DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING

http://engineering.tamu.edu/materials

Head: I. Karaman

Graduate Advisor: M. Radovic

The Department of Materials Science and Engineering curriculum is designed to provide advanced training for careers in the rapidly growing materials industry, national laboratories and academic (research and teaching) environments. The curriculum consists of core courses and technical electives, both of which are designed to complement practical application with a strong foundation of underlying theory. Research thrusts include advanced structural materials; materials for extreme environments; nanostructured materials, including thin films; multifunctional materials and composites; corrosion; polymers, including composites and nanocomposites; ceramics; computational materials science and engineering; and energy materials.

To review additional courses in the MSEN curriculum, refer to Designated Electives (http://engineering.tamu.edu/materials/academics/designated-electives).

Faculty

Arroyave, Raymundo, Professor
Materials Science And Engineering
PHD, Massachusetts Institute of Technology, 2004

Cagin, Tahir, Professor
Materials Science And Engineering
PHD, Clemson University, 1998

Case, Raymundo P, Professor of the Practice
Materials Science And Engineering
PHD, University of Manchester Institute of Science and Technology, 2002

Castaneda-Lopez, Homero, Associate Professor
Materials Science And Engineering
PHD, The Pennsylvania State University, 2001

Creasy, Terry S, Associate Professor
Materials Science And Engineering
PHD, University of Delaware, 1997

Demkowicz, Michal J, Associate Professor
Materials Science And Engineering
PHD, Massachusetts Institute of Technology, 2005

Hartwig, Karl T, Professor
Materials Science And Engineering
PHD, University of Wisconsin - Madison, 1977

Karaman, Ibrahim, Professor
Materials Science And Engineering
PHD, University of Illinois at Urbana-Champaign, 2000

Lendlein, Andreas, Professor
Materials Science And Engineering
PHD, Swiss Federal Institute of Technology Zurich, 1996

Ma, Ji, Lecturer
Materials Science And Engineering
PHD, Texas A&M University, 2012

Needleman, Alan, Distinguished Professor
Materials Science And Engineering
PHD, Harvard University, 1971

Pharr, George M, Professor
Materials Science And Engineering
PHD, Stanford University, 1979

Qian, Xiaofeng, Assistant Professor
Materials Science And Engineering
PHD, Massachusetts Institute of Technology, 2008

Radovic, Miladin, Associate Professor
Materials Science And Engineering
PHD, Drexel University, 2001

Shamberger, Patrick J, Assistant Professor
Materials Science And Engineering
PHD, University of Washington, 2010

Srivastava, Ankit, Assistant Professor
Materials Science And Engineering
PHD, University of North Texas, 2013

Su, Hung-Jue, Professor
Materials Science And Engineering
PHD, University of Michigan, 1988

Sukhishvili, Svetlana A, Professor
Materials Science And Engineering
PHD, Lomonosov Moscow State University, 1989

Masters

• Master of Engineering in Materials Science and Engineering (http://catalog.tamu.edu/graduate/colleges-schools-interdisciplinary/engineering/materials-science/meng)
• Master of Science in Materials Science and Engineering (http://catalog.tamu.edu/graduate/colleges-schools-interdisciplinary/engineering/materials-science/ms)

Doctoral

• Doctor of Philosophy in Materials Science and Engineering (http://catalog.tamu.edu/graduate/colleges-schools-interdisciplinary/engineering/materials-science/phd)

Courses

MSEN 601 Fundamental Materials Science and Engineering
Credits 3. 3 Lecture Hours.
Fundamentals of microstructure- properties and relationship of materials. Topics will include: electronic and atomic structure of solids, structure of crystalline materials, imperfections in crystalline materials, introduction to dislocation theory, mechanical properties, fundamental thermodynamics of materials, phase equilibria and diagrams, diffusion, and kinetics of phase transformations.
Prerequisite: Graduate classification.
MSEN 602 Physics of Materials
Credits 3. 3 Lecture Hours.
Understanding of modern molecular level description of underlying
physico-chemical behavior and properties of materials; includes
thermal, mechanical, kinetic (transport), electronic, magnetic and
optical properties; rational basis for the synthesis, characterization
and processing of such material, materials systems for engineering
applications.
Prerequisite: MSEN 604, undergraduate quantum mechanics course, or
approval of instructor.

MSEN 603 Fundamentals of Soft and Biomaterials
Credits 3. 3 Lecture Hours.
Introductory graduate-level survey on the general areas of soft materials
and biomaterials; includes basic concepts of colloidal particle physics,
polymer physics and chemistry, and general concepts in biomaterials.
Prerequisites: Undergraduate general chemistry course; graduate
classification.

MSEN 604 Quantum Mechanics for Materials Scientists
Credits 3. 3 Lecture Hours.
Provides a background in quantum mechanics for graduate materials
scientists or engineers with little or no quantum mechanics background.
The following topics will be covered: origins of quantum theory,
interpretation, Schroedinger equation and its applications, operator
mechanics, approximation methods, angular momentum, the hydrogen
atom, and quantum statistics.
Prerequisites: MATH 601, MATH 311 or approval of instructor; graduate
classification.

MSEN 605 Field Theories in Materials Science
Credits 3. 3 Lecture Hours.
Field theory concepts to understand and quantify a wide range of
material behaviors, including, transportable quantities; development of
constitutive relations; linear response theory and Maxwell’s equations;
deforation and motion of a continuum; Brownian motion; self-assembly
and patterning within reaction-diffusion formulations; thermal and ion/
charge transport; acoustic waves in solids; Fourier’s equations.
Prerequisites: Basic courses in materials science; graduate
classification.

MSEN 606 Multifunctional Materials
Credits 3. 3 Lecture Hours.
In-depth analysis of multifunctional materials and composites, and their
novel applications.
Prerequisites: MEMA 602/AERO 603/AERO 603/MEMA 602, MSEN 601.
Cross Listing: AERO 606 and MEMA 606.

MSEN 607/MEEN 607 Polymer Physical Properties
Credits 3. 3 Lecture Hours.
Macromolecular concepts; molecular weight characterization; solubility
parameters; phase diagrams; viscoelasticity; rheology; thermal behavior;
damage phenomena; morphology; crystallization; liquid crystallinity;
nanocomposites.
Prerequisites: MEEN 222/MSEN 222 (or other intro to materials science
course).
Cross Listing: MEEN 607/MSEN 607.

MSEN 608 Nanomechanics
Credits 3. 3 Lecture Hours.
Application of mechanics concepts to nano-scale behavior of materials.
Review of continuum mechanics; Extensions to generalized continua;
Nonlocal elasticity; Nano-scale plasticity. Focus on multi-scale modeling:
Dislocation Dynamics; Quasi-Continuum method; Molecular dynamics
with introductions to quantum mechanics and statistical mechanics.
Prerequisite: AERO 603/MEMA 602.
Cross Listing: AERO 608 and MEMA 608.

MSEN 610/MEMA 613 Principles of Composite Materials
Credits 3. 3 Lecture Hours.
Classification and characteristics of composite materials;
micromechanical and macromechanical behavior of composite laminate;
macromechanical behavior of laminates using classical laminate theory;
interlaminar stresses and failure modes; structural design concepts,
testing and manufacturing techniques.
Prerequisite: MENA 602/AERO 603.
Cross Listing: MEMA 613/MSEN 610.

MSEN 612/BIOL 602 Fundamentals of Transmission Electron Microscopy
Credits 3. 2 Lecture Hours. 2 Lab Hours.
State-of-the-art fundamentals in TEM; theoretical background supporting
a strong hands-on course component comprising specimen preparation
and image acquisition/interpretation; practical experience to attain
a proficiency level permitting independent operation of one of the
transmission electron microscopes in the Microscopy and Imaging
Center.
Prerequisite: Graduate classification or approval of instructor.
Cross Listing: BIOL 602/MSEN 612.

MSEN 613/BIOL 603 Advanced Transmission Electron Microscope (TEM)
Methodologies in Life and Materials Science (TEM II)
Credits 3. 1 Lecture Hour. 6 Lab Hours.
Advanced TEM methodologies, including specimen preparation and
TEM imaging/analysis techniques as applicable to both biological and
material samples; theory designed to support a strong hands-
on component comprising specimen preparation, different imaging/
diffraction/spectroscopic techniques and data interpretation.
Prerequisite: BIOL 602/MSEN 612 or MSEN 612/BIOL 602.
Cross Listing: BIOL 603/MSEN 613.

MSEN 614/BIOL 604 Fundamentals of Scanning Electron Microscopy and
Environmental Scanning Electron Microscopy
Credits 2. 1 Lecture Hour. 3 Lab Hours.
Fundamentals of Scanning Electron Microscopy (SEM) and
Environmental Scanning Electron Microscopy (ESEM). Provides
biologists, material scientists and students from other disciplines
with the techniques of operation of the scanning electron microscope
(SEM) and the environmental SEM (ESEM) coupled with the appropriate
theoretical background knowledge; individual instruction in support of
their research endeavors involving SEM/ESEM.
Prerequisite: Graduate classification.
Cross Listing: BIOL 604/MSEN 614.

MSEN 616/MEEN 616 Surface Science
Credits 3. 2 Lecture Hours. 2 Lab Hours.
Properties of surfaces, principles of classic and contemporary surface
characterization techniques, recent development and roles of surface
science in advanced technology.
Prerequisite: Graduate classification.
Cross Listing: MEEN 616/MSEN 616.
MSEN 617 Crystallography and Crystal Structure Determination
Credits 3. 3 Lecture Hours.
Symmetry operations in point group and space group; reciprocal lattice and kinematical diffraction theory; crystal structure determination by X-ray diffraction and transmission electron microscopy (TEM).
Prerequisites: Knowledge of calculus and vector algebra; graduate classification.

MSEN 618/MEEN 686 Composite Materials Processing and Performance
Credits 3. 3 Lecture Hours.
Fundamental science and design; processing and design interaction regarding multiphase composites; processing science, experimental characterization, laminate analysis; design structure and processing.
Prerequisite: Elasticity, continuum mechanics, or equivalent; graduate classification.
Cross Listing: MEEN 686/MSEN 618.

MSEN 619 Materials Modeling of Phase Transformation and Microstructural Evolution
Credits 3. 3 Lecture Hours.
Computer modeling and simulation of microstructural evolution during various phase transformation processes in solid materials, including spinodal decomposition, ordering, martensitic transformation, ferroelectric and ferromagnetic domain evolution, dislocation dynamics, and crack propagation.
Prerequisites: Graduate classification and approval of instructor.

MSEN 620/MEEN 620 Kinetic Processes in Materials Science
Credits 3. 3 Lecture Hours.
Atomic and mesoscale levels; foundation for microstructural evolution and behavior of materials; basic and irreversible thermodynamics; diffusion equations solutions; atomistic diffusion, nucleation; phase transformations: gas-solid, liquid-solid and solid-solid reactions; FiPy (finite volume solver for PDE) to simulate kinetic processes.
Prerequisites: MEE 222/MSEN 222 or equivalent materials science course; preliminary general thermodynamics course is not necessary.
Cross Listing: MEEN 620/MSEN 620.

MSEN 625/MEEN 625 Mechanical Behavior of Materials
Credits 3. 3 Lecture Hours.
Examination of deformation and microstructure mechanisms responsible for deformation and failure in metals; fatigue, creep, and fracture mechanisms of materials; emphasis on microstructural-mechanical property relationship.
Prerequisite: Undergraduate-level materials science course.
Cross Listing: MEEN 625/MSEN 625.

MSEN 626/MEEN 606 Polymers Laboratories
Credits 3. 2 Lecture Hours. 3 Lab Hours.
Introduction to basic experimental skills relating to polymers; experiments include polymerization, molecular weight determination, FTIR, tensile test, NMR, DSC, swelling index, viscosity, x-ray diffraction.
Prerequisite: Graduate classification.
Cross Listing: MEEN 606/MSEN 626.

MSEN 636 Damage Mechanics and Failure in Composite Materials
Credits 3. 3 Lecture Hours.
Mechanisms and models related to damage and failure in composite materials subjected to mechanical loads.
Prerequisites: Courses in composite materials, elasticity; graduate classification.
Cross Listing: AERO 616 and MEMA 616.

MSEN 640/MEEN 640 Thermodynamics in Materials Science
Credits 3. 3 Lecture Hours.
Use of thermodynamic methods to predict behavior of materials; codification of thermodynamic properties into simplified models; principles, methods, and models to generate accurate equilibrium maps through computational thermodynamics software; applications to bulk metallic, polymeric and ceramic materials, defects, thin films, electrochemistry, magnetism.
Prerequisites: MEEN 222/MSEN 222 or equivalent; graduate classification.
Cross Listing: MEEN 640/MSEN 640.

MSEN 641 Plasticity Theory
Credits 3. 3 Lecture Hours.
Theory of plastic yield and flow of two and three-dimensional bodies; classical plasticity theories, unified viscoplastic theories, numerical considerations; applications and comparisons of theory to experiment.
Prerequisite: MEE 602/AERO 603.
Cross Listing: MEEN 666 and MEMA 641.

MSEN 645/AERO 645 Failure Mechanics of Engineering Materials
Credits 3. 3 Lecture Hours.
Introduction and integration of key experimental, theoretical and computational aspects of failure in engineering materials, including metals, alloys and polymers; brittle fracture, ductile fracture and brittle-to-ductile transitions.
Prerequisites: Graduate classification; MSEN 601.
Cross Listing: AERO 645/MSEN 645.

MSEN 655 Materials Design Studio
Credits 3. 2 Lecture Hours. 3 Lab Hours.
Project-driven studio based on the integration of informatics and engineering systems design to address problems in materials discovery and development; projects derived from real industry-driven needs.
Prerequisites: MSEN 601 and MSEN/ECEN 618; MSEN 618/MSEN 668 or equivalent; approval of instructor.

MSEN 656/MEEN 656 Mechanical and Physical Properties of Thin Films
Credits 3. 3 Lecture Hours.
Mechanical properties (hardness, stress, strain, delamination, fracture) of films; nanomechanical testing techniques; electrical properties of thin films; electrical properties measurement techniques; magnetic properties of films; magnetic properties measurement techniques; laboratory includes (1) thin film fabrication (sputtering, PVD); (2) nanomechanical testing; (3) electrical/magnetic measurement.
Prerequisite: MEEN 222/MSEN 222, MSEN 601, or basic materials science background.
Cross Listing: MEEN 656/MSEN 656.

MSEN 657 Multiscale Modeling in Materials
Credits 3. 2 Lecture Hours. 3 Lab Hours.
Introduction to a wide range of computational methods to simulate materials behavior at multiple scales.
Prerequisite: Approval of instructor.

MSEN 658/MEEN 658 Fundamentals of Ceramics
Credits 3. 3 Lecture Hours.
Atomic bonding; crystalline and glassy structure; phase equilibria and ceramic reactions; mechanical, electrical, thermal, dielectric, magnetic, and optical properties; ceramic processing.
Prerequisite: MEEN 222/MSEN 222 or equivalent or approval of instructor.
Cross Listing: MEEN 658/MSEN 658.
MSEN 670 Computational Materials Science and Engineering  
**Credits 3. 3 Lecture Hours.**  
Modern methods of computational modeling and simulation of materials properties and phenomena, including synthesis, characterization, and processing of materials, structures and devices; quantum, classical, and statistical mechanical methods, including semi-empirical atomic and molecular-scale simulations, and other modeling techniques using macroscopic input.  
**Prerequisites:** Approval of instructor; graduate classification.  
**Cross Listing:** CHEN 670 and MEMA 670.

MSEN 681 Seminar  
**Credit 1. 1 Lecture Hour.**  
Selected research topics in materials science and engineering presented by faculty, students, and outside speakers.  
**Prerequisite:** Graduate classification.

MSEN 684 Professional Internship  
**Credits 1 to 9. 1 to 9 Other Hours.**  
Directed internship in an industrial or laboratory setting under the supervision of successful, experienced personnel; work related to the student's career aspirations and areas of specialization. May be taken 2 times for credit.  
**Prerequisite:** Graduate classification.

MSEN 685 Directed Studies  
**Credits 1 to 12. 1 to 12 Other Hours.**  
Special topics not within the scope of thesis research and not covered by other formal courses.  
**Prerequisite:** Graduate classification.

MSEN 689 Special Topics in...  
**Credits 1 to 4. 1 to 4 Lecture Hours. 1 to 4 Lab Hours.**  
Selected topics in an identified area of materials science and engineering. Potential topics include: advanced phase transformations, advanced materials and processing, nanomaterials and nanotechnologies, computational modeling of materials, advanced techniques of spectroscopy, surface and interface phenomena, thin film processing, ceramic engineering, organic materials for electronic and photonic devices, biomedical microdevices, materials fabrication, processing and fabrication of semiconductors, and materials and processing for MEMS. May be repeated for credit.  
**Prerequisite:** Approval of instructor.

MSEN 691 Research  
**Credits 1 to 23. 1 to 23 Other Hours.**  
Research toward thesis or dissertation.