**	*H/SS Elective 3*	3
Engineering Science Seminar	ENGSCI 1085	0
Term Units		16
Seventh Term		
Mechanical Measurements 1	MEMS 1041	3
Finite Element Analysis	MEMS 1047	3
Program Elective 1		3
Senior Design 1		3
*Social Sciences Elective**	*H/SS Elective 4*	3
Engineering Science Seminar	ENGSCI 1085	0
Term Units		15
Eighth Term		
*Humanities/Social Sciences Elective * [‡]*	*H/SS Elective 5*	3
*Humanities Elective**	*H/SS Elective 6*	3
Physics Elective	*PHYS*	3
Program Elective 2		3
Senior Design 2		3
Engineering Science Seminar	ENGSCI 1085	0
Term Units		15
Total Units		129
59 Minimum Engineering Units, 46 Minimum Math/Science Units		

Upper-Level Physics: Physics courses with course numbers > 1000

[+] A senior design course offered by one of the other SSOE engineering programs is required. Alternatively, may be ENGR 1050 Product Realization, or with preapproval, a senior design project arranged with a faculty mentor and taken as ENGSCI 1801.
[++] A semester-long research experience under the supervision of a faculty advisor at Pitt, not necessarily within the Swanson School of Engineering. Note that this requirement may also be fulfilled by participation in an undergraduate research program like the MCSI URP or the SURI during the summer semester.

[‡]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).

Engineering Mechanics 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:

Health & Rehabilitation Sciences
HRS 1701 Introduction to Prosthetics and Orthotics

Bioengineering
BIOENG 1630 Biomechanics 1: Mechanical Principles of Biological Systems
BIOENG 1631 Biomechanics 2: Introduction to Biodynamics and Biosolid Mechanics
BIOENG 1632 Biomechanics 3: Biodynamics of Movement
BIOENG 1633 Biomechanics 4: Biomechanics of Organs, Tissues, and Cells

Civil Engineering
CEE 1330 Introduction to Structural Analysis
CEE 1341 Design of Steel Structures
CEE 1401 Open Channel Hydraulics
CEE 1412 Introduction to Water Resources Engineering
CEE 1811 Principles of Soil Mechanics
CEE 1821 Foundation Engineering

Material Science
MEMS 0040 Materials and Manufacturing
MEMS 1011 Structure and Properties Lab
MEMS 1048 Analysis and Characterization at the Nanoscale
MEMS 1053 Structures of Crystals and Diffraction
MEMS 1058 Electromagnetic Properties of Materials
MEMS 1059 Phase Equilibria in Multi-Component Materials
MEMS 1063 Phase Transformation & Microstructure Evolution
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 1082 Electromechanical Sensors and Actuators

Physics
PHYS 1331 Mechanics
PHYS 1341 Thermodynamics and Statistical Mechanics

Appendix C – Key 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 Offerings by Term

Title	Course	Fall	Spring	Summer
Bioengineering				
Radiofrequency Medical Devices	BIOENG 1005	✓		
Introduction to Cell Biology I	BIOENG 1070	✓		
Introduction to Cell Biology II	BIOENG 1071			✓
Introductory Cell and Molecular Biology Lab	BIOENG 1075	✓		✓
Special Projects	BIOENG 1095	✓	✓	✓
Bioengineering Methods and Applications	BIOENG 1150			✓
Bioengineering Thermodynamics	BIOENG 1210	✓		✓
Biotransport Phenomena	BIOENG 1220	✓		✓
Linear Systems and Electronics I	BIOENG 1310			✓
Biological Signals and Systems	BIOENG 1320	✓		
Biomedical Imaging	BIOENG 1330	✓		
Biomedical Optical Microscopy	BIOENG 1383			✓
Introduction to Tissue Engineering	BIOENG 1620			✓
Biomechanics 1	BIOENG 1630			✓
Biomechanics 2	BIOENG 1631	✓		
Biomechanics 3	BIOENG 1632			✓
Biomechanics 4	BIOENG 1633	✓		
Biomaterials and Biocompatibility	BIOENG 1810	✓		
Biological Sciences				
Foundations of Biology Research Lab 1	BIOSC 0057	✓	✓	✓
Foundations of Biology Research Lab 2	BIOSC 0067	✓	✓	✓
Foundations of Biology I	BIOSC 0150	✓	✓	✓
Foundations of Biology II	BIOSC 0160	✓	✓	✓
Biochemistry	BIOSC 1000	✓		✓
Human Physiology - UHC	BIOSC 1070	✓		
Introduction to Human Physiology	BIOSC 1250	✓	✓	✓

Macromolecular Structure & Function	BIOSC 1810	✓		
Chemistry				
Organic Chemistry 1	CHEM 0310	✓	✓	✓
Organic Chemistry 2	CHEM 0320	✓	✓	✓
General Chemistry for Engineering 1	CHEM 0960	✓		
General Chemistry for Engineering 2	CHEM 0970	✓	✓	✓
Inorganic Chemistry	CHEM 1130	✓	✓	
Physical Chemistry 1	CHEM 1410	✓	✓	
Physical Chemistry 2	CHEM 1420	✓	✓	
Intermediate Physical Chemistry	CHEM 1480	✓	✓	
Atoms, Molecules, and Materials	CHEM 1620	✓		
Civil Engineering				
Introduction to Structural Analysis	CEE 1330	✓		✓
Design of Steel Structures	CEE 1341		✓	✓
Open Channel Hydraulics	CEE 1401		✓	✓
Introduction to Water Resources Engineering	CEE 1412	✓		✓
Principles of Soil Mechanics	CEE 1811	✓		✓
Foundation Engineering	CEE 1821		✓	✓
Electrical & Computer Engineering				
Linear Circuits & Systems	ECE 0101	✓		✓
Microelectronic Circuits & Lab	ECE 0102		✓	✓
Digital Circuits & Systems	ECE 0201	✓		✓
Problem Solving in C++	ECE 0301	✓		✓
Signals Systems & Probabilities	ECE 0402	✓	✓	✓
Electrical Circuits Design Lab	ECE 1212		✓	✓
Introduction to Lasers & Optical Electronics	ECE 1232			✓
Digital Electronics	ECE 1238	✓		
Semiconductor Device Theory	ECE 1247	✓		✓
Introduction to Nanotechnology & Nanoengineering	ECE 1250	✓		
Fabrication & Design in Nanotechnology	ECE 1251			✓
Applied Fields & Waves	ECE 1266	✓		
Junior Design Fundamentals	ECE 1895	✓	✓	✓
General Engineering				
Introduction to Engineering Analysis	ENGR 0011	✓		

Engineering Computing	ENGR 0012	✓		✓
Probability & Statistics	ENGR 0021	✓	✓	✓
Materials Structures & Properties	ENGR 0022	✓		✓
Statics & Mechanics of Materials 1	ENGR 0135	✓	✓	✓
Statics & Mechanics of Materials 2	ENGR 0145	✓	✓	✓
Introduction to Nanotechnology & Nanoengineering	ENGR 0240	✓		
Health & Rehabilitation Sciences				
Human Physiology	HRS 1023	✓		
Introduction to Prosthetics and Orthotics	HRS 1787	-	-	-
Industrial Engineering				
Manufacture of Structural Nanomaterials	IE 1012			✓
Materials Science				
Computational Material Science	MSE 2012	✓		
Math				
Analytical Geometry & Calculus 1	MATH 0220	✓	✓	✓
Analytical Geometry & Calculus 2	MATH 0230	✓	✓	✓
Analytical Geometry & Calculus 3	MATH 0240	✓	✓	✓
Matrices & Linear Algebra	MATH 0280	✓	✓	✓
Differential Equations	MATH 0290	✓	✓	✓
Vector Analysis & Applications	MATH 1550	✓		✓
Mechanical Engineering				
Introduction to Design	MEMS 0024	✓		
Linear Circuits & Systems 1	MEMS 0031		✓	✓
Thermodynamics of Materials	MEMS 0048			✓
Introduction Thermodynamics	MEMS 0051		✓	✓
Introduction to Fluid Mechanics	MEMS 0071	✓		✓
Experimental Methods in MSE	MEMS 1010	✓		
Structure & Properties Lab	MEMS 1011			✓
Dynamic Systems	MEMS 1014	✓		✓
Rigid Body Dynamics	MEMS 1015		✓	✓
Vibrations	MEMS 1020			✓
Mechanical Design 1	MEMS 1028	✓		✓
Mechanical Measurements 1	MEMS 1041	✓		✓

Automatic Controls	MEMS 1045	✓		
Finite Element Analysis	MEMS 1047	✓		
Analysis & Characteristics at the Nanoscale	MEMS 1048			✓
Mechatronics	MEMS 1049		✓	✓
Applied Thermodynamics	MEMS 1051	✓		✓
Heat & Mass Transfer	MEMS 1052	✓	✓	
Structures of Crystals	MEMS 1053	✓		
Micro/Nano Manufacturing	MEMS 1057	✓		
Phase Equilibria	MEMS 1059	✓		
Phase Transformation	MEMS 1063			✓
Applied Fluid Mechanics	MEMS 1071		✓	✓
Electromechanical Sensors & Actuators	MEMS 1082	✓		
Materials for Energy Generation & Storage	MEMS 1111			✓
Neuroscience				
Introduction to Neuroscience	NROSCI 1000	✓	✓	✓
UHC Introduction to Neuroscience	NROSCI 1003	✓		✓
Physics				
Physics for Science & Engineering 1	PHYS 0174	✓		✓
Physics for Science & Engineering 2	PHYS 0175		✓	✓
Lab Physics for Science & Engineering	PHYS 0219	✓	✓	✓
Principles of Modern Physics 1	PHYS 0477	✓		
Principles of Modern Physics 2	PHYS 0481			✓
Modern Physical Measurements	PHYS 0520	✓		
Mechanics	PHYS 1331			✓
Thermodynamics & Statistical Methods	PHYS 1341			✓
Intermediate Electricity & Magnetism	PHYS 1351	✓		
Wave Motion & Optics	PHYS 1361	✓		
Introduction to Quantum Mechanics 1	PHYS 1370	✓		
Introduction to Quantum Mechanics 2	PHYS 1371			✓
Electromagnetic Theory	PHYS 1372			✓
Solid State Physics	PHYS 1374	✓		
Foundations of Nanoscience	PHYS 1375			✓
Introduction to Biological Physics	PHYS 1376	✓		
Introduction to Nuclear & Particle Physics 1	PHYS 1378			✓
Statistics				

Applied Statistical Methods	STAT 1000	✓	✓	✓

Appendix D – 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.

Engineering Science Program General Co-op Schedule

Department of Mechanical Engineering and Materials Science Custom Co-op Schedule for the Engineering Science Program

Student Name: _____

Anticipated Co-op Start Date: _____

Current Status (Circle One): Sophomore 2 Junior 1 Junior 2 Senior 1

	Fall	*Spring*	*Summer*
Year 1	_____	_____	_____
	_____	_____	_____
	_____	_____	_____
	_____	_____	_____
	_____	_____	_____
Year 2	_____	_____	_____
	_____	_____	_____
	_____	_____	_____
	_____	_____	_____
	_____	_____	_____
Year 3	_____	_____	_____
	_____	_____	_____
	_____	_____	_____
	_____	_____	_____
	_____	_____	_____
Year 4	_____	_____	_____
	_____	_____	_____
	_____	_____	_____
	_____	_____	_____
	_____	_____	_____
Year 5	_____	_____	_____
	_____	_____	_____
	_____	_____	_____
	_____	_____	_____
	_____	_____	_____

Co-op Advisor Signature: _____ Date: _____

Student Signature: _____ Date: _____

**Any changes to your class scheduling must be approved by faculty advisors and the co-op office. The co-op office will not be responsible for students who deviate from their schedules without approval.*

Engineering Mechanics Co-op Schedule A

ENGINEERING MECHANICS CO-OP SCHEDULE A

Student Name: _____

Anticipated Co-op Start Term: _____

Current Status (Circle One): Sophomore 2 Junior 1 Junior 2 Senior 1

	Fall	*Spring*	*Summer*
Year 1	CHEM 0960 ENGR 0011 MATH 0220 PHYS 0174 *Social Sciences Elective*	CHEM 0970 ENGR 0012 MATH 0230 PHYS 0175 *Social Sciences Elective*	_____ _____ _____ _____ _____
Year 2	ENGR 0135 MATH 0280 MEMS 0024 MEMS 0031 PHYS 0477	ENGR 0022 ENGR 0145 MATH 0240 MATH 0280 MEMS 0051	_____ _____ _____ _____ _____
Year 3	MEMS 0071 MEMS 1010 MEMS 1015 MEMS 1053 STAT 1000	**Work Rotation**	**Work Rotation**
Year 4	MATH 1550 MEMS 1041 MEMS 1047 *Program Elective 1* *Social Sciences Elective*	MEMS 1014 *Humanities Elective* *Senior Design 1* *Physics Elective* *Program Elective 2*	**Work Rotation**
Year 5	**Work Rotation**	MEMS 1020 MEMS 1028 *Social Sciences Elective* *Social Sciences Elective* *Senior Design 2*	_____ _____ _____ _____ _____

Co-op Advisor Signature: _____ Date: _____

Student Signature: _____ Date: _____

**Any changes to your class scheduling must be approved by faculty advisors and the co-op office. The co-op office will not be responsible for students who deviate from their schedules without approval.*

Engineering Mechanics Co-op Schedule B

ENGINEERING MECHANICS CO-OP SCHEDULE B

Student Name: _____

Anticipated Co-op Start Date: _____

Current Status (Circle One): Sophomore 2 Junior 1 Junior 2 Senior 1

	Fall	*Spring*	*Summer*
Year 1	CHEM 0960 ENGR 0011 MATH 0220 PHYS 0174 *Social Sciences Elective*	CHEM 0970 ENGR 0012 MATH 0230 PHYS 0175 *Social Sciences Elective*	_____ _____ _____ _____ _____
Year 2	ENGR 0135 MATH 0280 MEMS 0024 MEMS 0031 PHYS 0477	ENGR 0022 ENGR 0145 MATH 0240 MATH 0280 MEMS 0051	**Work Rotation**
Year 3	**Work Rotation**	MEMS 0071 MEMS 1014 MEMS 1020 MEMS 1028 *Social Sciences Elective*	MATH 1550 MEMS 1015 STAT 1000 *Humanities Elective* *Social Sciences Elective*
Year 4	MEMS 1010 MEMS 1053 MEMS 1041 MEMS 1047 *Senior Design 1*	**Work Rotation**	**Work Rotation**
Year 5	*Senior Design 2* *Social Sciences Elective* *Physics Elective* *Program Elective 1* *Program Elective 2*	_____ _____ _____ _____ _____	_____ _____ _____ _____ _____

Co-op Advisor Signature: _____ Date: _____

Student Signature: _____ Date: _____

**Any changes to your class scheduling must be approved by faculty advisors and the co-op office. The co-op office will not be responsible for students who deviate from their schedules without approval.*

Engineering Physics Co-op Schedule

ENGINEERING PHYSICS CO-OP SCHEDULE

Student Name: _____

Anticipated Co-op Start Date: _____

Current Status (Circle One): Sophomore 2 Junior 1 Junior 2 Senior 1

	Fall	*Spring*	*Summer*
Year 1	CHEM 0960 ENGR 0011 MATH 0220 PHYS 0174 *Social Sciences Elective*	CHEM 0970 ENGR 0012 MATH 0230 PHYS 0175 *Social Sciences Elective*	_____ _____ _____ _____ _____
Year 2	ECE 0101 ECE 0201 ECE 0301 ENGR 0135 MATH 0290	ECE 0102 ECE 0402 ENGR 0022 MATH 0240 MATH 0280	_____ _____ _____ _____ _____
Year 3	ECE 1212 MEMS 0051 MEMS 1053 PHYS 0477 *Physics Elective 1*	**Work Rotation**	**Work Rotation**
Year 4	ECE 1247 ECE 1266 MEMS 1059 *Physics Elective 2* *Program Elective 1*	ECE 1895 PHYS 0219 PHYS 0481 *Humanities Elective* *Senior Design 1* *Social Sciences Elective*	**Work Rotation**
Year 5	**Work Rotation**	*Physics Elective 3* *Program Elective 2* *Senior Design 2* *Social Sciences Elective* *Social Sciences Elective*	_____ _____ _____ _____ _____

Co-op Advisor Signature: _____ Date: _____

Student Signature: _____ Date: _____

**Any changes to your class scheduling must be approved by faculty advisors and the co-op office. The co-op office will not be responsible for students who deviate from their schedules without approval.*

Nanotechnology, Chemistry & Bioengineering, Co-op Schedule A

NANOTECHNOLOGY CHEMISTRY & BIOENGINEERING CO-OP SCHEDULE A

Student Name: _____

Anticipated Co-op Start Date: _____

Current Status (Circle One): Sophomore 2 Junior 1 Junior 2 Senior 1

	Fall	*Spring*	*Summer*
Year 1	CHEM 0960 ENGR 0011 MATH 0220 PHYS 0174 *Social Sciences Elective*	CHEM 0970 ENGR 0012 MATH 0230 PHYS 0175 *Social Sciences Elective*	_____ _____ _____ _____ _____
Year 2	ECE 0101 ECE 0301 ENGR 0135 MATH 0280 *Chemistry Elective 1* *Life Sciences Elective 1*	ENGR 0022 MATH 0240 MATH 0290 MEMS 0051 PHYS 0219 *Chemistry Elective 2*	_____ _____ _____ _____ _____
Year 3	ENGR 0240 MEMS 1010 MEMS 1053 *Bioengineering Elective 1* *Life Sciences Elective 2*	**Work Rotation**	**Work Rotation**
Year 4	MEMS 1057 ENGR 0021 MEMS1057 *Bioengineering Elective 2* *Chemistry Elective 3*	ECE 0102 *Humanities Elective* *Program Elective 1* *Senior Design 1* *Social Sciences Elective*	**Work Rotation**
Year 5	**Work Rotation**	*Program Elective 2* *Program Elective 3* *Senior Design 2* *Social Sciences Elective* *Social Sciences Elective*	_____ _____ _____ _____ _____

Co-op Advisor Signature: _____ Date: _____

Student Signature: _____ Date: _____

**Any changes to your class scheduling must be approved by faculty advisors and the co-op office. The co-op office will not be responsible for students who deviate from their schedules without approval.*

Nanotechnology, Chemistry & Bioengineering, Co-op Schedule B

NANOTECHNOLOGY CHEMISTRY & BIOENGINEERING CO-OP SCHEDULE B

Student Name: _____

Anticipated Co-op Start Date: _____

Current Status (Circle One): Sophomore 2 Junior 1 Junior 2 Senior 1

	Fall	*Spring*	*Summer*
Year 1	CHEM 0960 ENGR 0011 MATH 0220 PHYS 0174 *Social Sciences Elective*	CHEM 0970 ENGR 0012 MATH 0230 PHYS 0175 *Social Sciences Elective*	_____ _____ _____ _____ _____
Year 2	ECE 0101 ECE 0301 ENGR 0135 MATH 0280 *Chemistry Elective 1* *Life Sciences Elective 1*	ENGR 0022 MATH 0240 MATH 0290 MEMS 0051 PHYS 0219 *Chemistry Elective 2*	**Work Rotation**
Year 3	**Work Rotation**	*Bioengineering Elective 1* *Chemistry Elective 3* *Program Elective 1* *Program Elective 2* *Social Sciences Elective*	ECE 0102 ENGR 0021 MEMS 0051 *Bioengineering Elective 2* *Humanities Elective*
Year 4	ENGR 0240 MEMS 1010 MEMS 1053 *Senior Design 1* *Social Sciences Elective*	**Work Rotation**	**Work Rotation**
Year 5	MEMS 1057 *Life Science Elective 2* *Program Elective 3* *Senior Design 2* *Social Sciences Elective*	_____ _____ _____ _____ _____	_____ _____ _____ _____ _____

Co-op Advisor Signature: _____ Date: _____

Student Signature: _____ Date: _____

**Any changes to your class scheduling must be approved by faculty advisors and the co-op office. The co-op office will not be responsible for students who deviate from their schedules without approval.*

Nanotechnology, Physics & Materials, Co-op Schedule A

NANOTECHNOLOGY PHYSICS & MATERIALS CO-OP SCHEDULE A

Student Name: _____

Anticipated Co-op Start Date: _____

Current Status (Circle One): Sophomore 2 Junior 1 Junior 2 Senior 1

	Fall	*Spring*	*Summer*
Year 1	CHEM 0960 ENGR 0011 MATH 0220 PHYS 0174 *Social Sciences Elective*	CHEM 0970 ENGR 0012 MATH 0230 PHYS 0175 *Social Sciences Elective*	_____ _____ _____ _____ _____
Year 2	ECE 0101 ECE 0301 ENGR 0135 MATH 0280 PHYS 0477	ENGR 0022 MATH 0240 MATH 0290 MEMS 0051 PHYS 0219	_____ _____ _____ _____ _____
Year 3	ENGR 0240 MEMS 1010 MEMS 1053 MEMS 1059 *Humanities Elective* *Program Elective 1*	**Work Rotation**	**Work Rotation**
Year 4	MEMS 1057 *Physics Elective 1* *Program Elective 2* *Senior Design 1* *Social Sciences Elective*	ECE 0102 ECE 1251 MEMS 1063 *Physics Elective 2* *Program Elective 3*	**Work Rotation**
Year 5	**Work Rotation**	ENGR 0021 PHYS 0481 *Senior Design 2* *Social Sciences Elective* *Social Sciences Elective*	_____ _____ _____ _____ _____

Co-op Advisor Signature: _____ Date: _____

Student Signature: _____ Date: _____

**Any changes to your class scheduling must be approved by faculty advisors and the co-op office. The co-op office will not be responsible for students who deviate from their schedules without approval.*

Nanotechnology, Physics & Materials, Co-op Schedule B

NANOTECHNOLOGY PHYSICS & MATERIALS CO-OP SCHEDULE B

Student Name: _____

Anticipated Co-op Start Date: _____

Current Status (Circle One): Sophomore 2 Junior 1 Junior 2 Senior 1

	Fall	*Spring*	*Summer*
Year 1	CHEM 0960 ENGR 0011 MATH 0220 PHYS 0174 *Social Sciences Elective*	CHEM 0970 ENGR 0012 MATH 0230 PHYS 0175 *Social Sciences Elective*	_____ _____ _____ _____ _____
Year 2	ECE 0101 ECE 0301 ENGR 0135 MATH 0280 PHYS 0477	ENGR 0022 MATH 0240 MATH 0290 MEMS 0051 PHYS 0219	**Work Rotation**
Year 3	**Work Rotation**	PHYS 1375 MEMS 1063 PHYS 0481 *Physics Elective 1* *Program Elective 1* *Social Sciences Elective*	ECE 0102 ENGR 0021 *Humanities Elective* *Program Elective 2* *Social Sciences Elective*
Year 4	ENGR 0240 MEMS 1010 MEMS 1053 MEMS 1059 *Senior Design 1*	**Work Rotation**	**Work Rotation**
Year 5	MEMS 1057 *Physics Elective 2* *Program Elective 3* *Senior Design 2* *Social Sciences Elective*	_____ _____ _____ _____ _____	_____ _____ _____ _____ _____

Co-op Advisor Signature: _____ **Date:** _____

Student Signature: _____ **Date:** _____

**Any changes to your class scheduling must be approved by faculty advisors and the co-op office. The co-op office will not be responsible for students who deviate from their schedules without approval.*

Engineering Science General Blank Co-op Schedule Form

Engineering Science Co-op Schedule

Student Name:

Anticipated Co-op Start Date:

Current Status:

Title	Course	Units
Year 1		
Fall		
Term Units		
Spring		
Term Units		
Summer		

Term Units		
Year 2		
Fall		
Term Units		
Spring		
Term Units		
Summer		
Term Units		
Year 3		
Fall		
Term Units		
Spring		

Term Units		
Summer		
Term Units		
Year 4		
Fall		
Term Units		12
Spring		
Term Units		
Summer		
Term Units		12

Year 5		
Fall		
Term Units		
Spring		
Term Units		
Summer		
Term Units		
Total Units		