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; ESG major
3 credits

ESG 111: Programming for Engineers
Introduces computer programming techniques for engineering students who have not completed any programming courses prior. Students learn the basics of programming in general and programming MATLAB in particular. This is designed for students to become comfortable enough to continue learning MATLAB and other programming languages on their own.
Pre- or Corequisites: AMS 151 or MAT 125 or 131 or 141; PHY 125/133 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; thermochemistry; 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: Learning from Engineering Disaster
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
0 credit, 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 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

**ESG 420: Fluid Flow, Heat & Mass Transport**

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.

**Prerequisite:** ESG 440

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 Eviromental 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: Introduction to Nanotechnology Studies**

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 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.
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 339: Microfabrication and 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 231 for ESE majors
4 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 and ESM 335
Students in BE/MS Program: Prerequisite: ESG 332; Corequisite: ESM 513
SBC: TECH
3 credits

ESM 453: Biomaterials
This course focuses on the clinical performance of metals, ceramics and polymers and discusses the chemical, physical, mechanical and biological questions raised by the unique use of these materials within the human body. The material’s response to the various components of its biological environment are addressed, followed by the response of the host to the presence of the implanted material. Applications to tissue engineering and the relevance of nanoscale phenomena are also discussed. This course is offered as both ESM 453 and CME 371.
Prerequisites: U3 or U4 standing; CME or ESG major
3 credits

ESM 455: 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 460: 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, ESM 332, and ESM 333
3 credits

ESM 469: 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 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

**SBC:** EXP+

3 credits

**ESM 486: Innovation and Entrepreneurship in Engineering**

Designed for upper division students, this course will explore the key elements and challenges involved in implementing innovation in complex engineering systems. This course will tackle this issue through historical analysis of engineering innovation through detailed case studies and examples. Framework for entrepreneurial developments will also be analyzed.

*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

**SBC:** EXP+

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