Materials Engineering (MATL)

Courses

MATL 6250. Soft Matter. (4 Hours)
Introduces the relatively young field of soft matter, which encompasses the physical description of various states of soft materials including liquids, colloids, polymers, foams, gels, granular materials, and a number of biological materials. Soft matter (also known as “soft condensed matter” or “complex fluids”) is less ordered than metals and oxides (hard condensed matter) and is more subject to thermal fluctuations and applied forces. Focuses on critical thinking, problem diagnosis, estimation, statistical analysis, and data-based decision making. Includes many in-class demonstrations from colloidal assembly to emulsion stability to cellular apoptosis. Highlights applications such as industrial processing, life sciences, and environmental remediation. Requires graduate study in related field or permission of instructor.

MATL 6270. Principles, Devices, and Materials for Energy Storage and Energy Harvesting. (4 Hours)
Introduces students to materials, devices, and mechanisms for clean and sustainable energy while providing a broad overview of energy storage and energy harvesting. Offers examples related to materials and devices used in energy storage and harvesting and delves into the principles that underlie the performance of advanced electrochemical storage and harvesting systems, for example solar energy and mechanical energy. Also covers efficient energy usage, such as energy-efficient lighting and building. Beyond course content, assignments provide students with opportunities to practice concise writing and peer review of abstracts, deliver scientific presentations, and explore optimum ways to present technical information. Students should have some prior knowledge of materials science, electrochemistry, and/or semiconductor physics.

MATL 6285. Structure, Properties, and Processing of Polymeric Materials. (4 Hours)
Provides an introduction to the organic chemistry of polymers, the effects of chemical composition on structure, melting point, and degradation, and the thermodynamics of polymers. Other topics include the mechanical properties of polymers, analysis and testing, the effects of processing on structures and properties, and the processing of industrial polymers, with applications.

MATL 6290. Fundamentals of Nanostructured Materials. (4 Hours)
Covers fundamentals of 1D and 2D nanomaterials such as carbon nanotubes, graphene, nanowires, 2D atomic crystals (transition metal dichalcogenides), nanostructured graphites and their novel physical properties, and related nanotechnology. Draws from various textbooks and from seminal scientific journal articles that paved the new era of nanomaterials and nanotechnology in the past couple of decades. Includes lab demonstrations and assignments for some nanomaterials synthesis and characterization. An introduction to materials science and engineering, solid-state physics, chemistry of materials, or any related materials engineering background is strongly recommended.

MATL 6300. Computational Material Science. (4 Hours)
Covers the principles and practice of modern computer simulation techniques used to understand solids, liquids, and gases. Reviews the statistical foundation of thermodynamics followed by in-depth discussion of Monte Carlo and molecular dynamics techniques, as well as their links to mesoscale and continuum computational techniques. Discusses intermolecular potentials; extended ensembles; and mathematical algorithms used in molecular simulations, parallel algorithms, and visualization. Requires knowledge of materials science.

Prerequisite(s): ME 6200 with a minimum grade of C-

MATL 6962. Elective. (1-4 Hours)
Offers elective credit for courses taken at other academic institutions. May be repeated without limit.

MATL 7350. Mechanical Behavior and Strengthening Mechanisms. (4 Hours)
Covers dislocation theory and includes such topics as crystalline defects, elastic properties of dislocation, movement of dislocations, multiplication, intersection, annihilation, dislocations in crystalline materials, and dislocation arrays and crystal boundaries. Examines application of dislocation theory to microplasticity, dynamic recovery and recrystallization, strengthening mechanisms, and high-temperature deformation. Requires knowledge of materials science.

MATL 7355. Thermodynamics of Materials. (4 Hours)
Covers fundamentals of materials thermodynamics that encompass the first, second, and third laws, entropy, enthalpy, and free energy. Emphasis is on phase stability and equilibria, phase diagram computation with applications to phases in metals, alloys, and ionic compounds. Requires knowledge of thermodynamics course and materials science course.

MATL 7360. Kinetics of Phase Transformations. (4 Hours)
Focuses on the different types of phase transformations that occur in materials in relation to theory and practice. Topics include the diffusion equations, mechanisms of diffusion in crystalline solids, random walk theory, ionic conduction, high-diffusivity paths, diffusional and nondiffusional phase transformations, and microstructural evolution in material processing.

Prerequisite(s): MATL 7355 with a minimum grade of C-

MATL 7365. Properties and Processing of Electronic Materials. (4 Hours)
Focuses on electronic principles and the processing techniques underlying the processing/structure/property relationships of materials. Covers metals and alloys, semiconductors, and insulators. Topics include electronic structures, band theory; thermal, electrical, and magnetic properties; and processing methods including film deposition.

MATL 7945. Master's Project. (4 Hours)
Offers theoretical or experimental work under individual faculty supervision.

MATL 7962. Elective. (1-4 Hours)
Offers elective credit for courses taken at other academic institutions. May be repeated without limit.

MATL 7986. Research. (0 Hours)
Offers students an opportunity to conduct full-time research under faculty supervision.

MATL 7990. Thesis. (4 Hours)
Offers analytical and/or experimental work conducted under the direction of the faculty in fulfillment of the requirements for the degree.

Prerequisite(s): MATL 7945 with a minimum grade of C-

MATL 7996. Thesis Continuation - Half-Time. (0 Hours)
Offers continuing master's thesis supervision under individual faculty supervision.