



UNDERGRADUATE ADVANCED PROGRAM

on

Materials Science and Engineering

BASED ON THE CURRICULUM OF THE

University of Illinois at Urbana Champaign, USA

Hanoi - 2006

7. Course Descriptions

MI1016 Calculus I

4 creds.

First course in calculus and analytic geometry; basic techniques of differentiation and integration with applications including curve sketching; antidifferentiation, the Riemann integral, fundamental theorem, exponential and circular functions.

MI1026 Calculus II

4 creds.

Second course in calculus and analytic geometry: techniques of integration, conic sections, polar coordinates, and infinite series, three dimensional space, functions of several variables, partial derivatives, and multiple integrals.

MI1036 Introductory Matrix Theory

4 creds.

Systems of linear equations, matrices and inverses, determinants, and a glimpse at vector spaces, eigenvalues and eigenvectors.

MI1046 Intro Differential Equations

3 creds.

Intended for engineering students and others who require a working knowledge of differential equations; included are techniques and applications of ordinary differential equations and an introduction to partial differential equations.

PH1016 Univ Physics, Mechanics

4 creds.

Kinetics and dynamics of material point - Mechanical energy and field of potential energy - Dynamics of rigid - Vibration and mechanical waves - Einstein's Relative Theory.

PH1026 Univ Physics, Elec & Mag

4 creds.

Statistic electrical field - Insulator - Conducting object and capacitor - Magnetic field - Electromagnetic induction - Magnetic material - Electromagnetic oscillations and waves - Electromagnetic field.

PH1036 Univ Physics, Quantum Phys

4 creds.

Theory of molecular kinetics, principles of thermodynamics - wave and particle characters of light - The wave-particle duality of matter, wave functions and the Schroedinger equation - Atoms and nuclei - Crystal solid.

CH1016 General Chemistry I

4 creds.

Principles governing atomic structure, bonding, states of matter, stoichiometry, and chemical equilibrium; descriptive chemistry of the elements and coordination compounds.

CH1026 General Chemistry II

4 creds.

Chemistry of materials, including organic and biological substances, chemical energetics and equilibrium, chemical kinetics, and solids and crystals.

IT1016 Intro to Computing, Eng & Sci

3 creds.

Fundamental principles, concepts, and methods of computing, with emphasis on applications in the physical sciences and engineering. Basic problem solving and programming techniques; fundamental algorithms and data structures; use of computers in solving engineering and scientific problems.

MSE3016 Intro to Mats Sci. and Eng.

3 creds.

Provides an overview of Materials Science and Engineering as a basis for understanding how structure/property/processing relationships are developed and used for different types of materials. Illustrates the role of materials in modern society by case studies of advances in new materials and processes. Laboratory/discussion periods will be devoted to demonstrations and experiments that illustrate the lectures. Design teams will analyze or synthesize objects that use materials creatively.

MSE3206 Phases and Phase Relations

3 creds.

This course provides the basis for the understanding of microstructure. It treats in quantitative terms and in some depth the concept of phases (crystalline and non-crystalline structures) and the relationships between phases (phase diagrams). Commercial practices for producing desired macroscopic phase configurations and macroscopic shapes are described (processing).

MSE3126 Mechanics for MatSE

4 creds.

Topics from statics, mechanics of materials, and fluid mechanics pertinent to the fields of metallurgical engineering, ceramic engineering, and materials science and engineering: force resultants, stresses and strains produced in elastic bodies, microscopic effects of different loading states (tension, compression, torsion and bending) on deformable bodies,

beam stresses and deflections, introduction to three-dimensional stresses and strains, stress and strain-rate relationships for Newtonian and non-Newtonian fluids, conservation equations (control volume analysis) for fluid flow, Reynolds number, and slow inertial and turbulent flows. This course is tailored for students with interests in materials science and engineering.

MSE3306 Electronic Properties of Mat'ls

3 creds.

Study of the electronic structure and bonding of materials, electrical conduction in metals and semiconductors, and dielectric and magnetic properties of solids.

MSE3316 Materials Laboratory I

3 creds.

Laboratory course to be taken simultaneously with or following MSE 301 and MSE 305. Experiments using optical and scanning electron microscopy and various thermal and thermodynamic measuring techniques. Introduction to use of laboratory test instruments.

MSE3326 Materials Laboratory II

3 creds.

Experiments characterizing mechanical, transport, and magnetic-electric properties of materials.

MSE3406 Thermodynamics of Materials

4 creds.

Examines basic thermodynamic principles including energy, entropy, and free energy; describes the macroscopic properties of various materials systems such as equilibrium states, phases, and phase transitions; emphasizes metals, ceramics, polymers, and electronic materials. Particular attention is paid to the application of phase diagrams; introduces the statistical interpretation of thermodynamics on the atomistic level.

MSE3416 Kinetic Processes in Materials

3 creds.

Studies kinetics of chemical reactions; rate equations, reaction mechanisms; transport processes; diffusion equations, atomic and molecular diffusion. Phase transformations; nucleation, crystallization, displacive, spinodal decomposition. Examines surface and interface phenomena; sintering, grain growth, recovery and recrystallization.

MSE3426 Synthesis of Materials

3 creds.

Studies fundamentals of the synthesis of materials. Examines principles of synthesis; processes, approaches, synthetic methodology and probes; methodologies in materials synthesis; polymerization, sol-gel processes, liquid and vapor phase synthesis, materials coupling reactions, and precursor-derived, radiation-induced and asymmetric synthesis.

MSE3436 Microstructure Determination

3 creds.

Studies the fundamentals and applications of various forms of microscopy (image formation) and diffraction for characterization of physical microstructure of materials and of various forms of spectroscopy for characterization of chemical microstructure.

MSE3446 Thermal-Mech Behavior of Materials

3 creds.

Studies fundamentals of elastic, viscoelastic and plastic deformation of materials, elementary theory of statics and dynamics of dislocations; examines strengthening mechanisms and behavior of composites; fracture and fatigue behavior; fundamentals of thermal behavior: heat capacity, thermal expansion and conductivity; effects of thermal stress.

MSE3456 Analysis of Data

3 creds.

Nature of probabilistic models for observed data; discrete and continuous distribution function models; inferences on universe parameters based on sample values; introduction to control charts, acceptance sampling, and measurement theory.

MSE4106 Adv. Mech. Prop. of Solids

3 creds.

Advanced treatment of the mechanical behavior of solids; examines crystal plasticity, dislocations, point defects and grain boundaries, creep and fatigue behavior, fracture.

MSE4116 Metals Processing

3 creds.

Discussion of melt, mechanical, thermal, powder and surface processing of metals. Extraction of metals, joining of metals, metal composites and metal recycling are also reviewed. The relationships between the processing of metals, the microstructures that are produced and the behavior of metal components are emphasized.

MSE4126 Metals Laboratory

3 creds.

Advanced metallurgy laboratory. Examines effects of heat treatment; mechanical testing, oxidation and corrosion; and metallography of selected alloys.

MSE4136 Design of Engineering Alloys

3 creds.

Examines the application of science and engineering principles to the design, selection and performance of engineering alloys. Studies alloy classes, design, effect of alloying elements, relation to processing variables and structure-property relationships; design project.

MSE4156 Corrosion of Metals

3 creds.

Electrochemistry, thermodynamics and kinetics of corrosion; behavior of ferrous and non-ferrous metals; corrosion rates; corrosion control; cathodic and anodic protection; high temperature corrosion; corrosion testing.

MSE4346 Electron Microscopy & Diff. Theory

3 creds.

Theory and application of transmission electron microscopy and diffraction with emphasis on thin crystals; electron optics, interference phenomena, interpretation of images and diffraction patterns, specimen preparation, etc.

MSE4406 Materials Design

1 creds.

Design of various engineering devices, objects, or systems. Teams of 2-5 students from different concentrations within the department work toward the development of materials-based solutions to problems originating from student, faculty, and industrial suggestions. Projects will be guided by various faculty within the department, with the teams presenting mid-term (oral) and final reports. Solutions are to be based on the knowledge, skills, and design experience acquired in earlier course work and incorporate engineering standards and realistic constraints including most of such factors as economic, environmental, sustainability, manufacturability, ethical, health and safety, social, and political concerns.

MSE4416 Process design

3 creds.

Reviews the basic concepts of heat and mass transfer, control theory and statistical analysis in the context of fabrication processes typical of materials industries; supplements the numerical procedures and algorithms that constitute a computational repertoire adequate for the engineering practice. In the frame of an actual engineering design project, the combined application of the principles of materials processing, plant layout, reactor design, peripheral facilities, logistics of supply, and economic feasibility are practiced.

MSE4426 Composite Materials

3 creds.

Introduction to metal and ceramic matrix composites, with an emphasis on understanding the interrelationships between processing, microstructure, and properties. The basis for selecting these systems for different engineering applications is considered.

MSE4206 Intro to Polymer Sci. and Eng.

3 creds.

Fundamentals of polymer science and engineering. Polymer solution properties, conformation and molecular weight characterization. Rheological and viscoelastic behavior: relaxations and transitions, rubber elasticity. Crystallinity, morphology and deformation of crystalline polymers. Blends and composites. Methods of fabrication.

MSE4226 Polymer Characterization Laboratory

3 creds.

Characterizes polymer materials experimentally to investigate molecular, microstructural, and macroscopic aspects of their mechanical, thermal, electrical, and optical properties. A team project is an integral part of this course.

MSE4236 Plastics Engineering

3 creds.

An introductory course to plastics engineering. Examines components of plastics and data banks; viscoelasticity, yield, and fracture; reinforced polymers; and forming, design (project), and current advances.

MSE4246 Polymer Physics I: Structure and Props.

3 creds.

Techniques and applications of polymer crystal structure and morphology observation; x-ray, electron, light and neutron scattering and diffraction; light and electron microscopy. Morphology-processing-property relationships of crystalline polymers, blends and copolymers; liquid, plastic and condis crystals; deformation mechanisms and orientation characterization; relaxations and transitions; crystallization theory.

MSE4256 Polymer Physical Chemistry

3 creds.

Intermediate level introduction to the fundamental physical chemistry of polymer systems. Focus is on equilibrium conformation, structure, properties and phase transitions of polymer solutions, dense melts, liquid crystals, mixtures, block copolymers, surfaces and interfaces, and electronic polymers.

MSE4266 Polymer Chemistry

3 creds.

Comprehensive overview and examination of the methods used to synthesize macromolecules. Both descriptive and mechanistic organic chemistry, as it relates to polymer synthesis, are discussed.

MSE4276 Mechanics of Polymers

3 creds.

Mechanical behavior of amorphous and semi-crystalline polymers; overview of polymer structure, properties, and processing; polymer linear viscoelasticity using Boltzmann superposition and mechanical models; measurement of viscoelastic properties; polymeric yield phenomena; fracture and craze formation; impact and fatigue.

MSE4306 Electronic Matls & Proc I, Semiconductors and Semiconductor Processing

3 creds.

Introduces senior engineers and new graduate students to the materials science, engineering, and processing of semiconductors. The structure and chemistry of semiconductors are related to the electronic and optical properties. Includes: how semiconductors are produced and how to control processing to achieve desired materials properties; how to design and produce novel materials to obtain superior performance from electronic devices.

MSE4316 Electronic Matls & Proc II, Non-semiconductor materials and processing

3 creds.

Introduction to the materials science, engineering, and processing of microlithographic materials, conductors and dielectrics for electronic applications. The course makes use of the concepts developed in materials science to understand why certain materials make acceptable contacts and dielectrics while others do not. Demonstrates how manufacturing problems can be overcome with careful materials design and processing. Examines some of the processing techniques commonly used in microelectronic circuit manufacture during metallization, dielectric formation and lithography.

MSE4326 Electronic Materials Lab

3 TC

Introduces seniors and new graduate students to the fabrication, analysis and properties of thin film materials through a combination of lectures and experiments. Covers both the principles and practice of: (a) deposition of thin film materials by vacuum evaporation, sputtering and plasma assisted processes: (b) modification of properties by thermal

reaction, surface treatment, etc., and (c) characterization of key properties including electrical conductivity, optical properties, and stress. Methods to optimize the film microstructure and engineering properties via growth techniques are emphasized. Students also undertake an independent project.

MSE4356 Solid State Electronic Devices

3 creds.

Semiconductor materials and their electronic properties and applications to electronic devices; p-n junctions; transistors; junction field effect transistors and MOS devices; and introduction to integrated circuits.

MSE4506 Nanoscale Materials

3 creds.

Introduction to the most recent advances in the synthesis, lithographic patterning and characterization of nanomaterials and to their physical and electronic properties. The materials presented include semiconductor and metal nanoparticles and nanowires, carbon fullerenes and nanotubes, organic nanoparticles and dendrimers. Fundamental concepts of surface physics and chemistry used to explain the working principles of devices such as nanotransistors and nanosensors.

MSE4516 Nano Processing technology

6 creds.

This course introduces the theory and technology of micro/nano fabrication. Because of the interdisciplinary nature of the subject, its content includes concepts from many disciplines in engineering (electrical, materials, mechanical, chemical) and science. In lecture, we will discuss the theory of basic processing techniques, such as diffusion, oxidation, photolithography, chemical vapor deposition, physical vapor deposition, etching, and metallization.