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 biotechnology, manufacturing engineering, electronics engineering, materials science and engineering, civil engineering, 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; Energy Science, Technology and Policy; Manufacturing Engineering; Environmental Engineering; 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.

Student Outcomes

The students will demonstrate the following:

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;

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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, http://www.abet.org.

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) a cumulative g.p.a. of 3.00,
2) earned a g.p.a. of 3.00 or above in all mathematics, physics, and chemistry 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 108 credits, in addition to any credits needed for Stony Brook Curriculum (SBC) and other University requirements.

A. Core

1. Mathematics

• AMS 151, AMS 161; AMS 261 or MAT 203 or MAT 205; 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; CHE 131/133, CHE 132/134

Notes:

a. The following alternate physics course sequences may be substituted for PHY 131/PHY 133, PHY 132/PHY 134: PHY 125, PHY 126, PHY 127, PHY 133, PHY134 Classical Physics A, B, C and Laboratories or PHY 141, PHY 142, PHY 133, PHY 134 Classical Physics I, II: Honors

b. The following alternate chemistry course sequence may be substituted for CHE 131/133, CHE 132/134: CHE 152 Molecular Science I and CHE 154 Molecular Science Laboratory I

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 201; ESG 312; ESG 375; ESG 420; ESM 450; ESM 460; and the following seven courses:

• Materials Science and Engineering: ESG 302 or CME 304, ESG 332, ESG 333

• Electrical Engineering and Electronic Properties: ESE 271

• Mechanical Engineering and Properties: MEC 260, MEC 363, ESM 335

5. Engineering Synthesis and Design
B. Engineering Specialization and Technical Electives

The area of specialization, composed of four technical electives, must be declared in writing by the end of the junior year. The area of specialization should be chosen in consultation with a faculty advisor to ensure a cohesive course sequence with depth at the upper level.

The eight areas of specialization are biotechnology, civil engineering, environmental engineering, electronics 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, AMS 261, AMS 361 or equivalents; PHY 131/133 and PHY 132/134 or equivalents; CHE 131/133 and CHE 132/134 or equivalents; ESG 100; MEC 260; ESG 302 or equivalents; ESG 312, ESG 332, ESG 440 and ESG 441.

2. Each of the four required technical electives offered by the college

Areas of Specialization

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

Biotechnology

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

1. The following two courses must be completed:
   a. BIO 202 Fundamentals of Biology: Molecular and Cellular Biology
   b. ESM 353 Biomaterials

2. Two courses from the following list:
   • ESM 369 Polymers
   • BIO 203 Fundamentals of Biology: Cellular and Organ Physiology
   • BIO 328 Mammalian Physiology
   • BIO 334 Principles of Neurobiology
   • BME 304 Genetic Engineering
   • BME 354 Advanced Biomaterials
   • BME 381 Nanofabrication in Biomedical Applications
   • BME 402 Contemporary Biotechnology
   • BME 404 Essentials of Tissue Engineering
   • BME 430 Engineering Approaches to Drug Delivery
   • BME 481 Biosensors
   • ESM 488 or ESM 499 (See Note)

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 ONCE as a technical elective.

Civil Engineering

Civil engineering entails the study, research, and design of infrastructure or processes responding to societal needs for sustainable development, transportation, or energy production and delivery.

1. Three required courses:
   a. GEO 102 The Earth
   b. GEO 112 Physical Geology Laboratory
   c. CIV 310 Structural Engineering
2. Two technical electives chosen from the following:
   • ARH 205 Introduction to Architecture
   • CIV 210 Land Surveying
   • CIV 305 Transportation Systems Analysis I
   • CIV 407 Transportation Economics
   • CSE 391 Solid Modeling Special Topics (Solid Modeling topic only)
   • MEC 442 Intro to Experimental Stress Analysis
   • MEC 455 Applied Stress Analysis
   • EST 330 Natural Disasters
   • EST 392 Eng & Managerial Economics
   • GEO 312 Structure & Prop of Materials
   • ECO 373 Eco of Env & Natural Resources
   • MAR 392 Waste Management Issues
   • MAR 393 Waste Treatment Tech
   • MEC 262 Dynamics
   • ESM 488/489 See Note*

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 ONCE as a technical elective.

Environmental Engineering

1. Two required courses:
   • BIO 201 Fundamentals of Biology
   • CHE 312 Physical Chemistry Short Course (or CHE 301 Physical Chemistry I)

2. Three technical electives chosen from:
   • ATM 205 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 302 Physical Chemistry II
   • CHE 321 Organic Chemistry I
   • CHE 361 Nuclear Chemistry
   • CHE 362 Nuclear Chemistry Laboratory
   • ECO 373 Economics of Environment and Natural Resources
   • ESG 301 Sustainability of the Long Island Pine Barrens
   • 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
   • GEO 309 Structural Geology
   • GEO 312 Structure and Properties of Materials
   • GEO 316 Geochemistry of Surficial Processes
   • MAR 301 Environmental Microbiology
   • MAR 308 Principles of Instrumental Analysis
   • MAR 320 Limnology
   • MAR 333 Coastal Oceanography
   • MAR 336 Marine Pollution
   • MAR 340 Environmental Problems and Solutions
   • MAR 385 Principles of Fishery Biology and Management
   • MAR 392 Waste Management Issues
   • MAR 393 Waste Treatment Technologies
   • MAR 394 Environmental Toxicology and Public Health

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

Electronics Engineering

To achieve an area of specialization in electronics engineering students must fulfill the following requirements:

1. Two required courses:
   • ESE 372 Electronics
   • ESM 336 Electronic Materials

2. Two technical elective courses chosen from the following:
• ESE 218 Digital Systems Design
• ESE 304 Applications of Operational Amplifiers
• ESE 311 Analog Integrated Circuits
• ESE 315 Control System Design
• ESE 325 Modern Sensors
• ESE 330 Integrated Electronics
• ESM 488/499 See Notes below
• MEC 456 Introduction to Mechanics of Composites
• MEC 457 Engineering Composites Fabrication and Characterization

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 ONCE as a technical elective.

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. Two required courses:
• ESM 336 Electronic Materials
• ESM 325 Diffraction Techniques and Structure of Solids

2. Two technical elective courses chosen from the following:
• ESM 212 Introduction to Environmental Engineering
• ESM 213 Introduction to Nanotechnology Studies
• ESM 353 Biomaterials: Manufacture, Properties, and Applications
• ESM 369 Polymer Engineering
• ESM 400 Nanotechnology and Research
• ESM 475 Undergraduate Teaching Practicum
• ESM 486 Innovation and Entrepreneurship in Engineering
• ESM 488/499 See Notes below.
• MEC 456 Introduction to Mechanics of Composites
• MEC 457 Engineering Composites Fabrication and Characterization

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 ONCE as a technical elective.

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. Two required courses:
• MEC 262 Dynamics
• MEC 310 Machine Design

2. Two technical elective courses chosen from the following:
• AMS 310 Survey of Probability and Statistics
• ESM 486 Innovation and Entrepreneurship in Engineering
• MEC 325 Manufacturing Processes
• MEC 410 Design of Machine Elements
• MEC 411 Control System Analysis and Design
• MEC 442 Introduction to Experimental Stress Analysis
• MEC 455 Applied Stress Analysis
• MEC 457 Engineering Composites Fabrication & Characterization
• ESM 488/499 See Notes below.

Note: Other upper level MEC coursework (completed with a grade of C or higher) may be counted as technical electives with permission of the ESG Undergraduate Program Director.

Nanoscale Engineering

The creation of functional materials and devices which involve 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,
This specialization prepares students for graduate study, as well as professional positions in materials and process engineering and research and development.

1. Two required courses:
   • ESM 213 Studies in Nanotechnology
   • ESM 336 Electronic Materials

2. Two technical elective courses chosen from the following:
   • 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
   • CHE 351 Quantum Chemistry
   • CHE 378 Materials Chemistry
   • BME 381 Nanofabrication in Biomedical Applications
   • ESM 325 Diffraction Techniques and Structures of Solids
   • ESM 353 Biomaterials: Manufacture, Properties, and Applications
   • ESM 400 Nanotechnology and Research
   • ESM 488 Cooperative Industrial Practice or ESM 499 Research in Materials Science (see Notes below)

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

Engineering Management

Strong engineering skills alone are not sufficient to guarantee professional success in today’s global economy. Industry requires that engineers also understand the business side of the organization, helping to ensure that products are quickly developed, brought to market and meet the ever increasing needs of the consumer. An Engineering Management specialization degree offered through the Department of Materials Science and Engineering will help prepare students to become effective leaders in the expanding global marketplace by equipping them with thorough technical as well as business skills. To achieve an area of specialization in engineering management, students must fulfill the following requirements:

1. Two required courses:
   • EST 392 Engineering Economics
   • EST 326 Management for Engineers

2. Two technical elective courses chosen from the following:
   • AMS 310 Survey of Probability and Statistics
   • BUS 210 Financial Accounting
   • BUS 330 Principles of Finance
   • BUS 340 Information Systems in Management
   • BUS 348 Principles of Marketing
   • EST 305 Applications Software for Information Management
   • EST 327 Marketing for Engineers
   • EST 391 Technology Assessment
   • EST 393 Project Management
   • ESM 486 Innovation and Entrepreneurship in Engineering
   • ISE 330 Information Management

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 460, 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
A course planning guide for this major may be found here.

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* Note: This course partially satisfies the following: ESI, CER, SPK, WRTD, SBS+, STEM+, EXP+. For more information contact the CEAS Undergraduate Student Office.
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. Engineering methods and theory through case studies and real-world applications. Introduction to modern engineering design and problem solving through discussion of design theory and tools with an emphasis on design for manufacturing and reliability, engineering ethics including value sensitive design, and participation in a design project.

Pre- or co-requisites: MAT 125 or AMS 151 or MAT 131 or MAT 141 and PHY 125 or PHY 131 or PHY 141
SBC: TECH
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 125/133 or 131/133 or 141
SBC: TECH
3 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: 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 from nuclear meltdowns to lost spacecraft to stock 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. E or SNW course
DEC: H
SBC: STAS
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 126/127/134
3 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 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 or CHE 131/133 or CHE 152 and AMS 261
Advisory Corequisite: AMS 361 and CHE 132/134 or CHE 154
3 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
4 credits

ESG 316: Engineering Science Design 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 100; AMS 161 or MAT 127 or MAT 132 or MAT 142 or MAT 171
4 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: CHE 131 and CHE 133 (or Mechanical Engineering majors may use MEC 301 as a corequisite)

3 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 251/252; ESG 302 or CME 304

3 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 per student. A final and detailed design report is required, not counted as a technical elective. Laboratory fee required.

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: Junior or Senior Standing

1 credit


This course introduces the description of phenomena associated with fluid statics and fluid flow and the unifying principles and analytical description of phenomena of momentum transport (viscous flow), energy transport (heat conduction and convection) and mass transport (diffusion) in continuous media; similarities and differences in these phenomena. Not for credit in addition to MEC 364.

Prerequisites: PHY 127/134 or PHY 132/134 or PHY 142; AMS 361 or MAT 303 or MAT 305

3 credits

ESG 440: Capstone Engineering Design I

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 312; ESG 316; ESG 332; ESG major; U4 standing; permission of the department

3 credits

ESG 441: Capstone Engineering Design II

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 150: Materials of the Modern World

Many of the technologies we rely on in our everyday lives - e.g. bridges, buildings, and other infrastructure, computers and modern electronics, energy efficient means of transportation, among many others - have only been made possible through the development and implementation of cutting-edge materials. Materials science principles will be introduced in the context of modern-day engineering applications. An overview of materials structure and its implications for engineering properties will be discussed and connected to real-world technologies through case studies. Design, selection, and problem solving techniques in material science will be demonstrated through problem sets and an interactive materials design project. Note: This course may not be used by ESG majors as a substitute for ESG 332.

Prerequisite: Level 3 or higher on the mathematics placement examination

SBC: TECH

3 credits

ESM 212: Introduction to Environmental 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 waste water 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 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
3 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 337: Solid State Physics
An introduction to the physics and physical chemistry of semiconductors, superconductors, ferromagnetism, and related systems. Emphasis is on the physical principles which 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.
Prerequisite: ESG 332
3 credits

ESM 338: Thermodynamics of Materials
Thermodynamics and statistical mechanics of materials. The effect of temperature on the properties of materials is emphasized. The treatment takes into account the nature of the materials and their environments.
Prerequisite: ESG 332
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).
Prerequisite: ESG 332
3 credits
Prerequisites: U4 standing; B+ or higher in ESG 316 or ESE 380 or ESM 450 or MEC 310 or permission of instructor.
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