

Department of Materials Science and Engineering

University of Tennessee - Knoxville

***Undergraduate
Student
Handbook***

Spring 2012

434 Dougherty Engineering Building

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I. Welcome to the Department

Welcome to the Department of Materials Science and Engineering at the University of Tennessee, Knoxville. The departmental faculty believes that you have selected an exciting and rewarding program of study. Programs in the materials field (i.e., Materials Science and Engineering, Materials Engineering, Metallurgical Engineering, Polymer Engineering) are often classified as “enabling technologies”. Almost every product that one uses from clothing to advanced aircraft depends upon the properties of materials for performance. The ability to control properties through processing or synthesis methods and through control of composition and microstructure allows us to tailor materials for a specific application with reasonable costs and high degrees of reliability and safety. In a paraphrase of a current television commercial, “we don’t make things. We make them possible!”

In addition to the Bachelor of Science in Materials Science and Engineering, the department offers graduate studies leading to the degrees of Master of Science and Doctor of Philosophy with a major in either Materials Science and Engineering or Polymer Engineering. Opportunities to participate in the research activities associated with these programs are often offered to undergraduate students. Additionally, the University of Tennessee - Knoxville has identified “materials” as a campus-wide focus area.

The Materials Science and Engineering Department supports an active Materials Advantage Chapter. Materials Advantage is a single low-cost membership that provides access to the American Ceramic Society (ACerS), ASM International (the Materials Information Society), The Minerals, Metals, and Materials Society (TMS), and the Association for Iron & Steel Technology (AIST). Activities of the UT Materials Advantage Chapter include travel to professional conferences including the Fall Materials Science and Technology Conference and Show and Congressional Visit Days and the TMS Annual Meeting in the Spring. The Chapter also participates in the Oak Ridge Chapter of ASM’s summer Materials Camp for high school students and the College of Engineering’s Engineers Day in the fall hosting an egg drop competition and laboratory tours and presenting a demonstration related to Materials Science and Engineering.

Your faculty advisor and departmental head are your front line advocates. If you encounter any problems, you are encouraged to discuss the details with one or both of them.

Kurt Sickafus
Professor and Head

II. Mission Statements

University of Tennessee, Knoxville, Mission Statement

The University of Tennessee, Knoxville, is committed to the development of individuals and society as a whole through the cultivation and enrichment of the human mind and spirit. Our mission is accomplished through teaching, scholarship, artistic creation, public service, and professional practice.

An elaboration of this statement follows:

The first priority of UTK faculty, staff, and administrators is the education of our students, from freshmen to postdoctorals, through a creative balance of academic, professional, extracurricular, and athletic programs of the highest quality. The centrality of liberal learning is affirmed with particular emphasis on the integration of liberal and professional learning. We are committed to excellence in disseminating knowledge and skills to our students, while at the same time helping them to develop critical thinking skills, acquire wisdom and insight, promote self-awareness and self-understanding, affirm diversity as an opportunity for personal growth and development, understand ethical and moral issues, and be committed to the pursuit of truth in all endeavors.

Scholarship of the highest quality by our faculty and students is central to our mission. It is always to be pursued in balance with good teaching and with an understanding of the potential for quality teaching and scholarship to reinforce and enrich each other. UTK aspires for its scholarship to be of increasing national and international relevance and recognition. We affirm that good teaching requires more than just teaching the knowledge of others but requires contributing through active scholarship to what is to be taught, thought, and practiced in the education of students.

UTK aspires to be a university of choice by persons of different backgrounds. We are committed to an expanded international perspective and emphasis at all levels. Constant attention to a sense of community for all members of the diverse university community is a high priority.

UTK College of Engineering Mission Statement

To provide high quality education in the major engineering disciplines from the undergraduate through doctoral levels through a creative balance of academic, professional, and extracurricular program;

To foster and maintain mutually beneficial partnerships with our alumni, friends, industry, and local, state and federal governments through public service assistance and collaborative research; and

To be a major contributor to our nation's technology base through scholarship and research.

UTK Department of Materials Science and Engineering Mission Statement

Provide quality education, BS through PhD, in the field of materials;

Develop new materials and new knowledge about existing materials, methods of processing, and materials utilization;

Perform public service in the discipline and encourage professionalism in our students;

Foster mutually beneficial relationships with alumni, industry and government;

III. Purpose of the Undergraduate Student Handbook

This handbook provides supplementary information to that contained in the University of Tennessee **Undergraduate Catalog** and the student handbook **Hilltopics** that pertain specifically to the Department of Materials Science and Engineering and its undergraduate program. It provides detailed information about the faculty, undergraduate degree program, policies and procedures. This edition is based on the University of Tennessee **Undergraduate Catalog 2004-05**. It is hoped that this handbook will assist you in making the transition from student to an engineer.

IV. History of the Program

The program that is currently entitled Materials Science and Engineering originated as “Metallurgy” in the early 1950s and was an option within the Chemical Engineering program. The degree of Metallurgical Engineering was recognized by the Engineering Council for Professional Development in 1964. The Department of Materials Science and Engineering was created as a separate entity in 1985 and the undergraduate degree program was changed to Materials Science and Engineering in 1988.

V. Accreditation

The B.S. degree in Materials Science and Engineering is accredited by the Engineering Accreditation Commission of ABET, <http://www.abet.org>.

VI. Program Educational Objectives

The general educational objectives of the college of engineering are to prepare students to enter and continue the practice of engineering and/or to continue their education by study in graduate or professional schools. The following specific Materials Science and Engineering Program Educational Objectives were established in consultation with our students, faculty, potential employers, and alumni to assure that the overall objectives of the College are met and that our students graduate with an undergraduate education that will sustain them for their lifetime.

- Our graduates will demonstrate a thorough understanding of general engineering principles and a deep understanding of the discipline of materials science and engineering.
- Our graduates will contribute to their disciplines and society and advance to leadership roles in their chosen career field.
- Our graduates will be prepared to successfully complete competitive postgraduate education programs.

VII. Program Outcomes

Specific program outcomes have been identified that support the Program Educational Objectives and the outcomes established by ABET, Inc. that articulate the expectations of industrial leaders.

Before our students receive the B. S. degree in Materials Science and Engineering, they will have demonstrated:

- a) an ability to apply knowledge of mathematics, science, and engineering
- b) an ability to design and conduct experiments, as well as to analyze and interpret data
- c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
- d) an ability to function on multidisciplinary teams
- e) an ability to identify, formulate, and solve engineering problems
- f) an understanding of professional and ethical responsibility
- g) an ability to communicate effectively
- h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
- i) a recognition of the need for, and an ability to engage in life-long learning
- j) a knowledge of contemporary issues
- k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice
- l) an understanding of the effect of composition, synthesis, and processing methods on structure and properties, and in turn to the performance in service of all classes of materials (metals, ceramics, polymers)
- m) an ability to apply statistical and computational methods for data analysis and solution of problems in materials systems
- n) an ability to integrate knowledge of processing, structure, properties, and performance to solve materials selection and design problems

The faculty have adopted a variety of strategies for helping students meet these outcomes and will use several techniques to assess your progress towards satisfactory demonstration of achievement. These strategies use both formal classroom instruction and extra-curricular activities as mechanisms for achievement.

VIII. Faculty

The Department of Materials Science and Engineering has an active faculty whose interest and expertise cover the broad spectrum of materials science and engineering. These interests and expertise cover all classes of materials (metals, ceramics, polymers, composites, electronic materials, and biomedical materials) and the areas of processing and synthesis, structure, properties and performance. With a low student-to-faculty ratio, the Department encourages one-on-one interactions among students and faculty.

<u>Name</u>	<u>Office No.</u>	<u>Telephone</u> (974- xxxx)	<u>E-Mail Address</u>
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Professor and Head

<i>Kurt E. Sickafus</i>	434 Dougherty	4858	kurt@utk.edu
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Ph.D. Materials Science and Engineering, Cornell 1985; Research Interest: Radiation Effects in Ceramics and Non-metallic Materials, Electron Microscopy, Crystallography, Microstructure of Materials

Professors

<i>Roberto S. Benson</i>	427C Dougherty	5347	rbenson1@utk.edu
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Associate Department Head
Ph.D Physical Chemistry, Florida State 1978; Research Interests: Biomedical Materials, Polymer Processing and Properties.

<i>Gajanan Bhat</i>	205 TANTEC	0976	gghat@utk.edu
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Ph.D. GA. Tech, 1990; Research Interests: Spunbond and Meltblown Nonwovens; High Performance Fibers, Natural Fiber-based Composites, and Plastics Recycling.

<i>Takeshi Egami</i>	206 S. College	7204	egami@utk.edu
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(MSE/ORNL Distinguished Scientist)
Ph.D., Pennsylvania 1971; Research Interests: Atomic Structure of Electronic Oxides including Superconducting, Ferroelectric, Catalytic, and Magnetic Oxides. Modeling of Structure. Neutron Scattering, Synchrotron X-ray Scattering.

<i>Easo George</i>	426 Dougherty	9331	egeorge@utk.edu
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(MSE/ORNL Joint Faculty Member)
Ph.D., Pennsylvania, 1985; Research Interest: Mechanical Behavior, Physical Metallurgy, Intermetallics, In-situ Composites.

<i>David C. Joy</i>	232 Science & Eng.	3638	djoy@utk.edu
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(Distinguished Scientist; Joint MSE and Biochemistry/Cellular and Molecular Biology)
Ph.D., Oxford (UK); Research Interests: Applications of Electron Diffraction and Microscopy.

<i>Peter K. Liaw</i>	427B Dougherty	6356	pliaw@utk.edu
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(Ivan Racheff Chair of Excellence)
Ph. D. Materials Science and Engineering, Northwestern 1980; Research Interests: Nondestructive Evaluation and Mechanical Properties of Composites, Life Prediction Methodology for High Temperature Materials.

<i>Carl D. Lundin</i>	307 Dougherty	5310	lundin@utk.edu
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Ph. D. Metallurgical Engineering, Rensselaer Polytechnic Institute 1966; Research Interests: Welding and Joining Metallurgy.

David G. Mandrus 326 Dougherty 3609 dmandrus@utk.edu
Ph.D., SUNY-Stony Brook, 1992; Research Interests: Materials Synthesis, Magnetism, Ferroelectricity, Transition Metal Oxides

Carl J. McHargue 514 East Stadium Hall 7680 crl@utk.edu
(Director, Center for Materials Processing)
Ph. D., Metallurgy, Kentucky 1953; Research Interests: Ion Beam Modification of Ceramics, Surface Mechanical Properties, Nanostructures.

Chuck Melcher 301 SERF 0254 cmelcher@utk.edu
Research Professor & Director of Scintillation Materials
Ph.D. Washington University, 1980; Research interests: Synthesis and Characterization of New Scintillation Materials; Crystal Growth; Optical and Gamma-ray Spectroscopy.

T. G. Nieh 422 Dougherty 5328 tnieh@utk.edu
(MSE/ORNL Joint Faculty Member)
Ph.D., Stanford, CA 1980; Research Interests: Superplasticity, Nanomaterials, Composites.

George M. Pharr 425 Dougherty 8202 pharr@utk.edu
(MSE/ORNL Joint Faculty Member)
Ph.D. Materials Science and Engineering, Stanford 1979; Research Interests: Mechanical Behavior of Solids with emphasis on Nanoindentation Techniques, Mechanical Properties of Thin Films and Coatings.

Philip D. Rack 603 Dougherty 5344 prack@utk.edu
Ph.D. Gainesville, Florida, 1977; Research Interests: Electronic and Optoelectronic Materials, Thin Film Processing and Characterization, and Selective Nanoscopic Processing.

Mike Simpson 310 Dougherty 3316 simpsonml1@ornl.gov
(MSE/ORNL Joint Faculty Member)
Ph.D., Tennessee; Research Interests: Electronic Materials, Nanostructured Materials, Nanofabrication, Biomaterials.

William Weber 201 TANDEC 0415 wjweber@utk.edu
(Governor's Chair)
Ph.D., University of Wisconsin-Madison, 1977; Research Interests: Radiation Effects on Materials

Emeritus Professors

Joseph E. Spruiell 424 Dougherty 5327 spruiell@utk.edu
Ph. D., Metallurgical Engineering, Tennessee, 1963; Research Interests: Influence of Processing Parameters and Resin Characteristics on the Structure and Properties of Polymers.

Larry Wadsworth 204 TANDEC 3572 lwadswor@utk.edu
Ph.D., Raleigh, NC, 1978; Research Interests: Nonwoven Materials, Process-Structure-Property Studies in Melt Blowing and Spunbonding and Composites Technologies.

Associate Professors

Hahn Choo 319 Dougherty 3643 hchoo@utk.edu
Ph.D., Illinois Institute of Technology, 1998; Research Interests: “Mechanical and Physical Behavior of Structural Materials; Neutron Diffraction; Amorphous and Nanostructured Alloys.

Gerd Duscher 325 Dougherty. 5319 guscher@utk.edu
Dr. rer. nat. University of Stuttgart Research Areas: Interface Science, Analytical Transmission Electron Microscopy

Yanfei Gao 323B Dougherty 2350 ygao7@utk.edu
Ph.D., Princeton, New Jersey, 2003; Research Interests: Computational Materials Science.

Bin Hu 608 Dougherty 3946 bhu@utk.edu
(MSE/ORNL Joint Faculty Member)
Ph.D., Chinese Academy of Sciences, 1991; Research Interests: NanoScience-Driven Optoelectronic and Spintronic Materials and Devices.

Ramki Kalyanaraman 304 Dougherty 5539 ramki@utk.edu
Ph.D., North Carolina State University, 1998; Research interests: Thin film growth and characterization; Phase Transformation & Self-organization; Energetic beam processing; and Functional nanostructures & nanocomposites

Veerle Keppens 312 Dougherty 3494 vkeppens@utk.edu
Ph.D., Katholieke, Leuven, Belgium 1995; Research Interests: Solid State Physics/Physical Acoustics, Resonant Ultrasound Spectroscopy, Synthesis and Characterization of Novel Materials, Tunneling States in Amorphous Materials.

Kevin Kit 510 Dougherty 7055 kkit@utk.edu
Ph.D., Delaware, 1997; Research Interests: Polymer Blends, Mechanical Behavior of Polymers and Polymer Composites, Polymer Crystallization, Polymer Processing, Electrospinning, Radiation Cured Resins.

Thomas T. Meek 306D Dougherty 0940 tmeek1@utk.edu
Ph. D. Ohio State 1977; Research Interests: Microwave Processing of Materials, Ceramics Processing, Acoustic Processing of Materials.

James R. Morris 323C Dougherty 2484 jmorri29@utk.edu
Ph.D. Cornell University, August 1992; Research Interests: Computational Materials Science

Assistant Professor

Wei He 209 Dougherty 5275 whe5@utk.edu
Ph.D. Univ. Connecticut, 2003; Research Interests: Biomaterials; Surface Modification; Neural Tissue Engineering.

Claudia Rawn 609 Dougherty 5340 rawncj@ornl.gov
(MSE/ORNL Joint Faculty Member)
Ph.D., University of Arizona 1995; Research Interests: Ceramic Processing, In-situ X-Ray and Neutron Diffraction, Crystallography, Thermal Expansion.

Shanfeng Wang

336 Dougherty

7809

swang16@utk.edu

(MSE/ORNL Joint Faculty Member)

Ph.D., University of Akron 2003; Research Interests: Biomaterials and Tissue Engineering, Polymer Physics and Rheology.

IX. Support Staff

The assistance of the department's support staff is important to the educational experience. Our staff members are eager to cooperate and help you when you need assistance or advice. Please call on them.

Name	Office (Dougherty)	Phone (974-xxxx)	Functions
Doug Fielden	106	5297	Technical Supervisor III
Danny Hackworth	106	4218	Design Technician
Frank Holiway	308	5264	Accounting Specialist II
Greg Jones	330	5446	Elec. Microscope Technician
Carla Lawrence	434	5335	Administrative Specialist I
Carolyn Nelson	430C	5338	Business Manager
David Stansberry	430C	0661	Accounting Specialist II
Susan Seymour	434	5336	Administrative Support Assistant III
Larry Smith	106	4218	Technical Specialist III
Steve Stiner	331	6839	Electronics Shop Supervisor
Randy Stooksbury	308	5264	Administrative Support Assistant II

X. General Information

Address: Department of Materials Science and Engineering
434 Dougherty Engineering Building
University of Tennessee - Knoxville
Knoxville, TN 37996-2200

Campus Mail Code: 2200

Main Office Phone: (865) 974-5336

Fax Number: (865) 974-4115

Computer Facilities: 314 Dougherty Engineering Building

XI. Academic Advising

Students are assigned a Departmental Advisor at the beginning of their Sophomore year. These advisors are specially chosen to be faculty that are usually available, have an interest in and are knowledgeable about the undergraduate program and have good rapport with students. All students must meet with these advisors each semester for a formal advising session. You are urged to contact your advisor as often as you need for advice and guidance. Do not wait until you are in trouble to see him or her!!

You will also get considerable informal advising from the newly established undergraduate seminar program, in which all undergraduate students will be enrolled every semester.

The following tools are used during the advising sessions:

- Curriculum Worksheet
- General Education Requirements
- Undergraduate Catalog.

XII. The Undergraduate Program

The program leading to the Bachelor of Science in Materials Science and Engineering provides breadth and depth in the field with treatment of all classes of materials. The mathematics and basic science component provides a firm scientific base for understanding and application of engineering principles to materials systems. Additional engineering topics are covered to broaden the engineering perspective of materials engineers. A general education component provides a basis for understanding the impact of engineering solutions on society and the engineer's responsibilities to society. The general education component also expands your horizons for a rewarding personal life.

The Materials Science and Engineering faculty has established Learning Objectives for each course and will assess your progress toward achieving these objectives using techniques other than test scores. These Learning Objectives have been linked to the Program Educational Objectives and Program Outcomes.

The curriculum requires 128 semester hours of credit. See Appendix B for list of requirements. Students can optionally choose to pursue official concentrations in either Biomaterials or Nanomaterials. See Appendix C for list of requirements.

The Program Educational Objectives of the Materials Science and Engineering Program articulate the need for understanding the economic, safety, environmental and social issues involved in designing components, systems or processes. Additionally, an understanding of the practice of engineering in contemporary and global environs is required. An important objective is also the enrichment of one's personal life. The achievement of these objectives very much relies upon the General Educational Component of the curriculum. The Learning Objectives and description of the Materials Science and Engineering courses are contained in Appendix A.

The University of Tennessee has established a university general education requirement that includes emphases upon building basic skills and developing broadened perspectives. These requirements apply to all undergraduate students and are listed at the front of the undergraduate catalog. Engineering students should consult with their advisor and carefully select General Education Electives to insure that (1) courses meet the general education needs of their program and (2) courses meet the university general education requirements. In addition to the university requirements, MSE students must also take Economics 201.

The requirement for three courses in writing communication may be filled by English 101 and 102 plus Materials Science and Engineering 405 (or other approved writing intensive course). The requirement for one course in communicating orally may be filled with Materials Science and Engineering 489 (or other approved communicating orally course). Graduation in materials science and engineering requires a minimum grade point average of 2.00 for all departmental courses.

XIII. Grades and Scholastic Requirements

Graduation in Materials Science and Engineering requires a minimum grade point average of 2.00 for all departmental courses.

A Lower Division student applies for Upper Division status after completing 50 semester hours of Lower Division engineering curriculum course work with an overall GPA of at least 2.4. This must include MSE 201. Lower Division courses generally carry 100 and 200 designations.

Students who have completed 50 semester hours of Lower Division engineering curriculum course work with an overall GPA between 2.0 and 2.4 may be admitted to the upper Division on a Provisional Status. Provisional students are required to demonstrate their ability to perform satisfactorily in upper division courses by attaining a minimum GPA of 2.0 in at least 8 hours of 300-level required courses in the department.

Transfer students are admitted to the Upper Division on a Provisional Status only.

The University requirements for grades and scholastic achievement are given in the Undergraduate Catalog.

The University requires that you register for a minimum of 12 semester hours in order to be classified as a full-time student. The maximum number of hours allowed by the College of Engineering without special permission is 19. The Associate Dean of Engineering must give permission to take 20 hours or more.

XIV. Ethics and Standards of Conduct

(See Honors Statement, Page 11-13)

The University of Tennessee-Knoxville is committed to maintaining an atmosphere of intellectual integrity and academic honesty. All students are expected to abide by the Standards of Conduct and Academic Honesty statements contained in the student handbook **Hilltopics**. All students are expected to abide by The University of Tennessee Honor Statement which reads: **“As a student of the University, I pledge that I will neither**

knowingly give nor receive any inappropriate assistance in academic work, thus affirming my personal commitment to honor and integrity”.

Faculty likewise are expected to treat all students with respect and to practice honorable and ethical dealings with each individual.

Engineers have special ethical and professional responsibilities in the practice of engineering. Our actions often have significant impact on the environment, safety, and economics of the society in which we live and work. These responsibilities will be emphasized in many of the courses.

The Code of Ethics adopted by the National Society of Professional Engineers is reproduced on the inside back cover of this Handbook. Please use it as a guide in your professional activities.

XV. Professional Societies

The Materials Science and Engineering Department supports an active Materials Advantage Chapter. Materials Advantage is a single, low-cost membership that provides access to the American Ceramic Society (ACerS), **ASM International (the Materials Information Society), The Minerals, Metals, and Materials Society (TMS), and the Association for Iron & Steel Technology (AIST)**. Activities of the UT Materials Advantage Chapter include travel to professional conferences including the fall Materials Science and Technology Conference and Show and Congressional Visit Days and the TMS Annual Meeting in the spring. The Chapter also participates in the Oak Ridge Chapter of ASM’s summer Materials Camp for high school students and the College of Engineering’s Engineers Day in the fall hosting an egg drop competition and laboratory tours and presenting a demonstration related to Materials Science and Engineering.

XVI. Scholarships and Awards

College Scholarships: The College of Engineering offers a scholarship to outstanding students enrolled in the College of Engineering. Interested students should apply through the academic dean, Dr. Luther Wilhelm, 101 Perkins Hall.

MSE Departmental Scholarships: The Materials Science and Engineering Department has a number of scholarships which it makes available to students enrolled in the Materials Science and Engineering undergraduate program. Interested students may obtain application materials from the departmental office or by writing to the Department Head.

Appendix A MSE Course Descriptions

101 Advances in Materials Science and Engineering (1)

Catalog Description: Review modern advances in Materials Science and Engineering. Expose students to a variety of materials science and engineering case studies to demonstrate the societal impact of materials science and engineering profession. Satisfactory/No Credit grading only.

MSE 201 Introduction to Materials Science and Engineering (3)

Learning Objectives: This course develops an introductory understanding of the atomic structure, crystalline structure and microstructure of solids. The student will learn the terminology and fundamental principles of materials structure and their related properties. The course introduces the student to mechanical, physical, and chemical properties which are of engineering significance. The course directly supports overall MSE program education outcomes 1, 2, 3, 4, and 7.

Catalog Description: Correlation of atomic structure, crystal structure and microstructure of solids with mechanical, physical and chemical properties of engineering significance.

Prereq: Chemistry 120. E.

Topics: Chemical Bonding; Structure of Crystalline Solids; Imperfections in Solids Diffusion; Mechanical Properties of Metals; Dislocations and Strengthening Mechanisms; Failure of Materials; Phase Diagrams; Phase Transformations in Metals; Thermal Processing; Structure and Properties of Ceramics; Applications and Processing of Ceramics; Polymer Structures; Applications and Processing of Polymers; Composites

Laboratory Projects: Mechanical Properties of Metals; Cold Working and Annealing Correlation of Microstructure with Phase Diagram; Heat Treatment of Steels; Mechanical Behavior of Polymers

MSE 210 Introduction to Materials Science and Engineering Laboratory (1)

Catalog Description: Laboratory assignments demonstrating introductory concepts in materials science and engineering; heat treating, mechanical testing, microscopy.

Corequisite: 201.

250 Introduction to Materials Kinetics and Transport Phenomena (3)

Learning Objective: This course develops an understanding of kinetics and transport subjects important to materials processing. This course supports MSE program outcomes 1 and 7.

Catalog Description: Mass and energy balances; reaction kinetics; steady state and transient heat transfer; viscous flow of gases and liquids; applications to synthesis and processing of engineering materials and technologies; analytical and numerical problem solving. 3 hours lecture, 1 hour lab. Prereq: Mathematics 142; Coreq: MSE 201, Mathematics 231.

260 Materials Engineering Thermodynamics (3)

Learning Objectives: The fundamental laws of thermodynamics are developed and applied to materials systems. Learning objectives are to prepare the student to 1) carry out simple thermochemical and thermodynamic calculations, 2) understand the physical significance of thermodynamic quantities such as internal energy, entropy, enthalpy, and free energy, and 3) understand the concept of thermodynamic equilibrium and the application to phase behavior, phase diagrams, and chemical reactions. The course directly supports overall MSE program education outcomes 1, 2, 6, and 7.

Catalog Description: Thermodynamic laws; entropy, internal energy, state functions; one- component and two- component phase equilibria; characteristics of small and large molecular systems; surface energy; elasticity; material defects. Prereq: Engineering Fundamentals 152, Chemistry 130, Mathematics 142. Coreq: 201

MSE 290 Professional Development (1)

Learning Objectives: This class provides sophomore Materials Science and Engineering students with information and considerations that are not covered formally in other undergraduate courses. The students are prepared for seeking employment, acquainted with industrial environments, and informed of the responsibilities of materials scientists and engineers. The course contributes to the fulfillment of MSE program educational outcomes 4, 7, 9, and 10.

Catalog Description: Professional and ethical considerations, safety, patents, products liability, field trips. Satisfactory/No Credit grading only.

Topics: Patents and Patent Law; Copyright Law; Ethics and the Responsible Engineer; Safety in the Laboratory;

Safety in the Work Place; Product Liability; Job Placement; Careers in Materials; Library Utilization; MSE Curriculum & Elective Options; Plant Trips; Term Paper: Topics of current interest to the materials community and of interest to the student.

MSE 300 Materials Laboratory Procedures (1)

Learning Objectives: The learning objectives of this course are to: (1) gain hands-on experience in conducting laboratory experiments involving fundamental principles in materials science and engineering, (2) understand the design of an experiment relative to the measuring and performance capabilities of a piece of equipment, (3) gain experience in analysis of data and writing reports in the accepted scientific format, and (4) take responsibility for a project and learn how to make an effective oral report on the project. The content directly supports MSE program education outcomes 2, 3, 4, 5, and 7.

Catalog Description: Hands-on sample preparation, characterization, and data analysis for introductory studies of crystal structures, microstructures, physical properties, and mechanical properties; Report writing skills including word processing and graphics usage; Oral presentation skills. Prereq: 201

Topics: Report writing and presentation methods; Crystal Structure and X-Ray Diffraction; Microstructure and Optical Microscopy; Quantitative Analysis of Microstructure; Thermophysical Properties; Characterization and Hardness Measurements; Impact Test and Scanning Electron Microscopy; Data Analysis; Oral Presentations

Computer Usage: Word Processing, PowerPoint Presentation, Spread Sheets, and Graphics

MSE 302 Mechanical Behavior of Materials I (3)

Learning Objectives: This course covers the basic principles needed to understand deformation and fracture in solid materials including metals, ceramics, polymers and composites. Both materials and mechanics approaches are developed. The course directly supports overall MSE program education outcomes 1, 2, 6, and 7.

Catalog Description: Tensile testing of metals, ceramics and polymers; deformation mechanisms in the various materials, including crystalline and non-crystalline forms; rubber elasticity, viscoelastic behavior, creep, time-temperature superposition in polymers; fatigue. Prereq: 201, or consent of instructor.

Topics: Stress and strain as tensor quantities; isotropic and anisotropic elasticity; anelastic and viscoelastic deformation; plasticity; tensile testing; mechanisms of plastic deformation in crystalline solids; basic strengthening mechanisms; elementary fracture mechanics.

Computer Usage: Word processing, graphics, curve fitting, equation solving, spread sheet analysis.

MSE 304 Principles of Materials Laboratory (1)

Learning Objectives: The learning objectives of this course are to: (1) reinforce the students' classroom studies by having them conduct laboratory experiments involving fundamental principles in materials science and engineering, (2) improve the students' teamwork and communication skills by having them work in groups and submit formal laboratory reports, and (3) introduce the students to statistical analyses of experimental data. The course directly supports overall MSE program educational outcomes 1, 2, 4, 5, 6 and 7.

Catalog Description: Laboratory assignments demonstrating fundamental principles of materials science and engineering. Prerequisite(s): 300, 320, 340, 360.

Laboratory Experiments (typically 5~6 experiments are selected from the list):

Segregation and Homogenization of Brass; Phase Diagram Determination by Thermal and Microstructural Analyses; Creep of Engineering Materials; Mechanical Properties of a Metal Matrix Composite; Fatigue Test and Thermography; Thermal Expansion Coefficients of Engineering Materials; Electrical Resistivities of Engineering Materials; Polymer Synthesis and Characterization; Dilute Solution Viscosity; Film Casting of Polypropylene; Dynamic Mechanical Properties of Polypropylene Film; Fourier Transform Infrared Spectroscopy; Slip Casting of Ceramics; Synthesis and Characterization of Amorphous Alloy Powders

Computer Usage: Spreadsheets, graphics, word processing required.

MSE 320 Diffusion and Phase Transformations (4)

Learning Objectives: The course is designed to provide both a qualitative and quantitative analysis of the kinetics of diffusion-controlled solid state phenomena and processes. It also develops the theory of phase transformations. It provides the basic background for analysis of commercial heat treatment, emphasizing the relationship between microstructure and mechanical properties. Microstructural techniques are used in the laboratory for the study of phase transformations. The course directly supports MSE program educational outcomes 1, 2, and 6.

Catalog Description: Introduction to diffusion in solids; the diffusion equations, point defects and atomic mechanisms of diffusion. Thermodynamics of phase equilibrium. Introduction to the kinetics and morphology of phase transformations. Prereq: 201 and 260.

Topics: The diffusion equations; Solution of Fick's equation for one-dimensional diffusion problem; Substitutional diffusion - Kirkendall effect, driving force for diffusion; Thermodynamic concepts; Atomic mechanisms of diffusion - metals and ceramics; Thermodynamics of interfaces - surface tension and surface free energy; Structure of interfaces; Thermodynamics of phase equilibrium; Nucleation; Solidification; Thermally-activated growth in metals and ceramics; Martensitic transformations.

Computer usage: Spreadsheets, graphics, programming and work processing.

MSE 340 Principles of Polymeric Materials (3)

Learning Objectives: This course provides an introduction to the field of polymer science and engineering. The unique macromolecular nature of polymers and the diversity of molecular structures are presented. The mechanisms and methods by which these structures are synthesized, the polymerization kinetics, and the statistical nature of the polymeric products are developed by drawing on the student's background in chemistry and mathematics. The properties of these materials in solution and the solid state including phase equilibria, molecular conformations, crystalline order, and mechanical and thermal properties are explained on the basis of their molecular structure and in conjunction with techniques to measure these properties. Aspects of polymer rheology and various processes which render these materials in desired and practical forms are presented. The course contributes to the fulfillment of MSE program educational outcomes 1, 2, 3, and 7.

Catalog Description: Synthesis and molecular structure of polymers; polymerization kinetics; molecular characterization; crystalline and glass transitions; crystallization kinetics, mechanical properties; rheology and processing. Prereq: MSE 201. F.

Topics: Introduction: Definitions, Classifications of Polymers, Molecular Structure; Synthesis: Mechanisms, Kinetics, Techniques; Solution Properties: Solution Thermodynamics, Phase Equilibria, Measurement of Molecular Weight, Polymer Characterization; Solid State Properties: Crystalline Order, Crystalline and Glass Transitions, Crystallization Kinetics, Mechanical Properties; Viscoelasticity: Linear Viscoelasticity, Time-Temperature Superposition; Rubber Elasticity: Statistical Theory; Polymer Processing: Process Operations, Rheology, Rheometry; Network Polymers

MSE 350 Principles of Electronic, Optical, and Magnetic Materials (3)

Learning Objective: This course provides the foundation for understanding modern devices. This course supports MSE program outcomes 1, 4, 5, 6, 7 and 10.

Catalog Description: Fundamental electronic, optical, and magnetic properties of solid state materials. Basic

bonding and crystallography correlations to electronic, optical, and magnetic properties of materials. Specific subjects that will be covered include: wave properties of electrons, Schrodinger's equation, energy bands in crystals, electrical conduction in metals and semiconductors, classical and quantum mechanical treatments of optical properties, and magnetic phenomena. Prereq: 201.

MSE 360 Principles of Ceramic Materials (3)

Learning Objectives: This course develops a knowledge of the atomic crystal structure of ceramic materials and glasses. Understanding the idea atomic structures allows defect structures and phase equilibria of binary and ternary ceramic systems to be introduced. In addition to the atomic structure and its relation to properties the link between processing and microstructure and the resulting properties is introduced. The course directly supports Educational Outcomes 1, 2 and 3 only.

Catalog Description: Description of the atomic structure of ceramic materials and glasses. Description of defects in ceramic materials and correlations to physical properties. Features and operations of ternary phase diagrams of ceramic systems. Prerequisite:: 201.

Topics: Basics of atomic crystal structures of ceramics and glasses. Crystal structure of important ceramic materials and the correlation to physical properties. Defect structures and the use of Kröger-Vink notation to describe defect chemical reactions. Features and operations of ternary phase diagrams of ceramic systems. Relating processing parameters to resulting microstructures.

MSE 370 Materials Processing (3)

Learning Objectives: This course demonstrates the application of basic science principles to the processing of all classes of materials and their conversion to useful products. Production of bulk materials, fibers, films and coatings by processes such as casting, molding, extrusion, forging, powder techniques, and various coating procedures will be treated. This course directly supports MSE Educational Outcomes 1 and 2.

Catalog Description: Application of fundamentals of mass and energy balances, mechanics, heat transfer, chemical thermodynamics and kinetics to the processing of materials and manufacturing of products. A wide range of materials (metals, ceramics, polymers), geometries (bulk, fibers, films, coatings) and processes (casting, molding, extrusion, forging, powder processing, coating techniques, etc.) are studied as examples of processing technologies. Elementary ideas of process measurement and control. Prereq. 201, 320, ChE 200 and ChE 240, or equivalent.

390 Principles of Metallic Materials (3)

Learning Objectives: This course develops an understanding of the relationships among processing, structure, properties and performance of metallic alloys. This course supports MSE program outcomes 1, 2 and 3.

Catalog Description: Property control through composition, mechanical and thermal processing; ferrous and nonferrous alloys; alloy selection. Prereq: 201.

MSE 405 Structural Characterization of Materials (4)

Learning Objectives: This course develops the fundamental understanding of the interaction of x-rays and electrons with matter and imparts an ability to apply this understanding to characterize crystal structure, microstructure and chemistry of engineering materials. The course introduces the student to diffraction techniques and to modern microanalytical techniques. The student will learn the terminology and fundamental principles of crystallography, powder techniques for determining crystal structure and phase analysis, techniques for measuring preferred orientation and crystallite size, and chemical analysis by x-ray fluorescence; and will be introduced to microstructural examination by scanning and transmission electron microscopy and to other microanalytical techniques. The course directly supports MSE program educational outcomes 1, 2, 3, 4, 5, 6, 7, 8, 9 and 10.

Catalog Description: 405 Structural Characterization of Materials (4) X-ray diffraction, X-ray fluorescence analysis, scanning and transmission electron microscopy, microanalytical techniques. Satisfies General Education Requirement: (WC), Prerequisite: Physics 232, Registration Permission: Consent of instructor.

Topics: The nature of X-Rays and their Interaction with matter; Geometry and Symmetry of Crystals; Bragg's Law and the directions of Diffracted Beams; The reciprocal Lattice; Diffraction Techniques with emphasis on Powder Techniques; Film Diffractometer and Spectrometer Techniques; Intensities of Diffracted Beams; Crystal Structure Analysis; Precision Lattice Parameter Measurements; Phase Identification and Chemical Analysis by Diffraction X-ray Fluorescence Analysis; Scanning Electron Microscopy and Microanalytical Techniques; TEM and Electron Diffraction Techniques

Computer Usage: Spreadsheets, Graphics, Word Processing required. Programming used by some

Laboratory experiences: Measurement of continuous and characteristic spectra emitted from an x-ray tube; Measurement of the mass absorption coefficient of a material, e.g. aluminum; Analysis of powder diffraction patterns-indexing, phase mixtures, lattice parameter variation for solid solutions; Verification of simple crystal structure (such as Cu_2O , CaF_2 , MgO , etc.) by comparing experimental and computed diffraction intensities, computation of best value of lattice parameter; Phase identification from powder diffraction pattern and JCPDS X-Ray Powder Data File; Measurement of preferred orientation in polymers; Use of scanning electron microscopy and microanalysis by x-ray spectroscopy to characterize materials

MSE 408 Functional Nanoscale Materials: Processing, Properties, and Applications (3)

Catalog Description: Principles of nanoscale materials processing by nucleation, self-assembly, thin film and bulk techniques, and lithography. Fundamentals of size-dependent mechanical, electronic and optical properties and their characterization. Applications of nanoscale materials to energy harvesting, information processing and structural materials. Prerequisite: 201.

MSE 410 Theory and Processing of Electronic Materials

Learning Objectives: This course is an introduction to the physical properties and material processing of semiconductor devices. The first part of the course introduces the student to the basic properties of semiconductors and their transport properties. In the second part the acquired concepts are applied to the understanding of the physics and characteristics of semiconductor devices. A detail analysis and discussion are made of p-n junctions, which are the building blocks of most semiconductor devices. The bipolar and unipolar devices are covered next. Crystal growth, oxidation and film deposition, and diffusion and ion implantation are materials processing issues addressed during the development of the course. The course directly supports overall MSE program education outcomes 1, 2, 3, and 7.

Catalog Description: Conventional and nano-scale device structure and processing; p-n junctions, semiconductor diode solid state amplifiers; semiconductor crystal growth, epitaxial growth, doping, ion implantation, diffusion, and lithography. Prerequisite: Physics 232. Registration Restriction(s): Minimum student level – junior.

Topics: Energy Bands and Carrier Concentration; Transport Phenomena; p-n Junction; Bipolar Devices-Transistors; Unipolar Devices; Metal Semiconductor Contacts; The Junction Field-Effect Transistor (JFET); The Metal-Semiconductor Field-Effect Transistor (MESFET); The Metal-Oxide-Semiconductor Device (MOS); The Metal-Oxide-Semiconductor Field-Effect Transistor (MOSFET); Crystal Growth; Doping of Semiconductors; Diffusion and Ion Implantation; Oxidation of Semiconductors; Deposition of Insulating Films

Computer Usage: Spreadsheets, Graphics and Word Processing required.

MSE 421 Mechanical Behavior of Materials II (3)

Learning Objectives: The learning objective of this course is to gain fundamental understanding of the topics related to the mechanical behavior of structural materials including the dislocation theory, plastic deformation at ambient and elevated-temperatures, strengthening mechanisms, and fatigue. This course supports overall MSE program educational outcomes 1, 2, 3, and 6.

Catalog Description: Dislocation theory, deformation by slip, twinning, strengthening mechanisms, fatigue, and time-dependent behavior. Prereq: 302 or consent of instructor.

Topics: Dislocation Theory; Plastic Deformation by Slip; Twinning; Strengthening Mechanisms; Elevated-Temperature Deformation Behavior; Fatigue; Deformation of Non-crystalline Materials.

Computer Usage: Spreadsheets and word processing required.

MSE 425 Welding Metallurgy (3)

Catalog Description: Welding processes; physical metallurgy of welding; phase transformations; heat flow; residual stresses; theories of hot cracking, cold cracking and porosity formation; applications to process utilization. *Registration Permission: Consent of instructor.*

MSE 432 Defects in Crystals

Learning Objective: This course develops an understanding of the characteristics of defects (point defects, dislocations, and surfaces) in non-metallic, crystalline materials and their effects on physical and mechanical properties. This course supports MSE program outcomes 1, 2 and 3.

Catalog Description: Analytical and experimental analysis of defect interactions in solids. *Registration Permission: Consent of instructor.*

MSE 440 Polymer Engineering (3)

Catalog Description: Non-Newtonian rheology, shear thinning fluids, rheometry, melt processing operations, molecular orientation, linear viscoelasticity, dynamic mechanical behavior, yield, fracture, mechanical properties of polymeric composites. Prerequisite: 340.

MSE 445 Polymer Engineering Processing and Characterization Laboratory (3)

Learning Objectives: The objectives of this course are to provide a fundamental understanding of polymer processing. This is a survey course in polymer processing with description of the physical, thermal, mechanical, and Theological properties of polymeric materials relevant to their processing behavior. Review of the basic transport phenomena equations: mass, momentum, and energy. Analysis of various processing operations for the manufacture of polymeric articles, with particular emphasis on: extrusion, injection molding, blow molding, thermoforming, fiber spinning, and compression molding. Discussion of plastics recycling issues. This course contributes to MSE program education outcomes 1, 2, 3, 4, 7 and 10.

Catalog Description: This is a project-based polymer processing laboratory course. Groups of students will work on specific projects that involve polymer processing and characterization. Each semester-long project includes processing of polymer samples, characterization of mechanical and physical properties of the products, variation of processing parameters to determine effect on properties, and generation of oral and written reports.

Topics: Structure of plastics; Properties of plastic Flow of viscous fluids; Non-Newtonian fluid;s Energy Equation; Extrusion (melting conveying); Extrusion (melting); Mixing; Die design; Injection molding; Compression molding; Processing of Reactive Polymers; Thermoforming and blow molding; Recycling

Computer Usage: Homework assignments dealing with extruder design, die design and material property characterization. Material properties will be obtained from databases and World Wide Web with analysis being done with the desktop software, MATLAB

Laboratory Projects: Capillary Viscometer Experiment (single screw extruder, capillary die and pressure transducer); Extrusion Experiment (single screw extruder and variable thickness sheeting die); Mixing Experiment (single screw extruder with transparent barrel)

MSE 455 Materials for Energy (3)

Catalog Description: Underlying physics and operating principles of functional materials used in energy applications such as photovoltaic and photocatalysts, fuel cells, batteries, thermoelectrics, and superconductors. (RE) Prerequisite(s): 350 or consent of instructor.

MSE 466 Magnetism and Magnetic Materials (3)

Catalog Description: Review of the atomic origin of magnetic moments and how these moments can be affected by their local environment. Properties, basic theory, and applications of para-, dia-, ferro-, ferri- and antiferromagnets. Novel magnetic phenomena and magnetic materials in modern technological applications. Prerequisite: 350.

MSE 470 Environmental Degradation of Materials (3)

Learning Objectives: The learning objectives of this course are to (1) develop an understanding of the fundamentals associated with corrosion processes, and (2) relate this knowledge to current corrosion-measurement techniques and engineering design principles for corrosion control. The course directly supports overall MSE program educational outcomes 1, 2, 3, 4, 5, 7 and 8.

Catalog Description: 470 Environmental Degradation of Materials (3) Mechanisms, measurement techniques and control of environmental degradation processes in metals, polymers, ceramics and composites; materials selection and design considerations. Prereq: 201. Recommended for chemical engineering, mechanical engineering, civil engineering and engineering science and mechanics majors

Topics: Introduction and overview of aqueous corrosion; Electrochemical thermodynamics, including Pourbaix diagrams; Kinetics of single half-cell reactions; Kinetics of coupled half-cell reactions; Corrosion of active-passive type metals and alloys; Electrochemical corrosion-rate measurements; Localized corrosion, stress-corrosion cracking and corrosion fatigue; Degradation of polymers; Degradation of ceramics; Student team-design projects with oral presentations and written reports

Computer Usage: Programming used by some students.

MSE 474 Biomaterials

Learning Objectives: This course develops the understanding of the interaction between materials and human biological environment. The course introduces students to the principles of materials science and engineering involved in the selection, design, and assurance of long and short-term function of materials for medical applications. The students will learn the fundamental principles involved in the interaction of biomedical materials (metals, polymers and ceramics) with cells, tissue and blood. Students will be introduced to the requirements for implantable materials. A discussion on soft tissue (cardiovascular, ophthalmic, and wound closure) and hard tissue (orthopedic and dental) medical implant devices will be presented. Students will conduct a meaningful design project utilizing the acquired knowledge. This course directly supports overall MSE program educational outcomes 1, 2, 3, 4, 5, 8, 9, and 10.

Catalog Description: 474 Biomaterials (3) Metals, polymers and ceramics utilized in orthopedic, cardiovascular, and dental surgical implant devices; corrosion and degradation problems; materials properties of primary importance; tissue response to synthetic materials. Prereq: 201. Recommended for engineering science and mechanics majors.

Topics: Tissue Response to Implants: Wound-Healing Process, Complement Activation; Blood Compatibility. (2);

Metallic Implant Materials: Stainless Steels, Co-Base Alloys, Ti and Ti-Base Alloys, other Metals, Mechanical Properties, Microstructures, Corrosion Fundamentals, Corrosion of Metallic Implant Materials. (8); Ceramic Implants. (2); Hard Tissue Replacement Implants: Fracture Fixation Devices, Joint Replacements, Dental Implants, Design and Function. (5); Polymeric Implant Materials: Polymerization, Structure and Properties, Biodegradation of Polymers. (7); Wound Closure: Sutures and Adhesives. (2); Soft Tissue Replacement Implants: Synthetic Skin; Maxillofacial, Ear and Eye Implants. (3); Vascular and Heart implants. (3); Artificial Kidney. (2); Blood Oxygenators (2)

MSE 476 Overview of Intermetallic Compounds and Composites (3)

Catalog Description: Fabrication and processing, ultrafine-grained materials nanotechnology, thermodynamics and stability, microstructural characterizations, mechanical properties, corrosion and oxidation properties, theoretical modeling, and design and industrial applications of intermetallics and composites. Laboratory demonstrations and group projects. Prereq: 201.

MSE 480 Materials Selection In Design (3)

Learning Objectives: The role of materials in design has been receiving specialized attention in recent years. The state of development of the subject is such that the organization of the tools to deal with this very broad and important problematic area now permits a somewhat systematized approach to the subject. The availability of usable computer data bases in association with material property maps and material design indices, provide a viable approach to materials design that is available now and will develop further with time. The current course provides instruction in a system of material selection mostly independent of the need to have extensive knowledge of the microstructural details of a material. The associated data base utilized includes the properties of polymers, light alloys, copper alloys, metal matrix composites, conductors, foams, and ferrous metals. In addition, supporting software is called to the students attention. This course supports program educational outcomes: 1, 2, 3, 4, 5, 7, and 8.

Catalog Description: Systematic materials selection in design. Review of material properties; use of property selection charts and indices. Materials selection, with and without shape constraints; materials processing in design; case studies. Sources of material property data, utilization of material data bases Industrial design, aesthetics, economics, regulations, forces for change.

Prerequisites: Junior standing

Topics: The design process, types of design; Engineering Materials and their properties; Review of relevant properties (Engineering Mechanics and failure modes); Materials selection charts, classes; Material selection without shape, performance indices; Case studies; Selection of material and shape and case studies; Materials processing and design process attributes and case studies; Sources of material property data; Use of material data sources; Materials, Aesthetics and Industrial Design; Forces of Change; Class design project employing concepts and Data Bases; Presentations.

Computer Data Base: Cambridge Materials Selector Version, for Windows™ Operating system, is the Data Base associated with the text.

Software: Internet Packages, ASM DATA Bases

484 Introduction to Maintainability Engineering (3)

Catalog Description: Principles of maintenance and reliability engineering and maintenance management. Topics include information extraction from machinery measurements, rotating machinery diagnostics, nondestructive testing, life prediction, failure models, lubrication oil analysis, establishing a predictive maintenance program, and computerized maintenance management systems. Registration Restriction(s): Minimum student level — senior. *(Same as Nuclear Engineering 484)*

MSE 485 Advanced Biomaterials: Biological Application of Nanomaterials (3)

Catalog Description: 0-d, 1-d and 2-d nanomaterials synthesis and characterization with emphasis of surface properties. Chemical and biological functionalization of nanomaterials and nano-bio interfaces. Biological and biomedical application of nanomaterials. Prerequisite: 474.

MSE 486 Cell and Tissue-Biomaterials Interaction (3)

Catalog Description: Study of the fundamental principles involved in materials/cell and tissue interactions. Students will learn the underlying cellular and molecular mechanisms in host response to biomaterials. Emphasis will be placed on the integration of biomaterials/neuronal cell and tissue interactions into the design of neural implants (sensors, scaffolds, and therapeutics delivery modalities, etc.). Prerequisite(s): 474 or Biomedical Engineering 409.

MSE 489 Materials Design (3)

Learning Objectives: This course is considered the capstone experience in the undergraduate program where the student brings together their fundamentals and laboratory practice skills to solve a major design or failure analysis problem. Students undertake a semester-long project under the tutelage of a professor or post doctoral

researcher and prepare a technical report and make a presentation of the results. The course directly supports the MSE program education outcomes 1, 2, 3, 4, 5, 6, 7, and 8.

Catalog Description: Design projects involving materials selection and performance. Satisfies General Education Requirement: (OC). Registration Restriction: Materials Science and Engineering majors and senior standing.

Topics: Report Writing and Presentation Methods; In-Depth Projects Involving Material Design and Failure Analyses.

Computer Usage: Word Processing, Spread Sheets and Graphics.

MSE 494 Special Project Laboratory (3)

Learning Objectives: This elective course allows undergraduates the opportunity to tackle a special project either individually or in a group environment. This course contributes to MSE program educational outcomes 3, 4, 5, 7, 8, and 10.

Catalog Data: 494 Special Project Laboratory (1-3) Group or individual investigation of problems related to materials science and engineering. May be repeated to a maximum of 6 credits. Repeatability: May be repeated. Maximum 6 hours. Prerequisite(s): 201.

Goals: This course provides flexibility for students to pursue special projects of a research or development nature. Students may work independently or as a team to solve either short-range or long-range problems requiring significant investigation and analysis.

Topics: Projects provided by professors.

MSE 495 Thesis (3)

Learning Objectives: This elective course allows students the opportunity to carry out and do their own research. This course contributes to MSE program educational outcomes 3, 4, 7, 8, and 10.

Catalog Data: 495 Thesis (3) Investigation and report on a research problem in materials science and engineering. By prior approval of a professor. May be repeated once. Prereq. Senior standing or consent of professor.

Goals: This course provides opportunities for students to do independent research projects under the direct supervision of a professor.

Topics: Available research projects.

APPENDIX B

Bachelor of Science

Semester 1

English 101; Composition	(3)
Chemistry 120; General Chemistry	(4)
Mathematics 141; Calculus I	(4)
EF 151; Engineering Approaches	(4)
EF 105; EF Laboratory	(1)

Semester 3

MSE 201; Intro. MSE	(3)
MSE 210; Intro. Lab	(1)
MSE 210; Intro. Lab	(1)
Mathematics 241; Calculus III	(4)
Physics 231; Elect. & Mag.	(3)
MSE 260; Materials Thermo	(3)
General Education Elective	(3)

Semester 5

MSE 300; Materials Laboratory	(1)
MSE 320; Diffusion & Phase Trans.	(3)
MSE 340 Prin. Of Polymeric Mat.	(3)
MSE 360; Principles of Ceramics	(3)
Stat 251; Statistics	(3)
General Education Elective	(3)

Semester 7

MSE 405; Structural Charact. ³	(3)
MSE 480; Mat. Selection in Design	(3)
MSE 4XX ⁵	(3)
EE 301; Circuits	(3)
General Education Elective	(3)

Semester 2

English 102; Composition	(3)
Mathematics 142; Calculus II	(4)
EF 152; Fund. Of Engr. Mechanics	(4)
Chemistry 130; General Chem. II	(4)
MSE 101; Advances in MSE	(1)

Semester 4

MSE 290; Materials Seminar	(1)
Mathematics 200; Matrix Comp.	(1)
Mathematics 231; Diff. Equations	(3)
Physics 232; Waves, Opt., Modern	(4)
MSE 250; Kinetics and Transport	(3)
General Education Elective	(3)

Semester 6

MSE 302; Mechanical Behavior	(3)
MSE 304; Prin. Materials Lab.	(1)
MSE 350; Prin. Elec. & Opt. Mat.	(3)
MSE 370; Materials Processing	(3)
MSE 390 Prin. Of Metallic Mat.	(3)
Technical Elective ^{1,2}	(3)

Semester 8

MSE 402; Fund. of Engineering	(1)
MSE 489; Mat. Design ⁶	(3)
MSE 4XX ⁵	(3)
Technical Elective ^{2,3}	(3)
General Education Elective	(3)
General Education Elective	(3)

1. Chemistry 350, Organic Chemistry, is recommended for students interested in polymeric materials.
2. ME 321 is strongly recommended to help prepare students for the FE exam.
3. Approved "writing intensive" (WC) course for General Education requirement.
4. Approved "oral communication" (OC) course for General Education requirement.
5. MSE 4XX Elective is chosen from the following:

410 Electronic Devices	445 Polym. Eng. Laboratory	485 Advanced Biomaterials
421 Mech. Behavior II	455 Materials for Energy	486 Cell and Tissue-Biomaterials
425 Welding Metallurgy	466 Magnetism & Magnetic Materials	494 Special Project Lab
432 Defects in Crystals	474 Biomaterials	495 Thesis
440 Polymer Engineering	476 Intermetallics & Composites	
	484 Intro. Maintenance Eng.	

APPENDIX C Concentrations

Biomaterials Concentration

An exciting option for MSE students is the Biomaterials Concentration within the Materials Science and Engineering (MSE) curriculum. MSE majors will be able to earn this concentration by proper selection of elective courses and without earning additional credits beyond the 128 required of most engineering disciplines. Biomaterials aid in the treatment of disease or injury by interfacing with biological systems in the human body. Knee replacements, cochlear implants, and arterial stents are common applications that rely on advanced biomaterials for their satisfactory performance.

Requirements

In addition to satisfying the requirements for the Materials Science and Engineering BS degree, candidates for the biomaterials concentration must also complete the following requirements:

Required¹

- MSE 474: Biomaterials (3)

One of the following¹

- MSE 485: Advanced Biomaterials – Biological Applications of Nanomaterials (3)
- MSE 486: Cell and Tissue-Biomaterials Interaction (3)

One of the following²

- Biology 140: Organization and Function of the Cell (4)
- Biochemistry and Cellular and Molecular Biology 230: Human Physiology (5)

One of the following

- MSE 485: Advanced Biomaterials – Biological Applications of Nanomaterials (3)^{1,3}
- MSE 486: Cell and Tissue-Biomaterials Interaction (3)^{1,3}
- Biosystems Engineering 231: Biochemistry for Engineers (3)²
- Biomedical Engineering 409: Cell and Tissue Engineering (3)²
- Chemical and Biomolecular Engineering 475: Applied Microbiology and Bioengineering (3)²

¹These courses will simultaneously satisfy the MSE senior level elective requirements of the MSE BS degree.

²These courses will simultaneously satisfy the technical elective requirements of the MSE BS degree.

³given that 485 or 486 is not used to satisfy the 2nd requirement

Nanomaterials Concentration

A recent, exciting addition to our program is the development of a Nanomaterials Concentration within the Materials Science and Engineering (MSE) curriculum. MSE majors will be able to earn this concentration by proper selection of elective courses and without earning additional credits beyond the 128 required of most engineering disciplines. Nanomaterials are materials that have structure features on the order of 1– 100 nm, and take advantage of the unusual properties that materials exhibit on that scale. Applications of nanomaterials include high speed electronics, catalysts, tissue engineering, environmental remediation, display technology, and advanced structural materials.

Requirements

In addition to satisfying the requirements for the Materials Science and Engineering BS degree, candidates for the biomaterials concentration must also complete the following requirements:

Required¹

- MSE 408 Functional Nanoscale Materials: Processing, Properties and Applications (3)
- MSE 410 Theory and Processing of Conventional and Nano-Structured Devices (3)

Select ***two*** of the following courses²:

- MSE 421 Mechanical Behavior of Materials II (3)
- MSE 466 Magnetism and Magnetic Materials (3)
- MSE 474 Biomaterials (3)
- Physics 411 Introduction to Quantum Mechanics (3)
- Chemistry 473 Physical Chemistry I (3)

¹These courses will simultaneously satisfy the MSE senior level elective requirements of the MSE BS degree.

²These courses will simultaneously satisfy the technical elective requirements of the MSE BS degree.

Five-Year BS-MS Program – Materials Science and Engineering

The department offers a 5-year BS-MS bib-thesis program with a major in materials science and engineering for qualified students. The primary component of the program is a qualified student may take up to 9 hours of approved graduate courses for their senior undergraduate courses and have them count toward both the bachelor's and master's degree. Qualifications for admission to the program are:

- The student must have an earned minimum cumulative GPA of at least 3.40 to be considered for admission to the program.
- The student must have an earned minimum cumulative GPA of at least 3.4 to be considered for admission to the program. Conditional admission may be granted to the student after completing 64 hours of required course work.
- Conditional admission must be obtained before taking a graduate course that is to be used to satisfy the requirements of both the bachelor's and master's degree.
- Full admission may be granted after completing 96 hours of required course work as previously defined and with a minimum cumulative GPA of 3.40 in the required coursework.
- Conditional and full admission of a student into this program must be approved by the Department of Materials Science and Engineering, the College of Engineering, and the Grad School
- Any course taken for graduate credit prior to satisfying all requirements for the bachelor's degree in materials science and engineering must be approved by the department head or designee and the Graduate School.
- A student will not be eligible for a graduate assistantship until the student has satisfied all of the requirements for the bachelor's degree.

HONOR STATEMENT *(From the 2011- 20012 Catalog)*

All facets of the university community have responsibilities associated with the Honor Statement. These responsibilities are unique to each sector of the university community.

Each student is responsible for his/her own personal integrity in academic life. While there is no affirmative duty to report the academic dishonesty of another, each student, given the dictates of his/her own conscience, may choose to act on any violation of the Honor Statement. Each student is responsible for knowing the terms and conditions of the Honor Statement and may acknowledge his/her adherence to the Honor Statement by writing “Pledged” and signing each graded class assignment and examination.

Students are also responsible for any acts of plagiarism. Plagiarism is using the intellectual property of someone else without giving proper credit. The undocumented use of someone else’s words or ideas in any medium of communication (unless such information is recognized as common knowledge) is a serious offense, subject to disciplinary action that may include failure in a course and/or dismissal from the university.

Specific examples of plagiarism are

- Copying without proper documentation (quotation marks and a citation) written or spoken words, phrases, or sentences from any source.
- Summarizing without proper documentation (usually a citation) ideas from another source (unless such information is recognized as common knowledge).
- Borrowing facts, statistics, graphs, pictorial representations, or phrases without acknowledging the source (unless such information is recognized as common knowledge).
- Collaborating on a graded assignment without instructor’s approval.
- Submitting work, either in whole or part, created by a professional service and used without attribution (e.g., paper, speech, bibliography, or photograph).

Faculty members also have responsibilities which are vital to the success of the Honor Statement and the creation of a climate of academic integrity within the university community. Each faculty member is responsible for defining, in specific terms, guidelines for preserving academic integrity in a course. Included in this definition should be a discussion of the Honor Statement. Faculty members at their discretion may also encourage their students to acknowledge adherence to the Honor Statement by “pledging” all graded class assignments and exams. The form of pledge may include writing the honor statement on the assignment, signing the printed statement, or simply writing “Pledged.”

Additionally, it will be the responsibility of each faculty member, graduate teaching assistant, and staff member to act on any violation of the Honor Statement. It is also incumbent upon faculty to maintain an atmosphere conducive to academic integrity by insuring that each quiz, test, and exam is adequately proctored.

The Statement

An essential feature of the University of Tennessee, Knoxville, is a commitment to maintaining an atmosphere of intellectual integrity and academic honesty. As a student of the university, I pledge that I will neither knowingly give nor receive any inappropriate assistance in academic work, thus affirming my own personal commitment to honor and integrity.