Engineering Science (ESG)

Major in Engineering Science

Department of Materials Science and Engineering, College of Engineering and Applied Sciences

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Minors of particular interest to students majoring in Engineering Science: Biomaterials (BES), Electronic, Optical, and Magnetic Materials (EOM), Manufacturing Engineering (MFE), Materials Science (ESM), Nanotechnology Studies (NTS), Physical Metallurgy (PME), Environmental Engineering (ENE)

Engineering Science (ESG)

The Department of Materials Science and Engineering offers the Bachelor of Engineering degree program in Engineering Science and several interdisciplinary undergraduate programs in conjunction with other science and engineering departments on campus. The joint programs provide basic training for graduates to enter a wide range of industries or to proceed to graduate studies in engineering fields. They are aimed at the materials aspect of mechanical engineering, electrical engineering, physics, and chemistry. Engineering Science students can choose to specialize in biomedical engineering, mechanical and manufacturing engineering, electrical engineering, materials science and engineering, civil and environmental engineering, nanoscale engineering, and engineering management. Reflecting the breadth and variety of topics falling within the domain of engineering science, the Department also offers seven minors that afford undergraduate students the opportunity to enhance their engineering or science studies with knowledge in a specific area. In addition to the minor in Materials Science, the Department offers minors in Biomaterials; Electronic, Optical, and Magnetic Materials; Manufacturing Engineering; Environmental Engineering; Physical Metallurgy; and Nanotechnology Studies. Each is detailed under a separate heading in the alphabetical listings of Approved Majors, Minors, and Programs.

The program mission is aimed toward providing an engineering education which thoroughly covers fundamental aspects of engineering design, physical and chemical sciences, mathematics, and materials science and engineering, while also providing flexibility so that students can create a program tailored to their particular academic and career interests in a traditional or emerging discipline. The program is designed to provide core competency and skills in communication, design, and research while preparing students to participate in a rapidly evolving high-technology environment.

Program Educational Objectives

Alumni of the ESG program should be engaged in the following activities:

1. Conducting successful careers in engineering or science-related disciplines, by recognizing and responding to emerging markets and technologies or completing graduate studies in top ranked institutions.

2. Contributing to the development of globally competitive economies on a regional and/or national scale.

3. Leading interdisciplinary research, design, and/or policy-making teams in government, academic, or industrial settings.

4. Engaging in life-long learning activities, including professional society membership and support, conference attendance, presentations or organization, and knowledge-transfer or community-based outreach activities in their organizations.

5. Conducting themselves in the engineering professions in a manner which holds paramount the importance of public health, safety and welfare, as well as their own ethical responsibilities.

Program Outcomes

Engineering programs must demonstrate that their students attain:

a. an ability to apply knowledge of mathematics, science, and engineering;

b. an ability to design and conduct experiments, as well as to analyze and interpret data;

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

d. an ability to function on multidisciplinary teams;

e. an ability to identify, formulate, and solve engineering problems;

f. an understanding of professional and ethical responsibility;

g. an ability to communicate effectively;
h. the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context;
  i. a recognition of the need for, and an ability to engage in, life long learning;
  j. a knowledge of contemporary issues; and

k. an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

More details about program educational objectives and outcomes can be found at http://www.matscieng.sunysb.edu/

In addition to preparation for graduate study in engineering and materials science, the program in engineering science prepares students for a variety of employment opportunities as it is particularly suited to the nature of modern manufacturing processes in industry as well as to scientific institutions and laboratories. Throughout the curriculum, students develop skills needed to participate in the research experience and are encouraged to become involved in the many state-of-the-art research facilities associated with the Department, including world-class laboratories in polymer engineering, thermal spray research, surface science and engineering, nano-technology, semiconductor materials and crystal growth, and environmental materials engineering. Graduates of the program, trained to understand the materials and forces of nature and to apply that knowledge to practical problem solving, occupy engineering, scientific, and management positions in development, manufacturing, and marketing in major corporations in areas including communications, computing, and aerospace. Small and medium-sized companies also rely on the expertise of materials scientists in design and manufacturing. In addition, some graduates apply their knowledge to patent law and consulting. About ten percent of the program's graduates pursue advanced degrees in engineering research as well as in law, business, and medicine. The Engineering Science program is accredited by the Engineering Accreditation Commission of ABET, 111 Market Place, Suite 1050, Baltimore, MD, 21202-4012 – telephone: (410)347-7700.

Requirements for the Major in Engineering Science (ESG)

Acceptance into the Major

Freshman and transfer applicants who have specified their interest in the Engineering Science major may be accepted directly into the major upon admission to the University. Students in good academic standing who were admitted to the University but not immediately accepted into the major may apply for acceptance in any semester, but priority for admission to the Engineering Science major is given to those students who have:
  1) completed AMS 161 and PHY 132 or their equivalents,
  2) earned a g.p.a. of 3.00 in all mathematics and physics courses with no more than one grade in the C range, and
  3) received completed course evaluations for all transferred courses that are to be used to meet requirements for the major.

Requirements for the Major

The major in Engineering Science leads to the Bachelor of Engineering degree.

Completion of the major requires approximately 93 credits, in addition to any credits needed for General Education (D.E.C.) and other University requirements.

A. Core

1. Mathematics

   AMS 151, AMS 161; AMS 261 or MAT 203; AMS 361 or MAT 303

   Note: The following alternate calculus course sequences may be substituted for AMS 151, AMS 161 in major requirements or prerequisites: MAT 125, MAT 126, MAT 127; or MAT 131, MAT 132; or MAT 141, MAT 142; or MAT 171.

2. Natural Sciences

   PHY 131/PHY 133 and PHY 132/PHY 134; PHY 251/PHY 252 or ESG 281; ESG 198

   Notes:
   a. The physics course sequence PHY 125, PHY 126, PHY 127 or PHY 141, PHY 142 is acceptable in lieu of PHY 131/PHY 133, PHY 132/PHY 134.
   b. The chemistry course sequence CHE 131, CHE 132, and CHE 133 or CHE 141, CHE 142, and CHE 143 is acceptable in lieu of ESG 198.

3. Computer Science: ESG 111

   Note: CSE 114 or CSE 130 or ESE 124 may be substituted with permission of the department.

4. Engineering Science

   - ESG 100; ESG 312; ESM 350; ESM 450; and the following eight courses:
   - Materials Science and Engineering
   - ESG 302 or CME 304, ESG 332, ESG 333, ESG 339
   - Electrical Engineering and Electronic Properties
   - ESE 271
   - Mechanical Engineering and Properties
   - MEC 260, ESM 335
5. Engineering Synthesis and Design

- ESG 217, ESG 316, ESG 440, ESG 441; ESM 355

B. Engineering Specialization and Technical Electives

The area of specialization, composed of five technical electives including at least two design-oriented courses, (or four electives plus the upper-division prerequisite in electrical engineering, ESE 372, or mechanical engineering, MEC 363) must be declared in writing by the end of the junior year. It is selected in consultation with a faculty advisor to ensure a cohesive course sequence with depth at the upper level.

The seven areas of specialization are biomedical engineering, civil and environmental engineering, electrical engineering, materials science and engineering, mechanical and manufacturing engineering, nanoscale engineering, and engineering management.

C. Upper-Division Writing Requirement: ESG 300 Writing in Engineering Science

All degree candidates must demonstrate skill in written English at a level acceptable for Engineering Science majors. The Engineering Science student must register for the writing course ESG 300 concurrently with ESG 312. The quality of writing in the technical reports submitted for ESG 312 is evaluated and students whose writing does not meet the required standard are referred for remedial help. Detailed guidelines are provided by the Department. If the standard of writing is judged acceptable, the student receives an S grade for ESG 300, thereby satisfying the requirement.

Grading

All courses taken to satisfy Requirements A and B above must be taken for a letter grade. A grade of C or higher is required in the following courses (or their equivalents):

1. AMS 151, AMS 161; PHY 131/PHY 133 and PHY 132/PHY 134; ESG 217, ESG 302, ESG 312, ESG 332, ESG 440, ESG 441
2. Each of the five required technical electives offered by the college

Areas of Specialization

Each area of specialization requires two design-related courses and three elective courses above those used toward Requirement A, Core. Other technical electives may be substituted only with the approval of the undergraduate program director.

Biomedical Engineering

Biomedical engineering is the application of various engineering disciplines to biomedical problems, requiring a sound understanding of an engineering discipline coupled with principles of biology and medicine. Students utilize elective courses to learn the fundamentals of biology and bioengineering.

1. One of the following two-course design sequences must be completed.
   a. ESM 334 Materials Engineering
      ESM 335 Strength of Materials
   b. MEC 310 Introduction to Machine Design
      MEC 410 Design of Machine Elements
   c. MEC 305 Heat and Mass Transfer
      MEC 364 Introduction to Fluid Mechanics
2. Three courses from the following:
   • BIO 202 Fundamentals of Biology: Molecular and Cellular Biology
   • BIO 203 Fundamentals of Biology: Cellular and Organ Physiology
   • BIO 328 Mammalian Physiology
   • BME 301 Bioelectricity
   • BME 303 Engineering Methods in Biomechanics
   • BME 304 Genetic Engineering
   • BME 305 Biofluids
   • ESM 353 Biomaterials: Manufacture, Properties, and Applications
   • ESM 488 or 499 (See Note)
   • ESG 440/ESG 441 Engineering Science Design III/IV (See Note)
   • EST 392 Engineering and Managerial Economics
Note: ESM 488 Cooperative Industrial Practice (3 credits) or ESM 499 Research in Materials Science (3-4 credits) or other departmental independent research with permission of the program director may be used as a technical elective.

Note: ESG 440/ESG 441 Engineering Science Design III/IV counts for one technical elective with permission of the instructor and the undergraduate program director.

Civil and Environmental Engineering

Civil and environmental engineering entails the study, research, and design of infrastructure or processes responding to societal needs for sustainable development. The student completes one of two specializations. Each provides preparation for further study or employment in structural materials engineering, environmental remediation, or engineering involving design for environment (DFE).

Civil Engineering Track:

1. Two required courses:
   a. ESM 334 Materials Engineering
   b. GEO/MAR 318 Engineering Geology and Coastal Processes or GEO 309 Structural Geology or MEC 364 Introduction to Fluid Mechanics

2. Three technical electives chosen from the following:
   • ARH 205-G Introduction to Architecture
   • ARH 324-G Architecture and Design of the 19th and 20th Centuries
   • ATM 345 Atmospheric Thermodynamics and Dynamics
   • ATM 348 Atmospheric Physics
   • CME 314 Chemical Engineering Thermodynamics II
   • CSE 325 Computers and Sculpture
   • ECO 329 Urban Economics
   • ECO 335 Economic Development
   • ECO 392 Economic Geography
   • ECO 373-H Economics of Environment and Natural Resources
   • ESG 301-H Sustainability of the Long Island Pine Barrens
   • EST 330-H Natural Disasters: Societal Impacts and Technological Solutions
   • GEO 312 Structure and Properties of Materials
   • GEO 315 Groundwater Hydrology
   • GEO 316 Geochemistry of Surficial Processes
   • ISE 320 Information Management
   • MAR 392-H Waste Management Issues
   • MAR 393 Waste Treatment Technologies
   • MEC 262 Dynamics
   • MEC 305 Heat and Mass Transfer
   • MEC 350 Energy Conversion and Alternate Energy Technologies
   • MEC 363 Mechanics of Solids
   • MEC 367 Transport and Fate of Pollutants
   • MEC 406 Energy Management in Commercial Buildings
   • MEC 455 Applied Stress Analysis
   • A third course from 1. above
   • ESM 212 Introduction to Environmental Materials Engineering
   • ESM 336 Electronic Materials
   • ESM 488 Cooperative Industrial Practice (3 credits) or ESM 499 Research in Materials Science (3-4 credits) or other departmental independent research with permission of the program director
   • ESG 440, ESG 441 Engineering Science Design III, IV (See Note)
   • EST 392 Engineering and Managerial Economics

Note: ESG 440/ESG 441 Engineering Science Design III/IV counts for one technical elective with permission of the instructor and the undergraduate program director.

Environmental Engineering Track:

It is highly recommended that students who intend to specialize in the Environmental Engineering track take CHE 131/CHE 133 and CHE 132/CHE 134 in place of ESG 198 in order to better prepare for higher level CHE coursework.

1. Two required courses:
   • ESM 212 Intro to Environmental Materials Engineering (or CME 318 Chemical Engineering Fluid Mechanics or MEC 364 Introduction to Fluid Mechanics or BME 305 Biofluids)
   • CHE 312 Physical Chemistry Short Course (or CHE 301 Physical Chemistry I)
2. Three technical electives chosen from:

- AMS 322 Groundwater Modeling
- ATM 205-E Introduction to Atmospheric Sciences
- ATM 247 Atmospheric Structure and Analysis
- ATM 305-E Global Atmospheric Change
- ATM 345 Atmospheric Thermodynamics and Dynamics
- ATM 348 Atmospheric Physics
- ATM 397 Air Pollution and its Control
- CHE 361 Nuclear Chemistry
- CHE 362 Nuclear Chemistry Laboratory
- CME 318 Chemical Engineering Fluid Mechanics or MEC 364 Introduction to Fluid Mechanics or BME 305 Biofluids may be taken as a technical elective if not taken as a required course
- CME 314 Chemical Engineering Thermodynamics II
- ECO 373-H Economics of Environment and Natural Resources
- ESG 301-H Sustainability of the Long Island Pine Barrens
- ESG 440, ESG 441 Engineering Science Design III, IV (See Note)
- ESM 334 Materials Engineering
- ESM 336 Electronic Materials
- ESM 488 Cooperative Industrial Practice (3 credits) or ESM 499 Research in Materials Science (3-4 credits) or other departmental independent research with permission of the program director
- EST 392 Engineering and Managerial Economics
- ISE 320 Information Management
- GEO 309 Structural Geology
- GEO 312 Structure and Properties of Materials
- GEO 316 Geochemistry of Surficial Processes
- GEO 318/MAR 318 Engineering Geology and Coastal Processes
- MAR 301 Environmental Microbiology
- MAR 315-H Conservation Biology and Marine Biodiversity
- MAR 318 Engineering Geology and Coastal Processes
- MAR 320 Limnology
- MAR 336 Marine Pollution
- MAR 340-H Environmental Problems and Solutions
- MAR 385 Principles of Fishery Biology and Management
- MAR 392-H Waste Management Issues
- MAR 393 Waste Treatment Technologies
- MAR 394 Environmental Toxicology and Public Health
- MEC 350 Energy Conversion and Alternate Energy Technologies
- MEC 381 Transport and Fate of Pollutants

Note: ESG 440/ESG 441 Engineering Science Design III/IV counts for one technical elective with permission of the instructor and the undergraduate program director.

Electrical Engineering

This specialization is intended to provide a depth of understanding of electronic devices, electronic materials, and electrical and electronic system design built upon the broad engineering science curriculum.

1. One of the following two-course design sequences:
   a. ESE 218 Digital Systems Design and ESE 380 Embedded Microprocessor Systems Design I
   b. ESE 305 Deterministic Signals and Systems and ESE 315 Control Systems Design

2. ESE 372 Electronics
3. ESM 336 Electronic Materials
4. Two courses chosen from the following:
   - ESE 304 Applications of Operational Amplifiers
   - ESE 306 Random Signals and Systems
   - ESE 307 Analog Filter Design
   - ESE 310 Electrical Circuit Analysis II
   - ESE 311 Analog Integrated Circuits
   - ESE 316 Digital Devices and Circuits
   - ESE 319 Introduction to Electromagnetic Fields and Waves
   - ESE 332 Semiconductor Device Characterization
   - ESE 350 Electrical Power Systems
   - ESE 352 Electromechanical Energy Converters
• ESE 358 Computer Vision
• ESE 362 Optoelectronic Devices and Optical Imaging Techniques
• ESE 381 Embedded Microprocessor Systems Design II
• ESG 440/ESG 441 Engineering Science Design III/IV (See Note)
• EST 392 Engineering and Managerial Economics

Note: ESM 488 Cooperative Industrial Practice (3 credits) or ESM 499 Research in Materials Science (3-4 credits) or other departmental independent research with permission of the program director may be used as a technical elective.

Note: ESG 440/ESG 441 Engineering Science Design III/IV counts for one technical elective with permission of the instructor and the undergraduate program director.

Materials Science and Engineering

This specialization provides the opportunity for in-depth study of the relationship between performance-properties-processing in materials engineering and its applications.

1. One of the following two-course design sequences:
   a. ESM 334 Materials Engineering and ESM 335 Strength of Materials
   b. MEC 310 Introduction to Machine Design and MEC 410 Design of Machine Elements
   c. MEC 305 Heat and Mass Transfer and MEC 364 Introduction to Fluid Mechanics
   d. ESE 218 Digital Systems Design and ESE 380 Embedded Microprocessor Systems Design I
   e. ESE 305 Deterministic Signals and Systems and ESE 315 Control System Design

2. ESM 336 Electronic Materials

3. Three courses from the following:
   • CME 315 Numerical Methods
   • CME 327 Molecular Modeling
   • ESM 212 Introduction to Environmental Materials Engineering
   • ESM 325 Diffraction Techniques and Structure of Solids
   • ESM 353 Biomaterials: Manufacture, Properties, and Applications
   • ESM 369 Polymer Engineering
   • ESM 475 Undergraduate Teaching Practicum
   • ESG 440/ESG 441 Engineering Science Design III/IV (See Note)
   • EST 392 Engineering and Managerial Economics

Note: ESM 488 Cooperative Industrial Practice (3 credits) or ESM 499 Research in Materials Science (3-4 credits) or other departmental independent research with permission of the program director may be used as a technical elective.

Note: ESG 440/ESG 441 Engineering Science Design III/IV counts for one technical elective with permission of the instructor and the undergraduate program director.

Mechanical and Manufacturing Engineering

This specialization addresses the rapidly changing technology in the mechanical engineering and manufacturing industries that requires a highly educated workforce with knowledge of mechanical properties of materials, materials processing, design, thermodynamics, statistics, and analysis.

1. One of the following two-course design sequences:
   a. MEC 310 Introduction to Machine Design and MEC 410 Design of Machine Elements
   b. ESM 334 Materials Engineering and ESM 335 Strength of Materials

2. MEC 363 Mechanics of Solids

3. Two courses from the following:
   • AMS 310 Survey of Probability and Statistics
   • CSE 391 Special Topics in Computer Science (Solid Modeling topic only)
   • CSE 325 Computers and Sculpture
   • ESM 212 Introduction to Environmental Materials Engineering
   • ESM 336 Electronic Materials
   • MEC 262 Dynamics
   • MEC 325 Manufacturing Processes
   • MEC 364 Introduction to Fluid Mechanics
   • MEC 381 Transport and Fate of Pollutants
   • MEC 393 Engineering Fluid Mechanics
   • MEC 398 Thermodynamics II
   • MEC 402 Mechanical Vibrations
• MEC 411 Control System Analysis and Design
• MEC 420 Turbomachinery and Applications
• MEC 422 Thermal System Design
• MEC 455 Applied Stress Analysis
• ESG 440/ESG 441 Engineering Science Design III/IV (See Note)
• EST 392 Engineering and Managerial Economics

Note: ESM 488 Cooperative Industrial Practice (3 credits) or ESM 499 Research in Materials Science (3-4 credits) or other departmental independent research with permission of the program director may be used as a technical elective.

Note: ESG 440/ESG 441 Engineering Science Design III/IV counts for one technical elective with permission of the instructor and the undergraduate program director.

Nanoscale Engineering

The creation of functional materials and devices which involves controllable processes and transformations at the scale of billionths of a meter promises to become a major focus of future efforts in both engineering and scientific research. With a thorough background in materials science, engineering design, and surface and molecular chemistry and devices, this specialization prepares students for graduate study, as well as professional positions in materials and process engineering and research and development.

It is highly recommended that students intending to specialize in the Nanoscale Engineering track take CHE 131/CHE 133 and CHE 132/CHE 134 in place of ESG 198 in order to better prepare for higher level CHE coursework.

1. Three required courses:
   a. ESM 213 Studies in Nanotechnology
   b. ESM 334 Materials Engineering
   c. ESM 336 Electronic Materials

2. Three technical electives chosen from:
   • ESM 212 Introduction to Environmental Materials Engineering
   • ESM 369 Polymer Engineering
   • CHE 301 Physical Chemistry I
   • CHE 302 Physical Chemistry II
   • CHE 312 Physical Chemistry
   • CHE 321 Organic Chemistry I
   • CHE 322 Organic Chemistry II
   • CHE 345 Structure and Reactivity in Organic Chemistry
   • CME 315 Numerical Methods
   • CME 327 Molecular Modeling
   • BME 381 Nanofabrication in Biomedical Applications
   • ESM 299 Directed Research in Materials Science
   • ESM 325 Diffraction Techniques and Structures of Solids
   • ESM 353 Biomaterials: Manufacture, Properties, and Applications
   • ESM 488 Cooperative Industrial Practice (3 credits) or ESM 499 Research in Materials Science (3-4 credits) or other departmental independent research with permission of the program director
   • ESG 440, ESG 441 Engineering Science Design III, IV (see Note)
   • EST 392 Engineering and Managerial Economics

Note: ESG 440/ESG 441 Engineering Science Design III/IV counts for one technical elective with permission of the instructor and the undergraduate program director.

Engineering Management

Students may take a specialization in Engineering Management consisting of the following courses:

1. Two required courses, EST 392 Engineering and Managerial Economics and ESG 201 Engineering Responses to Society

2. Three technical electives which may be satisfied by the following courses:
   a. BUS 210 Financial Accounting
   b. BUS 330 Principles of Finance
   c. BUS 340 Information Systems in Management
   d. BUS 348 Principles of Marketing
   e. EST 305 Applications Software for Information Management
   f. EST 326 Management for Engineers
   g. EST 327 Marketing for Engineers
   h. EST 391 Technology Assessment
   i. EST 393 Project Management
   j. ISE 330 Information Management
k. ESM 212 Introduction to Environmental Materials Engineering
l. ESM 336 Electronic Materials
m. Another upper level course in Business, Technology and Society, or Economics with the permission of the undergraduate program director

Engineering Chemistry

The Engineering Chemistry major combines work in the Department of Materials Science and Engineering and the Department of Chemistry and leads to the Bachelor of Science degree, awarded through the College of Arts and Sciences. See the major entry for additional information.

Physics of Materials

Physics majors may wish to pursue a career in engineering physics, particularly in the application of solid-state physics to materials science and engineering. After taking five courses in the Department of Materials Science and Engineering, the student may become eligible for the master's degree program. See the physics major entry for additional information.

Bachelor of Engineering Degree/ Master of Science Degree Program

An engineering science student may apply at the beginning of the junior year for admission to this special program, which leads to a Bachelor of Engineering degree at the end of the fourth year and a Master of Science degree at the end of the fifth year. In the junior year, the student takes ESM 350, which is normally taken in the senior year, instead of ESM 335. In the senior year, a student takes ESM 513, to use in lieu of ESM 335, in the fall and another graduate course in the spring. In the fifth year, the student takes 24 credits. The advantage of this program over the regular M.S. program is that a student may start his or her M.S. in the senior year, and that he or she needs only 24 credits in the fifth year as opposed to 30 credits for a regular M.S. student. For details of the M.S. degree requirements, see the graduate program director.

Sample Course Sequence for the Major in Engineering Science

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ESG

Engineering Science

ESG 100: Introduction to Engineering Science
An overview of the development and application of engineering principles in response to social, industrial, and environmental problems from ancient times to the present. Engineering methods and theory through case studies and real-world applications. Creativity and problem solving techniques of modern engineering through participation in a design project as well as learning through analyses of engineering disasters.

3 credits

ESG 111: C Programming for Engineers
Introduces computer programming techniques for engineering students who are not planning to take advanced computer science courses. Students learn C programming language as applied to various scientific and engineering problems. Includes advanced simulation packages such as LabVIEW to introduce computer control of experimental systems. Not intended for students who have completed a C programming course.

Pre- or Corequisites: AMS 151 or MAT 125 or 131 or 141; PHY 125 or 131/133 or 141
3 credits

ESG 198: Fundamentals of Engineering Chemistry
A quantitative introduction to chemistry (stoichiometry, bonding, states of matter, equilibrium) with emphasis on topics of interest to students in engineering (metals and semiconductors; thermochromy; electrochemistry and corrosion; polymers). Labs include an introduction to analytical techniques, electrochemistry and chemical synthesis. Both quantitative and qualitative methods are emphasized. May not be taken for credit in addition to CHE 131/133, 141/143 or 198/199.

Pre- or Corequisites: PHY 132 or PHY 142 or PHY 126 and PHY 127; MAT 127 or MAT 132 or MAT 142 or AMS 161
4 credits

ESG 199: Introduction to Undergraduate Research
An introduction to independent research and basic research skills. Students perform an independent research project in engineering science under the supervision of a faculty member. May be repeated.

Prerequisite: Permission of instructor
0-3 credits

ESG 201 - H: Learning from Disasters
The role of the engineer is to respond to a need by building or creating something along a certain set of guidelines (or specifications) which performs a given function. Just as importantly, that device, plan or creation should perform its function without fail. Everything, however, does eventually fail and, in some cases, fails with catastrophic results. Through discussion and analysis of engineering disasters from nuclear meltdowns to lost spacecraft to market crashes, this course will focus on how modern engineers learn from their mistakes in order to create designs that decrease the chance and severity of failure.

Prerequisite: One D.E.C. category E course
3 credits

ESG 217: Engineering Science Design I
An introduction to the philosophy of engineering design, emphasizing the integration of problem-solving techniques with choices of available technology and materials in order to respond to a particular human need. Engineering ethics are also examined from both historical and decision-making perspectives. Basic science of design, including system viability and project management, is discussed through examples, flowcharts, and optimization techniques with an emphasis on design for manufacturing and reliability.

3 credits

ESG 281: Engineering Introduction to the Solid State
A discussion of relativity followed by review of the atom and its constituents. Lectures treat the quantization of light and of atomic energy levels, matter waves, and introduce the Schrodinger equation, first in one dimension, then in three dimensions. Electron spin and magnetic effects are discussed, followed by multielectron atoms and the periodic table. Radiation and lasers, molecules and solids, including conductors, semiconductors, and insulators.

Prerequisite: PHY 132/134 or 142 or 126/127
4 credits

ESG 300: Writing in Engineering Science
See Requirements for the Major in Engineering Science, Upper-Division Writing Requirement.

Prerequisites: WRT 102; ESG major; U2 standing
Corequisite: ESG 312
S/U grading

ESG 301 - H: Sustainability of the Long Island Pine Barrens
The ecologically diverse Long Island Pine Barrens region provides a habitat for a large number of rare and endangered species, but faces challenges associated with protection of a natural ecosystem that lies in close proximity to an economically vibrant urban area that exerts intense development pressure. In this course we will consider the interaction of the ecological, developmental and economic factors that impact the Pine Barrens and the effectiveness of decision support systems in promoting sustainability of the Pine Barrens. This course is offered as BIO 301, GEO 301, ECO 301, and ESG 301.

Prerequisites: BIO 201 or ECO 108 or GEO 101 or 102 or ESG 100 or ESG 198 or CHE 131; and upper division status
3 credits

ESG 302: Thermodynamics of Materials
The basic laws and concepts of thermodynamics are elucidated, and the important thermodynamic relationships are systematically developed with reference to the behavior of materials. The thermodynamics of solids is discussed, including the thermodynamics of solutions and the calculation of reaction-free energies and equilibria in condensed phase reactions such as phase transformations, oxidation, and diffusion.

Prerequisite: ESG 198 and AMS 161
Advisory prerequisite: AMS 261
4 credits

ESG 312: Engineering Laboratory
Laboratory exercises and lectures covering the theory, practice, and design of engineering experimentation. The course has three components: error analysis and data message; electrical circuits and experiment control; and mechanical and optical measurement. Laboratory fee required.

Prerequisites: PHY 126 and 127 or PHY 132/134; U2 standing
Corequisite: ESG 300
3 credits

ESG 316: Engineering Science Design II: Methods
Design and design-planning methods are developed from the conceptual stages through the application stages using lecture and laboratory. Includes synthesis, optimization,
modeling, and simulation and systems engineering. Case studies illustrate the design process. Students undertake a number of laboratory projects employing various design tools. Laboratory fee required.

Prerequisites: ESG major; U2 standing or higher; ESG 217; AMS 161 or MAT 127 or MAT 132 or MAT 142 or MAT 171

4 credits

ESG 320: Sensor Materials and Devices

Presents sensors as the physical, chemical, and biological detectors necessary for monitoring human health, the environment, and industrial processes. Covers the basic principles of operation, materials selection, and fabrication using nanomaterials.

Prerequisites: ESG 198; ESG 281; and AMS 361

3 credits

ESG 332: Materials Science I: Structure and Properties of Materials

A study of the relationship between the structure and properties of engineering materials and the principles by which materials' properties are controlled. The structure and structural imperfections in simple crystalline materials and the role that these factors play in defining electrical conductivity, chemical reactivity, strength, and ductility are considered. The molecular structure of polymers is discussed and related to the behavior of plastics, rubbers, and synthetic fibers. The principles of phase equilibria and phase transformation in multicomponent systems are developed. These principles are applied to the control of the properties of semiconductors, commercial plastics, and engineering alloys by thermochemical treatment. Corrosion, oxidation, and other deterioration processes are interpreted through the interaction of materials with their environment.

Prerequisites: ESG 198 or CHE 131 or CHE 141; ESG 302 (or Mechanical Engineering majors may use ESG 301)

4 credits

ESG 333: Materials Science II: Electronic Properties

After a review of quantum mechanics and atomic physics, the binding energy and electronic energy levels in molecules and solids are discussed. The free-electron theory of metals is introduced and applied to the quantitative treatment of a number of electron emission effects. The band theory of solids is developed quantitatively via the Kronig-Penney model, and the transport properties of metals and semiconductors are discussed in detail. The physical principle of pn junctions, transistors, tunnel diodes, etc. is explained. Fundamentals and applications of photoconductors, lasers, magnetic materials, and superconductors are also discussed. (ESG 332 is not a prerequisite.)

Prerequisites: ESG 281 or PHY 251; ESG 302 or CME 304

4 credits

ESG 339: Thin Film Processing of Advanced Materials

Fundamental aspects of thin film materials design, fabrication, and characterization. Overviews of semiconductor fabrication, surface analysis, and vacuum system design. This course includes a design content of one credit, achieved through a design exercise related to thin film fabrication.

Prerequisite: ESG 332, or ESE 331 for ESE majors

4 credits

ESG 375: Fundamentals of Professional Engineering

The course provides an overview of professional licensure and focuses on the general fundamentals of the engineering exam. Students take a practice exam for both the general exam and in-depth general exam option and review the results.

Prerequisite: U3 or U4 standing

1 credit

ESG 440: Engineering Science Design III

Lectures by faculty members and visitors on typical design problems encountered in engineering practice. During this semester each student chooses a senior design project. A preliminary design report is required. Not counted as a technical elective. Laboratory fee required.

Prerequisites: ESG 316; ESG major; U4 standing; permission of the department

3 credits

ESG 441: Engineering Science Design IV

Student groups carry out the detailed design of the senior projects chosen during the first semester. A final and detailed design report is prepared. Not counted as a technical elective. Laboratory fee required.

Prerequisite: ESG 440

3 credits

ESG 487: Cooperative Research in Technological Solutions

An independent research course in which students apply principles of engineering design, technological problem solving, mathematical analysis, computer-assisted engineering, and effective teamwork and communication to develop solutions for a need in a governmental, educational, non-profit, or community organization in a multidisciplinary setting.

Prerequisites: U3 or U4 standing; an abstract of the project; permission of instructor

0-3 credits

ESM

Materials Science

ESM 212: Introduction to Environmental Materials Engineering

Multidisciplinary, materials-oriented approach to environmental and civil engineering, incorporating the concept of sustainable development: basic principles, including pollutant transport, water quality, waste and water waste treatment, energy systems and energy efficiency, use of sustainable building materials, ‘green’ manufacturing and pollution prevention, engineering materials issues unique to construction. Use of field and laboratory sensors and analytical tools will be discussed and demonstrated. Project and problem-based approach to design of structures and materials engineering, incorporating environmental considerations.

Prerequisites: ESG 100 or ESG 201; ESG 198 or equivalent; PHY 199 or 121 or 125 or 131 or 141.

3 credits

ESM 213: Studies in Nanotechnology

The emerging field of nanotechnology develops solutions to engineering problems by taking advantage of the unique physical and chemical properties of nanoscale materials. This interdisciplinary, co-taught course introduces materials and nano-fabrication methods with applications to electronics, biomedical, mechanical and environmental engineering. Guest speakers and a semester project involve ethics, toxicology, economic and business implications of nanotechnology. Basic concepts in research and design methodology and characterization techniques will be demonstrated. Course is cross-listed as BME 213, MEC 213, and EST 213 and is required for the Minor in Nanotechnology Studies (NTS).

Prerequisites: PHY 131 or PHY 125; CHE 131 or ESG 198

3 credits
ESM 299: Directed Research in Materials Science
A directed research project with faculty supervision or as part of a research team. Intended for freshman or sophomore students to develop research skills in a closely mentored environment. A final report and oral presentation are required at the end of the project. ESM 199 is a recommended prerequisite.
Prerequisite: Permission of the Undergraduate Program Director
0-3 credits

ESM 325: Diffraction Techniques and Structure of Solids
X-ray diffraction techniques are emphasized. Topics include coherent and incoherent scattering of radiation, structure of crystalline and amorphous solids, stereographic projection, and crystal orientation determination. The concept of reciprocal vector space is introduced early in the course and is used as a means of interpreting diffraction patterns. Laboratory work in X-ray diffraction patterns is also included to illustrate the methods.
Prerequisite: ESG 332
3 credits

ESM 334: Materials Engineering
Practical application of basic material and engineering concepts to fundamental and advanced material utilization. To that end, the course is divided into three sections: (1) “Tough stuff,” (2) “Hot stuff,” and (3) “Smart stuff.” Combined, these address issues of material operation and failure under normal and harsh conditions, high-temperature electrochemical devices (e.g., solid oxide fuel cells), thermal barrier coatings, electromagnetic devices and shape memory alloys.
Prerequisite: ESG 332
4 credits

ESM 335: Strength of Materials
The mechanical behavior of materials, assuming a basic knowledge of elasticity, plasticity, fracture and creep. Provides treatment of these topics across size scales. Continuum mechanics, advanced phenomena in mechanics of materials, and case studies and measurement techniques.
Prerequisites: AMS 261 or MAT 203; ESG 302
4 credits

ESM 336: Electronic Materials
The properties of intrinsic and extrinsic semiconductors are discussed with particular attention first to the equilibrium distribution of electrons in the bands and then to the nonequilibrium transport of charge carriers. The properties and applications of photoconductors and of luminescent materials are then described. The concept of stimulated emission is introduced, laser operation explained, and laser materials discussed in relation to their applications in science and technology. Other topics considered are the properties of magnetic materials, of dielectric materials, and of superconductors.
Prerequisite: ESG 333
3 credits

ESM 350: Advanced Engineering Laboratory
Students work in teams to perform advanced laboratory projects that emphasize the structure-property relationship. Emphasis on statistical analysis, multivariate fitting of data, and technical manuscript preparation.
Prerequisites: ESG 312, ESG 332, and ESG 333
3 credits

ESM 353: Biomaterials: Manufacture, Properties, and Applications
The engineering characteristics of materials, including metals, ceramics, polymers, composites, coatings, and adhesives, that are used in the human body. Emphasizes the need of materials that are considered for implants to meet the material requirements specified for the device application (e.g., strength, modulus, fatigue and corrosion resistance, conductivity) and to be compatible with the biological environment (e.g., nontoxic, noncarcinogenic, resistant to blood clotting if in the cardiovascular system). This course is offered as both ESM 353 and BME 353.
Prerequisite: ESG 332
3 credits

ESM 355: Materials and Processes in Manufacturing Design
The design of mechanical and electrical systems, materials selection, and fabrication processes are surveyed and shown to be essential components of manufacturing engineering. The mechanical and thermal processing of a wide range of metallic and nonmetallic materials is reviewed. Modern computer-based materials selection, advanced processing methods, and automation are explored.
Prerequisite: ESG 332 or 333
3 credits

ESM 369: Polymer Engineering
An introductory survey of the physics, chemistry, and technology of polymers. Topics covered include classification of polymers, molecular forces and bonds, structure of polymers, measurement of molecular weight and size, rheology and mechanical properties, thermodynamics of crystallization, polymerization mechanisms, and commercial polymer production and processing.
Prerequisite: ESG 332
3 credits

ESM 378: Materials Chemistry
Our high-technology world is driven forward by advances in materials chemistry. This class will discuss some of the materials that underpin these technologies, as well as some of the novel classes of materials that are being developed for future applications. The course will cover the synthesis, structures, and properties of advanced materials, focusing on a range of topics with current societal importance (e.g., energy, computers, nanoscience, etc.). Specific topics may include batteries, fuel cells, catalysts, metals, semiconductors, superconductors, magnetism, and polymers.
Prerequisites: CHE 375 or permission of the instructor
3 credits

ESM 400: Research and Nanotechnology
This is the capstone course for the minor in Nanotechnology Studies (NTS). Students learn primary aspects of the professional research enterprise through writing a journal-quality manuscript and making professional presentations on their independent research (499) projects in a formal symposium setting. Students will also learn how to construct a grant proposal (a typical NSF graduate fellowship proposal), methods to search for research/fellowship funding, and key factors in being a research mentor.
Prerequisites: ESM 213, at least one semester of independent research (499 level)
3 credits

ESM 450: Engineering Systems Laboratory
A systems approach will be taken to understand the fundamental properties of materials and their implications on engineering design and applications. The advanced gas turbine engine is used as the main testbed for this laboratory class. Results from mechanical testing and phase analysis will be analyzed in the context of real-world system construction, operation and reliability.
Prerequisites: ESG 332; ESM 335
3 credits

**ESM 475: Undergraduate Teaching Practicum**

May be used as an open elective only and repeated once.

*Prerequisites: U4 standing as an undergraduate major within the college; a minimum g.p.a. of 3.00 in all Stony Brook courses and the grade of B or better in the course in which the student is to assist; permission of department*

3 credits

**ESM 488: Cooperative Industrial Practice**

A design engineering course oriented toward both research/development and manufacturing technology. Students work in actual industrial programs carried out cooperatively with companies established as university incubators or with regionally located organizations. Supervised by a committee of faculty and industry representatives to which students report.

*Prerequisite: Permission of department*

0-6 credits

**ESM 499: Research in Materials Science**

An independent research project with faculty supervision. Permission to register requires a B average in all engineering courses and the agreement of a faculty member to supervise the research. May be repeated, but only three credits of research electives (AMS 487, BME 499, CSE 487, ESE 499, ESM 499, EST 499, ISE 487, MEC 499) may be counted toward technical elective requirements. Prerequisite: B average in all engineering courses and the agreement of a faculty member to supervise the research.

*Prerequisites: B average in all engineering courses; permission of faculty advisor*

0-4 credits