MATERIALS SCIENCE ENGINEERING (EMS)

College of Engineering

EMS 002 — Materials Marvels: The Science of Superheroes (3 units)

This version has ended; see updated course, below.
Course Description: Introduction to science and technology of materials as key engineering ingredients. Explores the relationship between art and materials, and how superheroes are both products and resources of ideas for new materials' technologies.
Learning Activities: Lecture 2 hour(s), Discussion 1 hour(s).
Grade Mode: Letter.
General Education: Science & Engineering (SE); Scientific Literacy (SL); Writing Experience (WE).

EMS 002 — Materials Marvels: The Science of Superheroes (3 units)
Course Description: Introduction to science and technology of materials as key engineering ingredients. Explores the relationship between art and materials, and how superheroes are both products and resources of ideas for new materials' technologies.
Learning Activities: Lecture/Discussion 3 hour(s).
Grade Mode: Letter.
General Education: Science & Engineering (SE); Scientific Literacy (SL); Writing Experience (WE).
This course version is effective from, and including: Spring Quarter 2026.

EMS 099 — Special Study for Undergraduates (1-5 units)

Course Description: Special study for undergraduates with lower division standing.
Prerequisite(s): Consent of instructor.
Learning Activities: Variable.
Repeat Credit: May be repeated with consent of instructor.
Grade Mode: Pass/No Pass only.

EMS 147 — Principles of Polymer Materials Science (3 units)

Course Description: Basic principles of polymer science presented including polymer structure and synthesis; polymerization mechanisms, polymer classes, properties, and reactions; polymer morphology, rheology, and characterization; polymer processing.
Prerequisite(s): CHE 002A; CHE 002B; ((CHE 008A, CHE 008B) or (ENG 045 or ENG 045Y)); introductory physics.
Learning Activities: Lecture 3 hour(s).
Cross Listing: FPS 100.
Grade Mode: Letter.
General Education: Science & Engineering (SE); Quantitative Literacy (QL).

EMS 160 — Thermodynamics of Materials (4 units)

This version has ended; see updated course, below.
Course Description: Review of thermodynamic principles of interest to materials scientists and engineers. Application of thermodynamics to material processing, phase stability, corrosion.
Prerequisite(s): (ENG 045 C- or better or ENG 045Y C- or better); PHY 009B C- or better; MAT 022B C- or better; CHE 002C recommended.
Learning Activities: Lecture 3 hour(s), Discussion 1 hour(s).
Enrollment Restriction(s): Pass One restricted to Materials Science & Engineering majors.
Grade Mode: Letter.
General Education: Science & Engineering (SE); Scientific Literacy (SL).

EMS 160 — Thermodynamics of Materials (4 units)
Course Description: Review of thermodynamic principles of interest to materials scientists and engineers. Application of thermodynamics to material processing, phase stability, corrosion.
Prerequisite(s): (ENG 045 C- or better or ENG 045Y C- or better); PHY 009B C- or better; MAT 022B C- or better; CHE 002C recommended.
Learning Activities: Lecture/Discussion 4 hour(s).
Enrollment Restriction(s): Pass One restricted to Materials Science & Engineering majors.
Grade Mode: Letter.
General Education: Science & Engineering (SE); Scientific Literacy (SL).
This course version is effective from, and including: Spring Quarter 2026.

EMS 162 — Structure & Characterization of Engineering Materials (4 units)

Course Description: Description of the structure of engineering materials on the atomic scale by exploring the fundamentals of crystallography. Importance of this structure to materials' properties. Description of experimental determination using x-ray diffraction techniques.
Prerequisite(s): (ENG 045 C- or better or ENG 045Y C- or better); MAT 022A C- or better; PHY 009B C- or better.
Learning Activities: Lecture 4 hour(s).
Grade Mode: Letter.
General Education: Science & Engineering (SE); Quantitative Literacy (QL).

EMS 162L — Structure & Characterization of Materials Laboratory (3 units)

Course Description: Experimental investigations of structure of solid materials are combined with techniques for characterization of materials. Laboratory exercises emphasize methods used to study structure of solids at the atomic and microstructural levels. Methods focus on optical, x-ray and electron techniques.
Prerequisite(s): EMS 162 (can be concurrent); concurrent enrollment in EMS 162 recommended.
Learning Activities: Laboratory 3 hour(s), Discussion 1 hour(s), Extensive Writing.
Grade Mode: Letter.
General Education: Science & Engineering (SE); Writing Experience (WE).

EMS 164 — Kinetics of Materials (4 units)

This version has ended; see updated course, below.
Course Description: Basic kinetic laws and the principles governing phase transformations. Applications in diffusion, oxidation, nucleation, growth and spinodal transformations.
Prerequisite(s): (ENG 045 C- or better or ENG 045Y C- or better); EMS 160; (ECH 060 or ENG 006).
Learning Activities: Lecture 3 hour(s), Discussion 1 hour(s).
Grade Mode: Letter.
General Education: Science & Engineering (SE); Quantitative Literacy (QL); Scientific Literacy (SL); Visual Literacy (VL).

EMS 164 — Kinetics of Materials (4 units)

Course Description: Basic kinetic laws and the principles governing phase transformations. Applications in diffusion, oxidation, nucleation, growth and spinodal transformations.
Prerequisite(s): (ENG 045 C- or better or ENG 045Y C- or better); EMS 160; (ECH 060 or ENG 006 or ECS 032A or ECS 032AV).
Learning Activities: Lecture/Discussion 4 hour(s).
Grade Mode: Letter.
General Education: Science & Engineering (SE); Quantitative Literacy (QL); Scientific Literacy (SL); Visual Literacy (VL).
This course version is effective from, and including: Spring Quarter 2026.

EMS 170 — Sustainable Energy Technologies: Batteries, Fuel Cells, & Photovoltaic Cells (4 units)

This version has ended; see updated course, below.
Course Description: Basic principles of future energy devices such as lithium batteries, fuel cells, and photovoltaic cells. Examines the current status of these energy technologies and analyze challenges that still must be overcome.
Prerequisite(s): ENG 045 or ENG 045Y.
Learning Activities: Lecture 3 hour(s), Discussion 1 hour(s).
Enrollment Restriction(s): Pass One restricted to Materials Science & Engineering majors.
Grade Mode: Letter.
General Education: Science & Engineering (SE).

EMS 170 — Sustainable Energy Technologies: Batteries, Fuel Cells, & Photovoltaic Cells (4 units)

Course Description: Basic principles of future energy devices such as lithium batteries, fuel cells, and photovoltaic cells. Examines the current status of these energy technologies and analyze challenges that still must be overcome.
Prerequisite(s): ENG 045 or ENG 045Y.
Learning Activities: Lecture/Discussion 4 hour(s).
Enrollment Restriction(s): Pass One restricted to Materials Science & Engineering majors.
Grade Mode: Letter.
General Education: Science & Engineering (SE).
This course version is effective from, and including: Spring Quarter 2026.

EMS 170L — Sustainable Energy Technologies Laboratory (3 units)

Course Description: Fundaments of manufacturing and characterization of energy devices, such as lithium batteries, fuel cells and photovoltaic cells. Discussion on limiting factors in the performance of the devices.
Prerequisite(s): (ENG 045 or ENG 045Y); EMS 170 (can be concurrent); EMS 172 (recommended).
Learning Activities: Laboratory 3 hour(s), Extensive Writing, Discussion 1 hour(s).
Grade Mode: Letter.
General Education: Science & Engineering (SE).

EMS 172 — Smart Materials (4 units)

This version has ended; see updated course, below.
Course Description: Electronic, optical, and magnetic properties of materials as related to structure and processing of solid state materials. Physical principles for understanding the properties of metals, semiconductors, ceramics, and amorphous solids and the applications of these materials in engineering.
Prerequisite(s): CHE 110A or PHY 009D; ENG 006 or ECH 060 or equivalent recommended.
Learning Activities: Lecture 3 hour(s), Discussion 1 hour(s).
Grade Mode: Letter.
General Education: Science & Engineering (SE); Visual Literacy (VL).

EMS 172 — Smart Materials (4 units)

Course Description: Electronic, optical, and magnetic properties of materials as related to structure and processing of solid state materials. Physical principles for understanding the properties of metals, semiconductors, ceramics, and amorphous solids and the applications of these materials in engineering.
Prerequisite(s): CHE 110A or PHY 009D; ECH 060 or ENG 006 or ECS 032A or ECS 032AV.
Learning Activities: Lecture/Discussion 4 hour(s).
Grade Mode: Letter.
General Education: Science & Engineering (SE); Visual Literacy (VL).
This course version is effective from, and including: Spring Quarter 2026.

EMS 172L — Smart Materials Laboratory (3 units)

Course Description: Experimental investigation of electronic, optical and magnetic properties of engineering materials, emphasizing the fundamental relationship between microstructure and properties as well as the influence of rate processes on the evolution of the microstructure and properties.
Prerequisite(s): EMS 172 (can be concurrent); concurrent enrollment in EMS 172 recommended.
Learning Activities: Laboratory 3 hour(s), Discussion 1 hour(s), Extensive Writing.
Grade Mode: Letter.
General Education: Science & Engineering (SE); Writing Experience (WE).

EMS 174 — Mechanical Behavior of Materials (4 units)

This version has ended; see updated course, below.
Course Description: Microscopic and macroscopic aspects of the mechanical behavior of engineering materials, with emphasis on recent development in materials characterization by nondestructive testing. Fundamental aspects of plasticity in engineering materials, strengthening mechanisms and mechanical failure modes of materials systems.
Prerequisite(s): (ENG 045 C- or better or ENG 045Y C- or better); EMS 162 recommended.
Learning Activities: Lecture 3 hour(s), Discussion 1 hour(s).
Grade Mode: Letter.
General Education: Science & Engineering (SE); Quantitative Literacy (QL); Scientific Literacy (SL); Visual Literacy (VL).

EMS 174 — Mechanical Behavior of Materials (4 units)
Course Description: Microscopic and macroscopic aspects of the mechanical behavior of engineering materials, with emphasis on recent development in materials characterization by nondestructive testing. Fundamental aspects of plasticity in engineering materials, strengthening mechanisms and mechanical failure modes of materials systems.
Prerequisite(s): (ENG 045 C- or better or ENG 045Y C- or better); EMS 162 recommended.
Learning Activities: Lecture/Discussion 4 hour(s).
Grade Mode: Letter.
General Education: Science & Engineering (SE); Quantitative Literacy (QL); Scientific Literacy (SL); Visual Literacy (VL).
This course version is effective from, and including: Spring Quarter 2026.

EMS 174L — Mechanical Behavior Laboratory (3 units)

Course Description: Experimental investigation of mechanical behavior of engineering materials. Laboratory exercises emphasize the fundamental relationship between microstructure and mechanical properties, and the evolution of the microstructure as a consequence of rate process.
Prerequisite(s): EMS 174 (can be concurrent); concurrent enrollment recommended.
Learning Activities: Laboratory 3 hour(s), Discussion 1 hour(s), Extensive Writing.
Grade Mode: Letter.
General Education: Science & Engineering (SE); Writing Experience (WE).

EMS 180 — Materials in Engineering Design (4 units)

This version has ended; see updated course, below.
Course Description: Quantitative treatment of materials selection for engineering applications. Discussion of design & material selection strategy; process & process selection strategy; process economics; life-cycle thinking & eco-design. Use of materials selection software.
Prerequisite(s): ENG 045 C- or better or ENG 045Y C- or better.
Learning Activities: Lecture 3 hour(s), Lecture/Discussion 1 hour(s).
Enrollment Restriction(s): Restricted to students with upper division standing.
Grade Mode: Letter.
General Education: Science & Engineering (SE); Oral Skills (OL); Scientific Literacy (SL); Visual Literacy (VL).

EMS 180 — Materials in Engineering Design (4 units)
Course Description: Quantitative treatment of materials selection for engineering applications. Discussion of design & material selection strategy; process & process selection strategy; process economics; life-cycle thinking & eco-design. Use of materials selection software.
Prerequisite(s): ENG 045 C- or better or ENG 045Y C- or better.
Learning Activities: Lecture/Discussion 4 hour(s).
Grade Mode: Letter.
General Education: Science & Engineering (SE); Oral Skills (OL); Scientific Literacy (SL); Visual Literacy (VL).
This course version is effective from, and including: Spring Quarter 2026.

EMS 181 — Manufacturing of 3D & Composite Materials (4 units)

This version has ended; see updated course, below.
Course Description: Fundamental physical and chemical principles underlying various processing techniques, used in manufacturing processes for bulk (3D) and composite structural and functional materials. Effects of processing variables on structure-property relationships.
Prerequisite(s): (ENG 045 C- or better or ENG 045Y C- or better); (ENG 105 or ECH 152B or EEC 140A or EEC 140AV or EMS 164).
Learning Activities: Lecture 3 hour(s), Lecture/Discussion 1 hour(s).
Grade Mode: Letter.
General Education: Science & Engineering (SE).

EMS 181 — Manufacturing of 3D & Composite Materials (4 units)
Course Description: Fundamental physical and chemical principles underlying various processing techniques, used in manufacturing processes for bulk (3D) and composite structural and functional materials. Effects of processing variables on structure-property relationships.
Prerequisite(s): (ENG 045 C- or better or ENG 045Y C- or better); (ENG 105 or ECH 152B or EEC 140A or EEC 140AV or EMS 164).
Learning Activities: Lecture/Discussion 4 hour(s).
Grade Mode: Letter.
General Education: Science & Engineering (SE).
This course version is effective from, and including: Spring Quarter 2026.

EMS 182 — Failure Analysis (4 units)

Course Description: Analysis of the way materials fail. Effects of temperature, mechanical deformation and corrosion on the properties of materials. forensics and methodologies for investigating failures of materials including optical microscopy, x-ray analysis and scanning electron microscopy. Investigation of practical problems.
Prerequisite(s): ENG 045 C- or better or ENG 045Y C- or better; EMS 174 recommended.
Learning Activities: Lecture 3 hour(s), Laboratory 3 hour(s).
Grade Mode: Letter.
General Education: Science & Engineering (SE); Quantitative Literacy (QL); Visual Literacy (VL); Writing Experience (WE).

EMS 183 — Processing of 2D & Nanomaterials (4 units)

This version has ended; see updated course, below.
Course Description: Fundamentals of processing methods for two-dimensional materials, including thin films and graphene-like materials; as well as nanomaterials, including nanoparticles, nanowires, and quantum dots.
Prerequisite(s): (ENG 045 C- or better or ENG 045Y C- or better); (ENG 105 or ECH 152B or EEC 140A or EEC 140AV or EMS 164).
Learning Activities: Lecture 3 hour(s), Discussion 1 hour(s).
Grade Mode: Letter.
General Education: Science & Engineering (SE).

EMS 183 — Processing of 2D & Nanomaterials (4 units)
Course Description: Fundamentals of processing methods for two-dimensional materials, including thin films and graphene-like materials; as well as nanomaterials, including nanoparticles, nanowires, and quantum dots.
Prerequisite(s): (ENG 045 C- or better or ENG 045Y C- or better); (ENG 105 or ECH 152B or EEC 140A or EEC 140AV or EMS 164).
Learning Activities: Lecture/Discussion 4 hour(s).
Grade Mode: Letter.
General Education: Science & Engineering (SE).
This course version is effective from, and including: Spring Quarter 2026.

EMS 186A — Materials Design Project (2 units)

Course Description: Advanced materials design including examination of materials synthesis, processing, fabrication, and their practical applications. Rigorous evaluation of economic, manufacturing, and ethical limitations. Incorporation of diverse principles from the field of materials science into a collaborative design project.
Prerequisite(s): EMS 160; EMS 162; EMS 164; EMS 172; EMS 174.
Learning Activities: Lecture 2 hour(s).
Grade Mode: Letter.
General Education: Science & Engineering (SE).

EMS 186B — Materials Design Project (3 units)

Course Description: Advanced materials design including examination of materials synthesis, processing, fabrication, and their practical applications. Rigorous evaluation of economic, manufacturing, and ethical limitations. Incorporation of diverse principles from the field of materials science into a collaborative design project.
Prerequisite(s): EMS 186A.
Learning Activities: Lecture/Discussion 2 hour(s), Project.
Grade Mode: Letter.
General Education: Science & Engineering (SE).

EMS 186C — Materials Design Project (3 units)

Course Description: Advanced materials design including examination of materials synthesis, processing, fabrication, and their practical applications. Rigorous evaluation of economic, manufacturing, and ethical limitations. Incorporation of diverse principles from the field of materials science into a collaborative design project.
Prerequisite(s): EMS 186B.
Learning Activities: Lecture/Discussion 2 hour(s), Project.
Grade Mode: Letter.
General Education: Science & Engineering (SE).

EMS 188AH — Honors Materials Design (1 unit)

Course Description: Examination of special topics covered in the materials design course through additional readings, discussions, collaborative work, or special activities which may include projects, laboratory experience or computer simulations.
Prerequisite(s): Enrollment in the Materials Science Engineering Honors Program.
Learning Activities: Discussion 1 hour(s).
Enrollment Restriction(s): Open only to students in the Materials Science & Engineering Honors Program.
Grade Mode: Letter.

EMS 188BH — Honors Materials Design (1 unit)

Course Description: Examination of special topics covered in the materials design course through additional readings, discussions, collaborative work, or special activities which may include projects, laboratory experience or computer simulations.
Prerequisite(s): Enrollment in the Materials Science Engineering Honors Program.
Learning Activities: Discussion 1 hour(s).
Enrollment Restriction(s): Open only to students in the Materials Science & Engineering Honors Program.
Grade Mode: Letter.

EMS 190C — Research Group Conference (1 unit)

Course Description: Individual and/or group conference on problems, progress and techniques in materials research.
Prerequisite(s): Consent of instructor. Upper division standing.
Learning Activities: Discussion 1 hour(s).
Repeat Credit: May be repeated.
Grade Mode: Pass/No Pass only.

EMS 192 — Internship in Materials Science & Engineering (1-5 units)

Course Description: Supervised work experience in the Materials Science & Engineering field.
Prerequisite(s): Consent of instructor.
Learning Activities: Internship 3-15 hour(s).
Repeat Credit: May be repeated with consent of instructor.
Grade Mode: Pass/No Pass only.

EMS 197T — Tutoring in Materials Science & Engineering (1-5 units)

Course Description: Tutoring of students in courses taught by instructors in the Department of Materials Science & Engineering. Tutor responsibilities may include attending class, assisting an instructor or TA in laboratory sections or group discussions, or providing non-graded feedback on assignments. Weekly meeting with the instructor.
Prerequisite(s): Consent of instructor.
Learning Activities: Tutorial 1-5 hour(s).
Grade Mode: P/NP only.

EMS 198 — Directed Group Study (1-5 units)

Course Description: Group study of selected topics.
Prerequisite(s): Consent of instructor.
Learning Activities: Lecture 1-5 hour(s).
Grade Mode: Pass/No Pass only.

EMS 199 — Special Study for Advanced Undergraduates (1-5 units)

Course Description: Special study for advanced undergraduates.
Prerequisite(s): Consent of instructor.
Learning Activities: Variable.
Grade Mode: Pass/No Pass only.

EMS 200 — Preparing for Graduate Student Success (1 unit)

Course Description: Introduction to the soft-skills and campus resources needed to succeed in graduate school. Emphasis on the student-mentor relationship and the process of selecting a research mentor.
Learning Activities: Seminar 1.50 hour(s).
Enrollment Restriction(s): Restricted to graduate students in Materials Science & Engineering.
Cross Listing: ECH 200.
Grade Mode: Satisfactory/Unsatisfactory only.

EMS 230 — Fundamentals of Electron Microscopy (3 units)

Course Description: Principles and techniques of scanning and transmission of electron microscopy used in the study of materials will be described. Emphasis upon practical applications.
Prerequisite(s): EMS 162.
Learning Activities: Lecture 2 hour(s), Lecture/Discussion 1 hour(s).
Grade Mode: Letter.

EMS 230L — Laboratory for Electron Microscopy (2 units)

Course Description: Practical application of techniques of electron scanning and transmission microscopy including x-ray microanalysis.
Prerequisite(s): EMS 230 (can be concurrent); EMS 230 required concurrently.
Learning Activities: Laboratory 6 hour(s).
Grade Mode: Letter.

EMS 244 — Interaction of Materials & their Environment (3 units)

Course Description: Thermodynamic and kinetic foundations of the corrosion and oxidation processes. Practical aspects of corrosion control and prevention. Stress-corrosion and gas-embrittlement phenomena. Special topics in corrosion; microbiological and atmospheric corrosion.
Prerequisite(s): (ENG 045 or ENG 045Y); ENG 105A recommended; or consent of instructor.
Learning Activities: Lecture 3 hour(s).
Grade Mode: Letter.

EMS 245 — Micro- & Nano-Technology in Life Sciences (4 units)

Course Description: Survey of biodevice design from engineering and biological perspectives; micro-/nano-fabrication techniques; surface science and mass transport; essential biological processes and models; proposal development skills on merging aforementioned themes.
Prerequisite(s): Graduate standing or consent of instructor.
Learning Activities: Lecture/Discussion 4 hour(s).
Cross Listing: EEC 245, ECH 245, MAE 245.
Grade Mode: Letter.

EMS 246 — Photovoltaics & Solar Cells (3 units)

Course Description: Physics and application of photovoltaics and solar cells, including design, fabrication technology, and grid incorporation. Mono and microcrystalline silicon devices; thin-film technologies, heterojunction and organic-semiconductor technologies. Collectors, electrical inverters and infrastructure issues. Challenges and concerns.
Prerequisite(s): EEC 140B; or consent of instructor, or equivalent.
Learning Activities: Lecture 3 hour(s).
Cross Listing: EEC 248.
Grade Mode: Letter.

EMS 248 — Fracture of Engineering Materials (3 units)

Course Description: Description of the failure of materials by crack propagation. Topics include the stress fields about elastic cracks, the Griffith-Irwin analysis, descriptions of plastic zones, fracture toughness testing, microstructural aspects of fracture and failure at elevated temperatures.
Prerequisite(s): EMS 174.
Learning Activities: Lecture 3 hour(s).
Grade Mode: Letter.

EMS 249 — Mechanisms of Fatigue (3 units)

Course Description: Microstructural description of the mechanisms of fatigue in metals. Topics include a phenomenological treatment of cyclic deformation, dislocation processes in cyclic deformation, fatigue crack nucleation, Stage I growth, threshold effects and high temperature cyclic deformation.
Prerequisite(s): EMS 174; or consent of instructor. EMS 248 recommended.
Learning Activities: Lecture 3 hour(s).
Grade Mode: Letter.

EMS 250A — Special Topics in Polymer & Fiber Science (3 units)

Course Description: Selected topics of current interest in polymer and fiber sciences. Topics vary each time course is offered.
Prerequisite(s): EMS 147; or consent of instructor.
Learning Activities: Lecture 3 hour(s).
Cross Listing: FPS 250A.
Grade Mode: Letter.

EMS 250B — Special Topics in Polymer & Fiber Science (3 units)

Course Description: Selected topics of current interest in polymer and fiber sciences. Topics vary each time course is offered.
Prerequisite(s): EMS 147; or consent of instructor.
Learning Activities: Lecture 3 hour(s).
Cross Listing: FPS 250B.
Grade Mode: Letter.

EMS 250E — Special Topics in Polymer & Fiber Science (3 units)

Course Description: Selected topics of current interest in polymer and fiber sciences. Topics vary each time course is offered.
Prerequisite(s): EMS 147; or consent of instructor.
Learning Activities: Lecture 3 hour(s).
Cross Listing: FPS 250E.
Grade Mode: Letter.

EMS 260 — Advanced Thermodynamics of Solids (4 units)

Course Description: Thermodynamic principles, formalism and their application to solid materials. Statistical mechanics and the relations between microscopic and macroscopic properties. Prediction of phase diagrams and phase stability, particularly for solids.
Prerequisite(s): EMS 160.
Learning Activities: Lecture/Discussion 4 hour(s).
Grade Mode: Letter.

EMS 262 — Advanced Topics in Structure of Materials (4 units)

Course Description: Electronic structure and crystal structure of engineering materials on the atomic scale with a detailed discussion of crystallography. Types of bonding, distinction between band structures of metals, semiconductors, and insulators. Symmetry elements, point and space groups, and common crystal structures.
Prerequisite(s): EMS 162; EMS 174 recommended; graduate standing in Engineering or consent of instructor.
Learning Activities: Lecture 3 hour(s), Discussion 1 hour(s).
Grade Mode: Letter.

EMS 264 — Transport Phenomena in Materials Processes (4 units)

Course Description: Thermodynamic driving forces and atomic-scale mechanisms underlying diffusive mass transport and interface motion in materials. Nucleation, growth and coarsening dynamics of phase transformations.
Prerequisite(s): Graduate standing in Engineering.
Learning Activities: Lecture/Discussion 4 hour(s).
Credit Limitation(s): Not open for credit to students who previously completed former course EMS 240.
Grade Mode: Letter.

EMS 268 — Advanced Materials Characterization (4 units)

Course Description: Fundamental working principles for characterization methods used in structural and compositional analysis of engineering materials. Topics include x-ray, electron, ion, and neutron interactions with materials and techniques include diffraction, spectroscopy, and imaging methods.
Learning Activities: Lecture/Discussion 4 hour(s).
Enrollment Restriction(s): Open to graduate students in Chemistry, Physics, and Engineering.
Grade Mode: Letter.

EMS 272 — Advanced Functional Properties of Materials (4 units)

Course Description: Fundamental physical properties of solid materials important to solid state devices, specifically electronic, magnetic, and optical properties. Topics include band structures, metals, superconductors, semiconductors, dielectrics, optical properties, and magnetic properties and implementation of these properties into devices.
Prerequisite(s): Graduate standing in Physics, Chemistry, and Engineering.
Learning Activities: Lecture/Discussion 4 hour(s).
Grade Mode: Letter.

EMS 274 — Advanced Mechanical Properties of Materials (4 units)

Course Description: Comprehensive study of mechanical properties of materials, with special attention to dislocations and deformation and fracture control mechanisms. Mechanical properties of conventional engineering materials as well as advanced materials such as nanocrystalline solids and thin films are considered.
Prerequisite(s): EMS 174.
Learning Activities: Lecture 3 hour(s), Discussion 1 hour(s).
Grade Mode: Letter.

EMS 280A — Graduate Capstone Project (4 units)

Course Description: Advanced materials design experience involving analysis of engineering applications of materials, including synthesis, processing, and fabrication. Additional consideration of critical assessments of economics, manufacturing, and ethical constraints. Fundamental principles of materials science are integrated into a culminating capstone project.
Prerequisite(s): Graduate standing in an engineering discipline.
Learning Activities: Laboratory 4 hour(s), Discussion 1 hour(s).
Grade Mode: Letter.

EMS 280B — Graduate Capstone Project (4 units)

Course Description: Advanced materials design experience involving analysis of engineering applications of materials, including synthesis, processing and fabrication. Additional consideration of critical assessments of economics, manufacturing, and ethical constraints. Fundamental principles of materials science are integrated into a culminating capstone project.
Prerequisite(s): EMS 280A.
Learning Activities: Discussion 1 hour(s), Laboratory 4 hour(s).
Grade Mode: Letter.

EMS 282 — Glass: Science & Technology (3 units)

Course Description: Modern paradigms in glass science and their applications to technologies. Relation of macroscopic properties of glasses and glass-forming liquids to atomic-level structures, including principles of formation, relaxation, transport phenomena, nucleation, crystallization and phase separation in glasses.
Prerequisite(s): Graduate standing in Chemistry, Physics or Engineering, or consent of instructor.
Learning Activities: Lecture 2 hour(s), Extensive Writing 1 hour(s).
Grade Mode: Letter.

EMS 285 — Advanced Computational Materials Science (3 units)

Course Description: Capabilities and limitations of modern approaches in computational materials science. Implementation and use of these approaches. Molecular dynamics, cellular automata, and phase field techniques.
Prerequisite(s): Prior numerical programming experience and familiarity with control flow statements is recommended.
Learning Activities: Lecture 3 hour(s).
Enrollment Restriction(s): Restricted to graduate students.
Grade Mode: Letter.

EMS 288 — Living Matter: Physical Biology of the Cell (3 units)

Course Description: Introduction to the origin, maintenance, and regulation of the dynamic architecture of the cell, including cellular modes of organization, dynamics and energy dissipation, molecular transport, motility, regulation, and adaptability.
Learning Activities: Lecture 3 hour(s).
Enrollment Restriction(s): Open to any student possessing general background in any disciplines of physical or biological sciences and engineering.
Cross Listing: BIM 288, BPH 288.
Grade Mode: Letter.

EMS 289A — Special Topics in Materials Science (1-5 units)

Course Description: Special topics in the discipline of Materials Science & Engineering. Topics will vary by instructor.
Prerequisite(s): Consent of instructor.
Learning Activities: Lecture/Discussion 1-5 hour(s).
Repeat Credit: May be repeated when topic differs.
Grade Mode: Letter.

EMS 290 — Materials Science & Engineering Seminar (1 unit)

Course Description: Selected topics of current interest in Materials Science & Engineering. Subjects covered vary from year to year and are announced at the beginning of each quarter.
Prerequisite(s): Graduate standing or consent of instructor.
Learning Activities: Seminar 1 hour(s).
Repeat Credit: May be repeated.
Grade Mode: Satisfactory/Unsatisfactory only.

EMS 290C — Graduate Research Conference (1 unit)

Course Description: Individual and/or group conference on problems, progress, and techniques in Materials Science & Engineering research.
Prerequisite(s): Consent of instructor.
Learning Activities: Discussion 1 hour(s).
Repeat Credit: May be repeated.
Grade Mode: Satisfactory/Unsatisfactory only.

EMS 292 — Materials Science & Engineering Internship (1-12 units)

Course Description: Work or lab experience in industry or off-campus lab focusing on Materials Science & Engineering applications at the graduate level.
Prerequisite(s): Consent of instructor. Graduate level standing.
Learning Activities: Internship.
Repeat Credit: May be repeated 1 time(s).
Grade Mode: Satisfactory/Unsatisfactory only.

EMS 294 — Materials Science Seminar (1 unit)

Course Description: Current literature and developments in materials science with presentations by individual students.
Learning Activities: Seminar 1 hour(s).
Repeat Credit: May be repeated.
Grade Mode: Satisfactory/Unsatisfactory only.

EMS 298 — Group Study (1-5 units)

Course Description: Group study.
Learning Activities: Variable.
Grade Mode: Letter.

EMS 299 — Research (1-12 units)

Course Description: Research.
Prerequisite(s): Consent of instructor.
Learning Activities: Variable.
Grade Mode: Satisfactory/Unsatisfactory only.

EMS 390 — The Teaching of Materials Science (1 unit)

Course Description: Participation as a teaching assistant or associate-in in a designated engineering course. Methods of leading discussion groups or laboratory sections, writing and grading quizzes, use of laboratory equipment, and grading laboratory reports.
Prerequisite(s): Meet qualifications for teaching assistant and/or associate-in in Materials Science Engineering.
Learning Activities: Discussion 1 hour(s).
Repeat Credit: May be repeated.
Grade Mode: Satisfactory/Unsatisfactory only.