Engineering Chemistry (ECM)

Interdisciplinary Major in Engineering Chemistry

Department of Chemistry, College of Arts and Sciences; 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 Chemistry: Science and Engineering (LSE)

Engineering Chemistry (ECM)

The interdisciplinary major in Engineering Chemistry, which leads to the Bachelor of Science degree, is designed to provide students with a basic understanding of the chemistry and materials technology underlying modern materials engineering.

This program emphasizes a strong background in physical chemistry infused with an orientation toward the solid-state sciences and materials technology. Its central theme is a chemistry core strengthened by and laboratory courses, the latter with a unique "chemistry of materials" component. The choice of suitable electives helps the student to prepare for work or advanced study in areas such as electronic materials, interfacial phenomena, solid-state science and technology, polymers, ceramics, biomaterials, etc.

Jointly sponsored by the College of Arts and Sciences and the College of Engineering and Applied Sciences, the program is a basic preparation for training chemical and materials professionals who can enter a wide range of industries or proceed to graduate work in either solid-state chemistry or materials science.

Requirements for the Major in Engineering Chemistry (ECM)

Diversified Education Curriculum Requirements

Students majoring in Engineering Chemistry must meet the D.E.C. requirements of the College of Arts and Sciences, with the following exceptions:

A. An elementary foreign language course numbered 101 or 112, if taken to fulfill the entry skill in foreign language requirement, may also be used for one of the two courses needed to fulfill the D.E.C. category G requirement.

B. Only one course need be taken from D.E.C. category F.

Major in Engineering Chemistry (ECM)

The interdisciplinary major in Engineering Chemistry leads to the Bachelor of Science degree. The following courses are required and must be taken for a letter grade; P/NC grades are not acceptable. All chemistry and engineering courses must be passed with a grade of C or higher with the exception of three courses for which the grade may be C-. No transferred course with a grade lower than C may be used to fulfill any major requirement.

Completion of the major requires approximately 66 to 68 credits.

A. Mathematics and Basic Science Requirements

1. MAT 131, MAT 132 Calculus I, II (See Note, below)
2. One of the following pairs of courses: AMS 261 and AMS 361 Engineering Mathematics I, II;
or MAT 205 and MAT 305 Calculus III, IV;
or MAT 203 and MAT 303 Calculus III, IV with Applications
3. MEC 111 Computer Science for Engineers
4. CHE 129, CHE 132 or CHE 131, CHE 132 General Chemistry
or CHE 141, CHE 142 Honors Chemistry
5. CHE 133, CHE 134 General Chemistry Laboratory
or CHE 141, CHE 142 Honors Chemistry Laboratory
6. PHY 131/PHY 133, PHY 132/PHY 134 Classical Physics I, II and labs
or PHY 141, PHY 142 Classical Physics I, II: Honors
or PHY 125, PHY 126, PHY 127 Classical Physics A, B, C
7. PHY 251/252 Modern Physics and Laboratory
or ESG 281 An Engineering Introduction to the Solid State

Note: The following alternate calculus sequences may be substituted for MAT 131, MAT 132: MAT 141, MAT 142 or MAT 171 or MAT 125, MAT 126, MAT 127.
B. Core Program

1. CHE 301, CHE 302 Physical Chemistry I, II
2. CHE 303 Solution Chemistry Laboratory
3. CHE 304 Chemical Instrumentation Laboratory
4. CHE 321 Organic Chemistry I
5. CHE 378 Materials Chemistry
6. ESM 325 Diffraction Techniques and Structure of Solids
7. ESG 332 Materials Science I: Structure and Properties of Materials
8. ESG 333 Materials Science II: Electronic Properties

C. Upper-Division Writing Requirement

Each student majoring in Engineering Chemistry must submit a portfolio of three to five papers from previous chemistry or materials science coursework, at least two of which should be full laboratory reports from chemistry or materials science courses. This portfolio is to be submitted by the end of the junior year. It must be found acceptable in its clarity and precision of communication before the student can be cleared for graduation.

Electives

Students make a selection of technical and open electives to total 120 credits. Students are advised to divide their electives among courses within the College of Engineering and Applied Sciences and the Department of Chemistry that strengthen their professional interests, and courses in the social sciences and humanities that help them place the problems of society and industry in perspective.

Students who wish to meet the American Chemistry Society certification requirements must take, in addition to the above, CHE 326 (organic), CHE 346 (biological), CHE 375 (inorganic), and the laboratories CHE 357, CHE 383, CHE 384.

Bachelor of Science Degree/Master of Science Degree in Chemistry Program

A student interested in this research-intensive graduate program, intended to prepare students for professional employment in the chemical or pharmaceutical industries, may apply for admission at the end of the junior year. The program leads to a Bachelor of Science degree in Engineering Chemistry at the end of the fourth year and a Master of Science in Chemistry at the end of the fifth year. During the senior year, the student is expected to take two 500-level CHE courses and begin research. In the fifth year, the student works full-time on research, earning 24 credits in CHE 599.

Bachelor of Science Degree in Chemistry/Master of Science Degree in Materials Science

Engineering Chemistry students who are interested in pursuing graduate study in materials science may wish to apply for the five-year program at the end of their junior year. For further details, contact the director of the program in engineering chemistry.

Sample Course Sequence for the Major in Engineering Chemistry

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<th>Freshman Fall</th>
<th>Credits</th>
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<td>MAT 131</td>
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<td>CHE 321</td>
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<td>ESG 281 or PHY 251/PHY 252</td>
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CHE

Chemistry

CHE 115 - E: Chemistry, Life, and Environment
This survey course introduces chemical principles by emphasizing the role chemistry plays in everyday life, the natural environment, the built environment, energy production, and in processes leading to environmental degradation. In addition, the role of chemistry in the development of alternative energy sources, remediation technologies, and eco-friendly products is discussed. This course for non-science majors introduces chemical principles using mostly qualitative approaches rather than quantitative approaches. Interactive tools and interactive visualization tools are extensively used to illustrate concepts, reactions, and processes. This course is offered as both CHE 115 and ENV 115.
3 credits

CHE 125: Learning Strategies Essential for Success in Chemistry
Focuses on developing techniques, strategies, and advanced learning skills that are essential for success in college-level chemistry. Real world contexts, issues, and problems are explored from a chemistry perspective. Provides a bridge from high school to college courses and from CHE 131 to CHE 132. A grade of C or higher in CHE 125 satisfies the prerequisite for entry into CHE 132, provided CHE 129 or CHE 131 have been completed with a passing grade (D or higher).
3 credits, ABC/U grading

CHE 129 - E: General Chemistry IA
A broad introduction to the fundamental principles of chemistry, including substantial illustrative material drawn from the chemistry of inorganic, organic, and biochemical systems. Basic concepts, problem solving, and factual material are emphasized. This course provides the necessary foundation for students who wish to pursue further coursework in chemistry. CHE 129 is inappropriate for students who satisfy the prerequisites for CHE 131 or 141. Three lecture hours, one 80-minute workshop, and one problem-solving session per week. The content and grading match that of CHE 131 (see course description for CHE 131), but the math prerequisites differ, and students attend a CHE 130 problem-solving session per week. The problem-solving session provides a structured environment for developing quantitative reasoning and problem-solving skills. CHE 129 may not be taken for credit in addition to CHE 123/124, CHE 131 or 141. This course has been designated as a High Demand/Controlled Access (HD/CA) course. Students registering for HD/CA courses for the first time will have priority to do so.
Mandatory co requisites: MAT 123 and CHE 130
4 credits

CHE 130: Problem Solving in General Chemistry
This course provides a structured environment for completing CHE 129 homework assignments and helping students develop the quantitative reasoning and problem solving skills needed in General Chemistry. Satisfactory/Unsatisfactory grading only. Grading is based on attendance and participation. Required for students taking CHE 129 along with MAT 123.
Mandatory corequisites: CHE 129 and MAT 123
1 credit, S/U grading

CHE 131 - E: General Chemistry IB
A broad introduction to the fundamental principles of chemistry, including substantial illustrative material drawn from the chemistry of inorganic, organic, and biochemical systems. The principal topics covered are stoichiometry, the states of matter, chemical equilibrium and introductory thermodynamics, electrochemistry, chemical kinetics, electron structure and chemical bonding, and chemical periodicity. The sequence emphasizes basic concepts, problem solving, and factual material. It provides the necessary foundation for students who wish to pursue further coursework in chemistry. This sequence is inappropriate for students who have completed two or more years of chemistry in high school; such students should take CHE 141, 142. Three lecture hours and one 80-minute workshop per week. May not be taken for credit in addition to CHE 142. This course has been designated as a High Demand/Controlled Access (HD/CA) course. Students registering for HD/CA courses for the first time will have priority to do so.
Prerequisite: C or higher in CHE 129 or CHE 131; or C or higher in CHE 125 and D or higher in CHE 129 or CHE 131. Pre- or Corequisite: MAT 125 for those who took CHE 129 or 130; MAT 126 or higher for all others
4 credits

CHE 133: General Chemistry Laboratory I
Designed to familiarize students with (1) some chemical and physical properties of substances, (2) techniques of quantitative chemistry, and (3) scientific methodology. Four hours of laboratory and discussion per week. CHE 133 may not be taken for credit in addition to CHE 143, and CHE 134 may not be taken for credit in addition to CHE 144. This course has been designated as a High Demand/Controlled Access (HD/CA) course. Students registering for HD/CA courses for the first time will have priority to do so.
Pre- or Corequisite: CHE 129 or 131
1 credit

CHE 134: General Chemistry Laboratory II
Designed to familiarize students with (1) some chemical and physical properties of substances, (2) techniques of quantitative chemistry, and (3) scientific methodology. Four hours of laboratory and discussion per week. CHE 133 may not be taken for credit in addition to CHE 143, and CHE 134 may not be taken for credit in addition to CHE 144.
Prerequisites: CHE 133
Pre- or Corequisite: CHE 132
1 credit

CHE 141 - E: Honors Chemistry I
The topics covered in this sequence are similar to those in CHE 131, 132, but draw more on students' previous background in science and mathematics in order to present the material in a more quantitative manner. Recommended
CHE 144 - Honors Chemistry Laboratory
Laboratory program similar in content to CHE 133, 134 but conducted at a more intensive and stimulating level. Four hours of laboratory and discussion per week. CHE 143 may not be taken for credit in addition to CHE 133, and CHE 144 may not be taken for credit in addition to CHE 134. Priority given to students in the University's honors programs. This course has been designated as a High Demand/Controlled Access (HD/CA) course. Students registering for HD/CA courses for the first time will have priority to do so.
Prerequisite: CHE 143
Corequisite: CHE 142
1 credit

CHE 301: Physical Chemistry I
The quantitative study of microscopic and macroscopic chemical systems, covering introductory quantum theory of atoms and molecules (energy levels and states), statistical thermodynamics, and fundamental thermodynamics with application to chemical reactions and simple systems. May not be taken for credit by students who have completed CHE 312.
Prerequisite: CHE 132 or 142; MAT 132 or 142 or 127 or 171 or AMS 161
Pre- or Corequisite: PHY 121/123 or 125 or 131/133 or 141
4 credits

CHE 302: Physical Chemistry II
Applications of thermodynamics to chemical equilibria, electrochemistry, and ideal solutions. Applications of quantum theory to chemical bonding, molecular structure, and spectroscopy.
Prerequisites: CHE 301; MAT 211 or 203 or 205 or AMS 161
Pre- or Corequisite: PHY 122/124 or 132/134 or 142 or PHY 126/127
4 credits

CHE 303: Solution Chemistry Laboratory
Prerequisite: CHE 143 or 144
Corequisite: CHE 301
2 credits

CHE 304: Chemical Instrumentation Laboratory
Prerequisite: CHE 303. Corequisites: CHE 302 and 385
Advisory Prereq: Knowledge of computer programming
2 credits

CHE 310 - H: Chemistry in Technology and the Environment
Use of chemical principles in understanding processes that occur in the modern technological world and in the natural environment. Certain ecological problems of a chemical nature are analyzed. Methods of controlling these problems are discussed. Not for credit in addition to ENV 320.
Prerequisite: CHE 132 or 142
3 credits

CHE 312: Organic Chemistry I
An introduction to the structure, reactivity, and properties of organic compounds is presented using modern views of chemical bonding. These fundamental ideas are applied to topics ranging from synthetic chemistry to complex functional structures such as lipid bilayers. This course has been designated as a High Demand/Controlled Access (HD/CA) course. Students registering for HD/CA courses for the first time will have priority to do so.
Prerequisite: CHE 302 or 142; MAT 132 or 142 or 127 or 171 or AMS 161
Pre- or Corequisite: PHY 121/123 or 125 or 131/133 or 141
3 credits

CHE 322: Organic Chemistry IIA
Discussion of the structure, reactivity, and properties of organic compounds introduced in CHE 321 is continued. The chemistry of substances important in biology, medicine, and technology is emphasized. CHE 322 may not be taken for credit in addition to CHE 326. This course has been designated as a High Demand/Controlled Access (HD/CA) course.
CHE 326: Organic Chemistry II
Similar to CHE 322 but providing a more fundamental view of organic compounds, reaction mechanisms, and synthesis, based somewhat more explicitly on thermodynamics and kinetics. Especially for those who may major in chemistry, biochemistry, or another physical science. CHE 326 may not be taken for credit in addition to CHE 322. This course has been designated as a High Demand/Controlled Access (HD/CA) course. Students registering for HD/CA courses for the first time will have priority to do so.
Prerequisite: C or higher in CHE 321
4 credits

CHE 345: Structure and Reactivity in Organic Chemistry
Electronic and stereochemical theories relating to organic structure and reactions. Topics such as bonding, strain, aromaticity, MO theory, molecular rearrangements, pericyclic reactions, and photochemistry are covered.
Prerequisite: CHE 322 or 326
Pre- or Corequisite: CHE 301 or 312
3 credits

CHE 346: Biomolecular Structure and Reactivity
The reactivity and physiological function of biological macromolecules and their monomeric constituents are described at the chemical level. The course reflects the most recent advances at the interface of organic chemistry and biochemistry. Specific topics include catalysis, biomimicry, protein and DNA modification, binding and target recognition, and correlation between three-dimensional structure and reactivity.
Pre- or Corequisites: CHE 322 or 326; CHE 301 or 312
3 credits

CHE 348: Reaction Mechanisms in Organic Chemistry
Important classes of mechanisms of reactions useful in synthesis are explored. The kinetics and thermodynamics of these reactions are analyzed using modern structural theories. Examples of reaction types are substitutions, rearrangements, additions, eliminations, and selected organometallic reactions.
Prerequisite: CHE 322 or CHE 326
3 credits

CHE 351: Quantum Chemistry
Concepts of quantum theory, Schrodinger wave mechanics, and related mathematical techniques illustrated by application to systems of chemical bonding, spectroscopy, molecular structure, and molecular collision phenomena.
Prerequisites: CHE 302; MAT 203 or 205
3 credits

CHE 353: Chemical Thermodynamics
A rigorous development of thermodynamics and its application to systems of interest to chemists, including electrochemical cells, gases, polymers, and homogeneous and heterogeneous equilibrium. An introduction to statistical mechanics is included.
Prerequisites: CHE 302; CHE 321
3 credits

CHE 355: Inorganic Chemistry I
A survey of inorganic chemistry covering various classes of inorganic compounds and
reactions with emphasis on the structural aspects. Wherever possible, the subject is treated on the basis of modern concepts of chemical bonding. Thermodynamic and kinetic aspects of inorganic reactions are included.  
Prerequisite: CHE 322 or 326

3 credits

CHE 376: Inorganic Chemistry II

The chemistry of the elements with an emphasis on the transition metals. Reaction mechanisms, synthesis, and structure are covered. Specific areas of concern include coordination chemistry, organometallic chemistry, bioinorganic chemistry, and selected topics from solid-state and non-transition metal chemistry.  
Prerequisite: CHE 375

3 credits

CHE 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.  
Prerequisite: CHE 375 or ESG 332

3 credits

CHE 383: Introductory Synthetic and Spectroscopic Laboratory Techniques

Fundamental laboratory techniques including methods of separation, purification, synthesis, and analysis. Emphasis is on organic with an introduction to inorganic problems. For students who require substantial laboratory skills, such as those planning careers in research. Not for credit in addition to CHE 327.  
Prerequisite: CHE 134 or 144  
Corequisite: CHE 321

2 credits

CHE 384: Intermediate Synthetic and Spectroscopic Laboratory Techniques

Application of fundamental laboratory techniques to organic and inorganic problems including multistep syntheses and structural and mechanistic determinations. Lectures cover material pertaining to the experimental work, with an emphasis on spectroscopy.  
Prerequisite: CHE 383  
Corequisites: CHE 322 or 326; CHE 385

3 credits

CHE 385: Tools of Chemistry

A seminar course covering topics common to all areas of chemistry: scientific ethics, chemical literature and information retrieval, scientific writing, and oral presentation. Should be taken concurrently with the student's second 300-level chemistry laboratory course. Satisfactory completion of the course fulfills the Chemistry department's upper division writing requirement. A through C/ Unsatisfactory grading only.  
Corequisite: CHE 304 or 384

1 credit, ABC/U grading

CHE 386: Professional Skills

Development and refinement of the professional skills used by scientists. The exploration of more sophisticated presentation skills used in oral and poster presentations. The incorporation of collaborative problem solving that mimics real world situations, including simple proposal writing. An exposure to professional societies and meetings. An exploration of career options and employment resources. Tips for resume preparation, and interviews will be presented. Recommended for upper division undergraduates and Masters students.  
Prerequisite: CHE 385 or permission of instructor

2 credits, S/U grading

CHE 461: Selected Topics in Chemistry

Semester supplements to this Bulletin contain specific description when course is offered. May be repeated as the topic changes.  
Prerequisite: Varying with topic

1-3 credits

CHE 475: Undergraduate Teaching Practicum I

Work with a faculty member as an assistant in one of the faculty member's regularly scheduled classes. Students assume greater responsibility in such areas as leading discussions and analyzing results of tests that have already been graded. Students may participate only in courses in which they have excelled. The course in which the student is permitted to work as a teaching assistant must be different from the course in which he or she previously served.  
Prerequisite: Permission of department

3 credits, S/U grading

CHE 477: Undergraduate Teaching Practicum III

Work with a faculty member as an assistant in one of the faculty member's regularly scheduled classes. Students may participate only in courses in which they have excelled. May be repeated.  
Prerequisites: Permission of instructor and department

0-6 credits

CHE 487: Research in Chemistry

Students pursue research or tutorial study in specialized areas of chemistry. May be repeated.  
Prerequisites: Permission of instructor and department

0-6 credits

CHE 488: Internship

Research participation in off-campus laboratories. Students are required to submit to the department a proposal at the time of registration and a research report at the end of the semester. May be repeated up to a limit of 12 credits.  
Prerequisites: CHE 384; permission of instructor and department

0-6 credits

CHE 490: Current Trends in Biological Chemistry

A discussion of current trends of research and methodology in modern biological chemistry. The course includes directed readings, attendance, and discussion at seminars presented by speakers from various academic and industrial institutions. May be repeated.  
Prerequisite: CHE 322 or 326  
Pre- or Corequisite: CHE 301 or 312

1 credit

CHE 495: Senior Research

First course of a two-semester research program to be carried out under the supervision of a staff member. The results of
this work are to be submitted to the department in the form of a senior research report. The student is given an oral examination in May by a faculty committee consisting of the student's supervisor and three other faculty members. Students receive only one grade upon completion of the sequence CHE 495-496.

Prerequisite: U4 standing; permission of instructor and department
3 credits

CHE 496: Senior Research
Second course of a two-semester research program to be carried out under the supervision of a staff member. The results of this work are to be submitted to the department in the form of a senior research report. The student is given an oral examination in May by a faculty committee consisting of the student's supervisor and three other faculty members. Students receive only one grade upon completion of the sequence CHE 495-496.

Prerequisite: U4 standing; permission of instructor and department
3 credits

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; thermochimistry; 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 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. 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 relativty 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 or CHE 131/132/133 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: CHE 131 or CHE 141 or ESG 198 and ESG 302 or PHY 306 or CME 304 or CHE 353 (or Mechanical Engineering majors may use MEC 301 as a corequisite)
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.