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 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 Engineering Responses to Society
The roles that engineers and engineering scientists play in supporting the societal infrastructure of urban and rural populations throughout the world. Focuses on relating examples of engineering achievement so that students may expand their perspective with regard to the increasingly scientific and technological mode of current culture. Includes the relationship between engineering and aesthetics, the engineering design process, forensic engineering, and biology-related engineering.
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 Schrödinger equation, first in one dimension and then in three dimensions. Electron spin and magnetic effects are discussed, followed by multi-electron 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
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; U3 or U4 standing
Corequisite: ESG 316
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: CHE 198
Pre-or Corequisite: AMS 361 or MAT 303
3 credits

ESG 310 Research Methods for Engineers and Scientists
Introduction to the scientific method and research methods within the context of engineering and the sciences. Topics include: interpretation of research, design of experiments, ethics, writing an abstract, use and abuse of statistics in reporting data, presentation and publication.
Pre-or Corequisite: A research, independent study, or internship course
2 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 management; electrical circuits and experiment control; and mechanical and optical measurement.
Laboratory fee required.
Prerequisites: PHY 126 and 127 or PHY 132/134; U3 standing
Pre-or Corequisite: ESG 332
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
Corequisite: ESG 300
3 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: CHE 198, ESG 281, and AMS 361
3 credits

ESG 322 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.
Prerequisite: CHE 131 or 141 or 198
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.)
Prerequisite: ESG 281 or PHY 251
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, achieved through a design exercise related to thin film fabrication.
Prerequisites: ESG 332, or ESE 331 for ESE majors
3 credits

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
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

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