MATERIALS SCIENCE & ENGR (MSE)

MSE 6001. Written and Visual Communications. 2 Credit Hours.
Writing and editing engineering documents; designing and explaining visuals; creating electronic presentations. May not be used for duplicate credit with MSE 6754.

MSE 6010. Fundamentals of Functional Materials. 3 Credit Hours.
This course focuses on the effects of defects on physical properties; charge/mass transport; semiconductors, heterojunctions, electrical and magnetic polarization, interaction processes between various physical properties; electrical characterization techniques.

MSE 6105. Diffraction Studies. 3 Credit Hours.
Principles and theory of crystallography and diffraction analysis of materials are covered, emphasizing X-ray diffraction, including electron diffraction and diffraction-based imaging. Reciprocal lattice concepts are emphasized.

MSE 6110. Transmission Electron Microscopy. 3 Credit Hours.
Introduction to the kinematical electron scattering theory, optics in TEM, diffraction contrast imaging of defects, dynamical electron diffraction effects; and chemical microanalysis using EDS.

MSE 6120. Quantitative Characterization of Microstructures. 3 Credit Hours.
Application of statistically unbiased methods for estimating geometrical attributes of microstructures and nonplanar fracture surfaces from plane sections and projections, digital image analysis, and computer simulations of microstructures.

MSE 6130. Surface Analysis. 3 Credit Hours.
Introduction to vacuum science and technology; structure of solid surfaces; electron and ion energy analyzers, electron spectroscopies (e.g., AES and XPS); ion-based techniques (e.g., SIMS and RBS); depth profiling; ion channeling.

MSE 6140. Computational Materials Science and Engineering. 3 Credit Hours.
This course aims to provide a broad understanding of a spectrum of modern state-of-the-art computational methods used in materials science and engineering.

MSE 6210. Defects. 3 Credit Hours.
Emphasis on the origin and character of point, line, and surface defects in crystalline materials and their influence on mechanical, chemical, magnetic, optical, and electronic properties.

MSE 6310. Thermodynamics and Kinetics of Transformations. 3 Credit Hours.
Classical thermodynamics and phase equlibria with applications to chemical reactions, control of phase transformations via reduction of chemical-free energy, strain energy, and interfacial energy.

MSE 6334. Materials for Energy Storage and Conversion. 3 Credit Hours.
Scientific principles concerning the transfer, capture, and storage of energy harnessed from various sources, including solar, wind, geothermal, and biomass.

MSE 6335. Fundamentals of Soft Nanomaterials and Nanostructures. 3 Credit Hours.
Fundamentals and applications of soft (polymer and biological) nanomaterials such as colloidal assemblies, self-assembled structures, energy devices, photonic materials, drug delivery, flexible electronics, soft robotics.

MSE 6401. Thermodynamics of Materials. 3 Credit Hours.
To examine the principles of thermodynamics as applied to equilibria associated with solutions, mixtures, chemical reactions, and interfaces in materials.

MSE 6402. Crystallography, Structure and Defects. 3 Credit Hours.
Provides students with a fundamental understanding of crystal structures, symmetry, origin, character, defects in crystalline materials, and the influence of these defects on different properties.

MSE 6403. Kinetics of Phase Transformations. 3 Credit Hours.
To introduce the fundamentals of thermodynamics and mathematics to the kinetics of diffusional and non-diffusional phase transformation in engineering materials.

MSE 6404. Scattering Theory. 3 Credit Hours.
A general introduction to the scattering/diffraction of electromagnetic radiation from solids. The kinematical formalism is developed emphasizing x-ray scattering as a characterization tool.

MSE 6405. Advanced Nanomaterials. 3 Credit Hours.
Topics include the synthesis and growth processes controlling quantum dot formation, nanowires, and three- dimensional self-assembled nanostructures. Additional characterization techniques and emerging applications are presented.

MSE 6406. Corrosion of Materials. 4 Credit Hours.
To introduce students to the basic kinetic mechanisms associated with the interactions of materials with liquids and gases.

MSE 6407. Biological Properties. 3 Credit Hours.
Addresses structure-property relationship of cellular components.

MSE 6408. Quantum Mechanics - MSE. 3 Credit Hours.
Fundamental of quantum mechanics of atoms, molecules and solids necessary for engineers to understand the electronic, optical and thermal properties of inorganic and organic materials.

MSE 6409. Fundamentals of Corrosion. 3 Credit Hours.
Course covers thermodynamics, and kinetics of metallic corrosion in electrolytes and high-temperature oxidation. Different forms of corrosion, their mechanisms, and corrosion control methods are discussed.

MSE 6411. Thermodynamics of Materials. 3 Credit Hours.
This course introduces structural features of materials, including point/space groups, representative crystal structures, quasi-crystals, amorphous and rubbery state, liquid crystals, colloids, solutions, and effect of symmetry on properties.

MSE 6412. Structure of Materials. 3 Credit Hours.
This course introduces structural features of materials, including point/space groups, representative crystal structures, quasi-crystals, amorphous and rubbery state, liquid crystals, colloids, solutions, and effect of symmetry on properties.

MSE 6500. Thermodynamics of Materials. 2 Credit Hours.
To examine the principles of thermodynamics as applied to equilibria associated with solutions, mixtures, chemical reactions, and interfaces in materials.

MSE 6501. Phase Equilibria. 1 Credit Hour.
The object of this course is to review the concepts of phase equilibria in ceramic and metallic systems and develop the methodology to calculate phase diagrams in these systems.

MSE 6502. Thermo Analysis. 1 Credit Hour.
To examine the principles of thermodynamics as applied to equilibria associated with mixtures and solutions.

MSE 6510. Polymers for Electronic and Photonic Applications I. 3 Credit Hours.
Review of fundamentals and principles of polymers used in electronics and photonics; relationships between the advances of semiconductor technology and the importance of polymers and their applications.

MSE 6600. Advanced Polymer Processing. 3 Credit Hours.
Common polymer processing techniques and recent advancement; Modeling of polymer processing focusing on how to build a sound model; Computer aided engineering for polymer processing.

MSE 6601. Carbon Nanotubes, Graphene, and Nanocomposites. 3 Credit Hours.
Synthesis, characterization, and properties of carbon nanotubes and graphene. Carbon nanotube and graphene dispersion in various media. Carbon nanotube and graphene nano-composites processing and applications.

MSE 6602. Tensor Analysis and Mathematical Techniques for Materials. 3 Credit Hours.
Introduction to tensor analysis and mathematical techniques for solving problems enountered in materials physics, processing and characterization, particularily involving polymeric fluids and solids.

MSE 6603. Natural Polymers. 3 Credit Hours.
The structures and properties of natural products are presented. Production of cellulose and proteins in discussed. Credit not allowed for both MSE 6603 and PTFE 6301.

MSE 6610. Biomaterials. 2 Credit Hours.
The course will emphasize the interaction between the human body environment and synthetic materials. Materials for both medical implants and dental restoration and appliances will be covered.

MSE 6620. Advanced Corrosion. 3 Credit Hours.
The emphasis will be on electrochemical corrosion and dry oxidation of metals and alloys. In the laboratory, the student will be introduced to the methodology of corrosion testing.

MSE 6730. Materials Science of Cellular Components. 3 Credit Hours.
Addresses structure-property relationship of cellular components. Credit not allowed for both MSE 6730 and BMED 6730.

MSE 6750. Preparation & Reactions of Polymers. 3 Credit Hours.
A detailed treatment of the reactions involved in the synthesis of both human-made and natural polymers, including preparation and degradative reactions of polymer systems.

MSE 6751. Physical Chemistry of Polymer Solutions. 3 Credit Hours.
Study of polymer solutions, polymer miscibility, adsorption, sorptions, plasticization, molecular weights, molecular weight distribution, and interfacial phenomena using thermodynamics and statistical mechanics. Crosslisted with CHEM, CHE, and PTFE 6751.

MSE 6752. Polymer Characterization. 4 Credit Hours.
This course introduces the student to surface, near-surface and structural methods of polymer characterization. Specialized techniques critical to physical structure are emphasized. Crosslisted with CHEM, CHE, and PTFE 6752.

MSE 6754. Engineering Communication. 3 Credit Hours.
Writing and editing engineering documents; designing and explaining visuals; creating and delivering electronic presentations. Crosslisted with CEE 6754.

MSE 6755. Theoretical Chemistry of Polymers. 3 Credit Hours.
Thermodynamics and microscopic dynamics of polymers. Fundamental concepts, including scaling concepts, governing anisotropy of polarizability, phase transitions, morphology, time-dependent correlations, etc. are discussed. Crosslisted with CHEM and PTFE 6755.

MSE 6757. Advanced Polymer Chemistry. 3 Credit Hours.
Advanced topics in synthetic polymerization methodology, polymer structure, and polymer properties in solution and the solid state.

MSE 6759. Materials in Environmentally Conscious Design and Manufacturing. 3 Credit Hours.
Covers the environmental impact of materials choices and quantitative measure of life-cycle assessment and environmental burden. The Natural Step philosophy will be used as a model for the overall approach. Crosslisted with ME and PTFE 6759.

MSE 6768. Polymer Structure, Physical Properties, and Characterization. 3 Credit Hours.
Formulations and analysis of molecular and phenomenological models of elastic and viscoelastic behavior, development and description of structure, and fundamental aspects of structure-property relations. Crosslisted with TFE, CHE, and ME 6768.

MSE 6774. Biomaterials: Structure and Function. 3 Credit Hours.
Structure-function relationships of biomaterials and biomaterial characterization will be covered. Materials for medical implants, tissue engineering, biosensing, imaging, and drug delivery will be covered. Crosslisted with BMED, CHE, and ME 6774.

MSE 6775. Polymer Communications. 1 Credit Hour.
Oral and written presentation of modern polymer topics, with an emphasis on constructive and ethical critical thinking in a group setting.

MSE 6776. Integrated Low-cost Microelectronics Systems Packaging. 3 Credit Hours.
Broad overview of system-level, cross-disciplinary microelectronics packaging technologies, including design, test, thermal, reliability, optoelectronics, and RF integration. Comparison of system-to-chip and system-to-package. Crosslisted with ECE and ME 6776.

MSE 6777. Advanced Biomaterials. 3 Credit Hours.
Advanced topics of biomaterials performance and engineering, including biointerfaces, host reactions to materials, and bio-inspired/smart-materials strategies. Crosslisted with BMED, CHE, and ME 6777.

MSE 6795. Mathematical, Statistical, and Computational Techniques in Materials Science. 3 Credit Hours.
Fundamental physical, analytical, and mathematical techniques encountered in materials engineering including stress and strain, crystallographic and orientation transformations, X-ray, TEM, and solid-state concepts are emphasized. Crosslisted with ME and PTFE 6795.

MSE 6796. Structure-Property Relationships in Materials. 3 Credit Hours.
Introduction to the multi-scale structure effects on material properties. Course will prepare students for future in-depth courses. Crosslisted with PTFE and ME 6796.

MSE 6797. Thermodynamics and Kinetics of Microstructural Evolution. 3 Credit Hours.
The reduction of chemical-free, strain, and interfacial energies control of the kinetics of diffusional transformations. These factors are explored from the viewpoint of processing and stability of microstructure during service. Crosslisted with PTFE and ME 6797.

MSE 6XXX. Materials Science & Engineering Elective. 1-21 Credit Hours.

MSE 7000. Master's Thesis. 1-21 Credit Hours.

MSE 7010. Electroceramics. 3 Credit Hours.
Defects chemistry; electrochemical and electrophysical behavior of metallic/semiconducting ceramics, dielectrics, and ferrites; device applications of various electronic ceramics.

MSE 7110. Advanced Transmission Electron Microscopy. 3 Credit Hours.
Introduction to theory, techniques, and applications of high-resolution transmission electron microscopy (HRTEM) in materials research.

MSE 7140. Impedance and Dielectric Spectroscopy. 3 Credit Hours.
The basic theory of how current, voltage, and phase angle measurements over a wide frequency range (typically mHz-MHz) can provide information about microstructural features at all length scales.

MSE 7210. Dislocation and Deformation Mechanics. 3 Credit Hours.
Emphasis on interactions of dislocations with other defects, dislocation dynamics, and their correlation with mechanical properties under different rates of loading.

MSE 7420. Solidification Processing. 3 Credit Hours.
Fundamentals of thermodynamics, kinetics, mass transport, and physical materials are applied to the development of microstructure during solidification.

MSE 7510. Polymers for Electronic and Photonic Applications II. 3 Credit Hours.
Review of fundamentals and principles of polymers used in electronics and photonics. The relationship between the recent advances of semiconductor technology and the importance of polymers will be discussed.

MSE 7757. Teaching Practicum. 3 Credit Hours.
Students will learn about what it takes to be a faculty through sills needed for “delivery of lecture” via the practice of teaching.

MSE 7771. Mechanics of Polymer Solids and Fluids. 3 Credit Hours.
Continuum mechanics of solids and fluids; mechanics of deformation of anisotropic polymers; yield, breaking and fatigue; non-Newtonian vioscous and viscoelastic behavior of polymer fluids. Crosslisted with CHE, ME and PTFE 7771.

MSE 7772. Fundamentals of Fracture Mechanics. 3 Credit Hours.
Advanced study of failure of structural materials under load, mechanics of fracture, and microscopic and macroscopic aspects of the fracture of engineering materials. Crosslisted with AE, CEE, CHE, and ME 7772.

MSE 7773. Advanced Fracture Mechanics. 3 Credit Hours.
Nonlinear fracture mechanics including elastic-plastic and time-dependent fracture, advanced test methods, J-integral theory, and extensions. Crosslisted with AE, CEE, CHE, and ME 7773.

MSE 7774. Fatigue of Materials and Structures. 3 Credit Hours.
Mechanical and microstructural aspects of nucleation and growth of cracks under cyclic loading conditions, notch effects, cumulative damage, multiaxial loading, and fatigue crack propagation. Crosslisted with AE, CEE, CHE, and ME 7774.

MSE 7775. Topics in Fracture and Fatigue of Metallic and Composite Structures. 3 Credit Hours.
Brittle and ductile failure criteria. Failure prediction in composite structures. Free-edge and internal delamination. Anisotropic cracks. Fatigue behavior of composites and comparison with metal fatigue. Crosslisted with AE, CHE, and ME 7775.

MSE 7791. Damage, Failure, and Durability of Composite Material. 3 Credit Hours.
Analysis and failure of fiber-reinforced composite material systems. Mechanisms of toughening, multiple cracking mechanisms. Failure in woven fabric, braided, and special geometry composites. Crosslisted with AE, CHE, CEE, ME, and PTFE 7791.

MSE 7792. Advanced Mechanics of Composites. 3 Credit Hours.
Anisotropic elasticity, hygrothermal behavior, stress analysis of laminated composites including 3-D effects, stress concentrations, free-edge effects, thick laminates, adhesive and mechanical connections, fracture of composites. Crosslisted with AE, CHE, CEE, ME, and PTFE 7792.

MSE 7793. Manufacturing of Composites. 3 Credit Hours.
Major manufacturing techniques for metal, ceramic, and polymer composites. Modeling of processes with emphasis on fundamental mechanisms and effects. Crosslisted with AE, CHE, CEE, ME, and PTFE 7793.

MSE 8001. Seminar. 1 Credit Hour.
The latest advances in research and development will be presented by the enrolled students from articles in recent issues of recognized periodicals.

MSE 8200. Advanced Presentation Skills. 1 Credit Hour.
Designing and explaining visuals; creating and delivering scientific electronic presentations; learning to speak and present to a variety of audiences.

MSE 8801. Special Topics. 1 Credit Hour.
Special topic offerings of current interest not included in regular courses.

MSE 8802. Special Topics. 2 Credit Hours.
Special topic offering of current interest not included in regular courses.

MSE 8803. Special Topics. 3 Credit Hours.
Special topic offering of current interest not included in regular courses.

MSE 8813. Special Topics. 3 Credit Hours.
Special Topics in MSE.

MSE 8883. Special Topics. 3 Credit Hours.
special topics.

MSE 8901. Special Problems. 1-21 Credit Hours.
Lectures, laboratory, and library work on special topics of current interest in materials suitable for a master's degree candidate.

MSE 8902. Special Problems. 1-21 Credit Hours.
Lectures, laboratory, and library work on special topics of current interest in materials suitable for a master's degree candidate.

MSE 8903. Special Problems. 1-21 Credit Hours.
Lectures, laboratory, and library work on special topics of current interest in materials suitable for a master's degree candidate.

MSE 8997. Teaching Assistantship. 1-9 Credit Hours.
For graduate students holding teaching assistantships.

MSE 8998. Research Assistantship. 1-9 Credit Hours.
For graduate students holding a research assistantship.

MSE 9000. Doctoral Thesis. 1-21 Credit Hours.

MSE 9999. GT-PKU. 12 Credit Hours.
For GT-PKU students during terms when they are not taking other GT courses. Placeholder course.