SCHOOL OF MATERIALS SCIENCE AND ENGINEERING

Established in 1985
(School of Textile Engineering established in 1897)
(School of Ceramic Engineering established in 1924)

General Information

The School of Materials Science and Engineering provides high-quality academic programs focused on developing a fundamental understanding of all forms of materials and the creation of new materials in different environments for the next generation of engineering applications and functions. A discipline on the forefront of innovations in both science and engineering, the BSMSE degree offers students three separate concentrations:

- Polymer and Fiber materials;
- Structural and Functional materials, and
- Biomaterials.

The BSMSE degree involves studies of engineering materials, such as metals, ceramics, polymers, fibers, textiles, composites, biomaterials, nanomaterials and electronic materials, from a fundamental point of view, emphasizing the relationships between the atomic- and micro-scale structure, with the processing, properties, and performance of the materials.

Completion of the BS degree prepares students for entry into the workforce in diverse technology sectors, or for advanced study in materials science and engineering, or for other graduate programs. Materials scientists and engineers have many career options available, such as in aerospace, automotive, biomedical, chemical, defense, electronics, materials processing, textiles, consumer products, and recreational and sporting equipment industries, as well as in universities, government, and industrial laboratories, and even in consulting, legal, business, and medical disciplines

Academic instruction and research in the School of Materials Science and Engineering at Georgia Tech spans the following areas:

1. Synthesis and processing focusing on development of advanced and traditional materials with novel compositions and tailored microstructures;
2. Characterization and evaluation of structure and properties using advanced techniques and state-of-the-art instrumentation; and
3. Computational modeling of processing-structure-property-performance relationships emphasizing correlation of properties with the structure across nano-, micro-, meso-, and macro-length scales.
4. Design of materials through fundamental theoretical and experimental understanding of materials behavior to address societal challenges in energy, infrastructure, environment, security, health and welfare, and transportation.

MSE faculty participate in collaborative research projects with faculty from other schools in the Colleges of Engineering and Sciences, and the Georgia Tech Research Institute. Several interdisciplinary centers are led by MSE faculty. The external sponsored research funding brought in by the FTE faculty in the School of Materials Science and Engineering exceeds $15 million per year and comes from a wide variety of sources including industry, private foundations, and federal agencies including AFOSR, ARO, DARPA, DoE, DTRA, NSF, NIH, and ONR. A significant number of materials specialists are required to meet the present and future opportunities and challenges of this field, which makes MSE graduates sought after in practically every aspect of technological advancement.

The school offers a Bachelor of Science in Materials Science and Engineering degree. An undergraduate minor in materials science and engineering is available for non-MSE majors. Graduate degrees (MS and PhD) are offered in materials science and engineering, paper science and engineering, and in the interdisciplinary bioengineering program. Certificate programs are also available in biomaterials, composite materials, nanomaterials, and computational materials science and engineering.

Minor

- Minor in Material Science and Engineering

Bachelor's Degree

- Bachelor of Science in Materials Science and Engineering

Master's Degrees

- Master of Science in Bioengineering
- Master of Science in Computational Science and Engineering
- Master of Science in Materials Science and Engineering

Doctoral Degrees

- Doctor of Philosophy with a Major in Bioengineering
- Doctor of Philosophy with a Major in Computational Science and Engineering
- Doctor of Philosophy with a Major in Materials Science and Engineering

MSE 1111. Introduction to Materials Science and Engineering. 1 Credit Hour.
A general introduction to the field of Materials Science and Engineering and the MSE curriculum at Georgia Tech.

MSE 1750. Introduction to Bioengineering. 3 Credit Hours.
An introduction to the field of bioengineering, including the application of engineering principles and methods to problems in biology and medicine, the integration of engineering with biology, and the emerging industrial opportunities. Crosslisted with AE, BMED, CHE, ECE, and ME 1750.

MSE 1801. Special Topics. 1 Credit Hour.
Topics of current interest not covered in other courses.

MSE 1802. Special Topics. 2 Credit Hours.
Topics of current interest not covered in other courses.

MSE 1803. Special Topics. 3 Credit Hours.
Topics of current interest not covered in other courses.

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

MSE 2001. Principles and Applications of Engineering Materials. 3 Credit Hours.
The structure-property-processing-performance relationships of engineering materials are described. Materials selection is treated as a part of engineering design.

MSE 2021. Materials Characterization. 4 Credit Hours.
The fundamentals of basic microstructural and compositional materials characterization techniques are presented with an emphasis on tools using electromagnetic radiation and electrons as stimuli.

MSE 2698. Undergraduate Research Assistantship. 1-12 Credit Hours.
Independent research conducted under the guidance of a faculty member.

MSE 2699. Undergraduate Research. 1-12 Credit Hours.
Independent research conducted under the guidance of a faculty member.

MSE 2801. Special Topics. 1 Credit Hour.
Topics of current interest not covered in other courses.

MSE 2802. Special Topics. 2 Credit Hours.
Topics of current interest not covered in other courses.

MSE 2803. Special Topics. 3 Credit Hours.
Topics of current interest not covered in other courses.

MSE 2XXX. Materials Science & Engineering Elective. 1-21 Credit Hours.

MSE 3001. Chemical Thermodynamics of Materials. 3 Credit Hours.
Principles and applications of thermodynamics to materials science and engineering. Phase equilibria and the concepts necessary to interpret phase diagrams.

MSE 3002. Structural Transformations in Metallic, Ceramic, and Polymeric Systems. 3 Credit Hours.
Principles that govern the important structural transformations that occur in engineering materials.

MSE 3005. Mechanical Behavior of Materials. 3 Credit Hours.
The correlation of mechanical properties with atomic bonding, microstructure, and micromechanics, for applications relevant to materials selection and design, mechanical forming, and failure of materials.

MSE 3012. Thermal and Transport Properties of Materials. 3 Credit Hours.
The thermophysical and transport properties of solids and fluids, i.e. heat capacity, expansion, viscosity, conduction, convection, and radiation are discussed, along with thermal analysis instrumentation.

MSE 3015. Electrical, Optical, and Magnetic Properties. 3 Credit Hours.
Introduction to quantum mechanics and the band theory of solids to describe semiconducting, superconducting, dielectric, optical, and magnetic properties of nano- and micro-structured materials.

MSE 3021. Materials Laboratory I. 2 Credit Hours.
Characterization of engineering properties of materials through hands-on experiments. Instruction on basic laboratory skills, safety, statistical analysis of data, use of laboratory notebooks and technical report writing.

MSE 3025. Statistics and Numerical Methods in Materials Science and Engineering. 3 Credit Hours.
Concepts of computational modeling and statistics, with examples based on materials science and engineering applications.

MSE 3210. Transport Phenomena. 3 Credit Hours.
An introduction to transport emphasizing applications to materials. Credit not allowed for MSE 3210.

MSE 3220. Operations and Management Methods. 3 Credit Hours.
Principles and applications of production and operations management to the manufacturing enterprise, including process flow analysis, production planning and scheduling, optimization, quality management and facilities planning. Restricted to MSE majors. Credit not allowed for MSE 3220.

MSE 3225. Rheology. 3 Credit Hours.
Introduction to non-Newtonian fluid mechanics and rheology.

MSE 3230. Polymer and Fiber Processing. 3 Credit Hours.
Discussion of the principles of fiber formation from polymers including rheology, mechanics, energetics, phase transition, and polymer structure. High-performing fiber processing, and plastics processing. Credit not allowed for both MSE 3230 and PTFE 3230.

MSE 3300. Materials Science & Engineering of Sports. 3 Credit Hours.
The structure-property-performance relationships of engineered materials are described as it relates to past, present, and future use in sports.

MSE 3720. Introduction to Polymer/Fiber Enterprise. 3 Credit Hours.
Approaches the manufacture of engineered fibrous structures from a manager's viewpoint and gives a working knowledge and understanding of various processes used in producing polymers/fibers/fiber products. Restricted to non-MSE majors. Credit not allowed for MSE 3720.

MSE 3801. Special Topics. 1 Credit Hour.
Topics of current interest not covered in other courses.

MSE 3802. Special Topics. 2 Credit Hours.
Topics of current interest not covered in other courses.

MSE 3803. Special Topics. 3 Credit Hours.
Topics of current interest not covered in other courses.

MSE 3XXX. Materials Science & Engineering Elective. 1-21 Credit Hours.

MSE 4002. Ceramic Materials: Properties, Processing, Applications. 3 Credit Hours.
Properties, processing, and applications of the industrially and technically important ceramic materials. Traditional and oxide ceramics in addition to glass and nonoxide ceramics.

MSE 4004. Materials in Electronic Applications. 3 Credit Hours.
Basics of photolithography, screen printing, and tape casting. Requirements for fuel cells, magnetic nanocomposites, flat-panel displays, gas sensors, piezoelectric acutators, photonic crystals, etc.

MSE 4006. Processing and Applications of Engineering Alloys. 3 Credit Hours.
Solidification, deformation, and powder processing of metals and alloy;, microstructural design at nano- and meso-length scales; and structure-property correlations.

MSE 4010. Environmental Degradation. 3 Credit Hours.
Theory of environmental degradation of metals, ceramics, polymers, and biomaterials. Emphasis on the scientific principles of corrosion and physical degradation.

MSE 4022. Materials Laboratory II. 2 Credit Hours.
Processing, structure, properties relationships are explored through a series of hands-on experiments. Instruction on basic laboratory skills, safety, statistical analysis of data, use of laboratory notebooks and technical report writing.

MSE 4025. Fiber Product Manufacturing. 3 Credit Hours.
The manufacture of fiber products and their process- structure-property relationships are detailed, covering fibers, yarns, fabrics, nonwovens, carpets, composites, and related materials.

MSE 4026. Testing and Evaluation of Polymer and Fiber Products. 3 Credit Hours.
Properties influencing the end use performance of fiber and polymer products including that of plastic materials will be tested using standard ASTM, AATC and federal test methods. Standard statistical tools will be used to analyze and interpret the test data.

MSE 4100. Chemical Applications to Fiber Materials. 2 Credit Hours.
The chemical, thermal, and mechanical processes used in the preparation, coloration, printing and finishing of polymeric fiber materials are explored. Credit not allowed for MSE 4100.

MSE 4105. Deformation and Fracture of Materials. 3 Credit Hours.
Deformation and fracture of metals, ceramics, polymers and composites for applications relevant to material selection and design, mechanical forming processes, and analysis of engineering failures.

MSE 4122. Fiber Chemistry Lab. 1 Credit Hour.
Laboratory course in preparation, coloration and finishing of fiber materials. Credit not allowed for MSE 4122.

MSE 4140. Polymer Physics. 3 Credit Hours.
Physical chemistry of polymer solutions, polymer miscibility, adsorptions, sorptions, plasticization, molecular weights, molecular weight distributions. Study of polymer surfaces. Credit not allowed for MSE 4140.

MSE 4230. Industrial Ctrls In MFG. 3 Credit Hours.
Introduction to industrial controls in manufacturing, process modeling, control of continuous-variable processes, digital control, discrete control, and control of manufacturing systems.

MSE 4315. Nondestructive Evaluation. 3 Credit Hours.
Principles and theory of industrial nondestructive evaluation methods are covered. Emphasis is on testing the soundness and reliability of primary and secondary engineering structures.

MSE 4320. Electronic Packaging and Design. 3 Credit Hours.
Electronic packaging design, covering properties of materials, fabrication and assembly processes, thermal-mechanical considerations, practical concerns regarding interconnection and processing issues, and reliability assessment.

MSE 4325. Thin Film Materials Science. 3 Credit Hours.
Introduction to principal vapor deposition processes and vacuum technology. The fundamentals of the formation, characterization, and properties of inorganic nano- to micro-scale thin films.

MSE 4330. Fundamentals of Nanomaterials and Nanostructures. 3 Credit Hours.
Introduction to nanotechnology. Description of various nanomaterials, their applications and synthesis methods.

MSE 4335. Soft Nano and Bio Materials. 3 Credit Hours.
Introduction soft nanomaterials and nanostructures that have been discovered and synthesized for prospective applications in nanotechnology.

MSE 4410. Capstone Engineering Design I. 3 Credit Hours.
A capstone engineering design course covering the principles of concurrent product/process design and development. Team-based projects will explore product/process design and development. Credit not allowed for MSE 4410.

MSE 4420. Capstone Engineering Design II. 3 Credit Hours.
A team problem-solving approach is used to work on a project developed in cooperation with industry. Weekly communications, both oral and written, are required. Credit not allowed for MSE 4420.

MSE 4698. Undergraduate Research Assistantship. 1-12 Credit Hours.
Independent research conducted under the guidance of a faculty member.

MSE 4699. Undergraduate Research. 1-12 Credit Hours.
Independent research conducted under the guidance of a faculty member.

MSE 4723. Interdisciplinary Capstone Design. 3 Credit Hours.
Seniors will work in teams to apply a systematic design process to real multi-disciplinary problems. Problems selected from a broad spectrum of interest areas, including biomedical, environmental, mechanical, industrial design, electrical and thermal/fluids. Projects must be based on the knowledge and skills acquired in earlier course work, and incorporate appropriate engineering standards and multiple realistic constraints. Emphasis is placed on the design process, the technical aspects of the design, and on reducing the proposed design to practice. The course consists of faculty and guest lectures, prototyping in design studios, and a multi-disciplinary design project.

MSE 4740. Biologically Inspired Design. 3 Credit Hours.
We examine evolutionary adaptation as a source for engineering design inspiration, utilizing principles of scaling, adaptability, and robust multifunctionality that characterize biological systems. Credit not allowed for both MSE 4740 and (BIOL 4740 or ISYE 4740 or ME 4740).

MSE 4751. Introduction to Biomaterials. 3 Credit Hours.
Introduction to different classes of biomaterials (polymers, metals, ceramics) and physiological responses to biomaterial implantation. Topics include material properties, host response, and biomaterial characterization techniques. Crosslisted with BMED 4751.

MSE 4754. Electronics Packaging Assembly, Reliability, Thermal Management, and Test. 3 Credit Hours.
The course provides hands-on instruction in electronics packaging, including assembly, reliability, thermal management, and test of next-generation microsystems. Crosslisted with ECE and ME 4754.

MSE 4755. Electronic Packaging Substrate Fabrication. 3 Credit Hours.
This course provides students with hands-on instruction in basic SOP concepts and techniques, including interconnect design, substrate material selection and properties, photodielectric deposition, via formation and photolithography, copper metallization, and finally, substrate testing. Laboratory instructions are augmented by an interactive multimedia educational presentation that makes the course work material remotely accessible via the internet.

MSE 4759. Electrochemical Energy Storage and Conversion. 3 Credit Hours.
An elective class for senior-level students interested in electrochemical storage and conversion, including the fundamentals of electrochemistry and practical battery and fueld cells. Cross-listed with ChBE and ME 4759.

MSE 4761. Industrial Controls and Manufacturing. 3 Credit Hours.
Students are introduced to industrial controls and the fundamentals of manufacturing with hands-on experience based on lab projects using industry software and hardware for communications and control. Credit not allowed for MSE 4761.

MSE 4766. Fabrication and Properties of Nanoscale Devices. 3 Credit Hours.
Fundamental properties at the nanoscale for photonics and sensors. Nanoscale fabrication methods including thin films, ion beam, lithography, electroplating, and example case studies in NEMS/MEMS and photonics. Credit not allowed for both MSE 4766 and ME 4766.

MSE 4775. Polymer Science and Engineering I: Formation and Properties. 3 Credit Hours.
An introduction to the chemistry, structure, and formation of polymers, physical states and transitions, physical and mechanical properties of polymer fluids and solids. Crosslisted with CHE, CHEM, and ME 4775.

MSE 4776. Polymer Science and Engineering II: Analysis, Processing, and Laboratory. 3 Credit Hours.
Polymer fabrication processes and methods of characterization and identification of polymers are presented. Experiments in polymerization, processing, and property evaluation of polymers. Crosslisted with CHE, CHEM, ME, and TFE 4776.

MSE 4790. Materials Selection and Design. 3 Credit Hours.
Principles of selecting materials and processes for engineering applications. Methodologies for designing new materials and conceiving hybrid solutions. Credit not allowed for both MSE 4790 and ME 4213 (or ME 4790).

MSE 4791. Mechanical Behavior of Composites. 3 Credit Hours.
Introduction to properties and structures of common matrix and reinforcing materials, mechanics of fiber-reinforced composites, lamina and laminate analysis, and mechanical performance. Crosslisted with AE, CEE, CHE, and ME 4791.

MSE 4793. Composite Materials and Processing. 3 Credit Hours.
Basic principles of selecting component materials and manufacturing composites are presented. Polymeric, metallic, and ceramic systems are considered. Crosslisted with AE, CEE, CHE, and ME 4793.

MSE 4794. Composite Materials and Manufacturing. 4 Credit Hours.
Basic principles of selection and design of composite materials and their manufacturing and testing. Cost factors. Laboratory exercises on manufacturing and tests. Crosslisted with AE, CEE, CHE, and ME 4794.

MSE 4795. Fundamental Elements of Nuclear Reactor Materials. 3 Credit Hours.
Introduction to fundamentals of nuclear reactor materials. Topics covered are basics of radiation damage, defect creation and evolution, microstructure-property correlations in cladding and fuel of nuclear materials.

MSE 4801. Special Topics. 1 Credit Hour.

MSE 4802. Special Topics. 2 Credit Hours.

MSE 4803. Special Topics. 3 Credit Hours.

MSE 4883. Special Topics. 3 Credit Hours.
special topics.

MSE 4901. Special Problems. 1-21 Credit Hours.

MSE 4902. Special Problems. 1-21 Credit Hours.

MSE 4XXX. Materials Science & Engineering Elective. 1-21 Credit Hours.

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.