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.html).

**Faculty**

<table>
<thead>
<tr>
<th>Name</th>
<th>Title</th>
<th>Institution</th>
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<tbody>
<tr>
<td>Akbulut, Mustafa</td>
<td>Associate Professor</td>
<td>Materials Science &amp; Engr</td>
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<td></td>
<td></td>
<td>PHD, University of California, Santa Barbara, 2007</td>
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<tr>
<td>Alge, Daniel L</td>
<td>Assistant Professor</td>
<td>Materials Science &amp; Engr</td>
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<td>PHD, Purdue University, 2010</td>
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<tr>
<td>Arroyave, Raymundo</td>
<td>Professor</td>
<td>Materials Science &amp; Engr</td>
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<td>PHD, Massachusetts Inst of Technology, 2004</td>
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<tr>
<td>Balbuena, Perla B</td>
<td>Professor</td>
<td>Materials Science &amp; Engr</td>
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<td>PHD, University of Texas, 1996</td>
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<td>Banerjee, Sarbjit</td>
<td>Professor</td>
<td>Materials Science &amp; Engr</td>
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<td>PHD, State University of New York at Stony Brook, 2004</td>
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<td>Batteas, James D</td>
<td>Professor</td>
<td>Materials Science &amp; Engr</td>
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<td>PHD, University of California, Berkeley, 1995</td>
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<tr>
<td>Benzerga, Amine A</td>
<td>Professor</td>
<td>Materials Science &amp; Engr</td>
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<tr>
<td>Bisrat, Yordanos</td>
<td>TEES Research Scientist</td>
<td>Materials Science &amp; Engr</td>
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<td>PHD, University of Oxford, 2001</td>
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<tr>
<td>Cagin, Tahir</td>
<td>Professor</td>
<td>Materials Science &amp; Engr</td>
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<td></td>
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<td>PHD, Clemson University, 1988</td>
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<tr>
<td>Case, Raymundo P</td>
<td>Professor of the Practice</td>
<td>Materials Science &amp; Engr</td>
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<td>PHD, University of Manchester Institute of Science and Technology, 2002</td>
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<td>Castaneda-Lopez, Homero</td>
<td>Associate Professor</td>
<td>Materials Science &amp; Engr</td>
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<td>Cheng, Zheng Dong</td>
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<td>Creasy, Terry S</td>
<td>Associate Professor</td>
<td>Materials Science &amp; Engr</td>
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<td>PHD, University of Delaware, 1997</td>
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<td>Demkowicz, Michal J</td>
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<td>Elabd, Yossef A</td>
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<td>Fang, Lei</td>
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<td>Gaharwar, Akhilesh K</td>
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<td>Grasley, Zachary C</td>
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<td>Green, Micah</td>
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<td>Grunlan, Jaime C</td>
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<td>Grunlan, Melissa A</td>
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<td>Guo, Bing</td>
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<td>Harris, Harlan R</td>
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<td>Hartwig, Karl T</td>
<td>Senior Professor</td>
<td>Materials Science &amp; Engr</td>
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<td>PHD, University of Wisconsin - madison, 2018</td>
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<tr>
<td>Hemmer, Philip R</td>
<td>Professor</td>
<td>Materials Science &amp; Engr</td>
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</tbody>
</table>
Henkes, Amanda E, TEES Research Scientist
Materials Science & Engr
PHD, Texas A&M University, 2008

Hwang, Wonmuk, Associate Professor
Materials Science & Engr
PHD, Boston University, 2001

Jeong, Hae-Kwon, Associate Professor
Materials Science & Engr
PHD, University of Minnesota, 2004

Kameoka, Jun, Professor
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PHD, Cornell University, 2002

Kane, Matthew H, Associate Professor
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Karaman, Ibrahim, Professor
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Kuttolamadom, Mathew A, Assistant Professor
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Lagoudas, Dimitris C, Professor
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PHD, Lehigh University, 1986

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PHD, Ecole Nationale de Mécanique et d'Aérotechnique, France, 2013

Liang, Hong, Professor
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PHD, Stevens Institute of Technology, 1992

Lin, Paotai, Assistant Professor
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Madsen, Christi K, Professor
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Mannan, Mahboobul, Professor
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Mansoor, Bilal, Assistant Professor
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McDeavitt, Sean M, Associate Professor
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McShane II, Michael J, Professor
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Naraghi, Mohammad, Assistant Professor
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Naugle, Donald G, Professor
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PHD, Texas A&M University, 1965

Needleman, Alan, Distinguished Professor
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PHD, Harvard University, 1971

Nyakiti, Luke O, Assistant Professor
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Ozmetin, Ali E, Research Assistant Professor
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Pharr IV, George M, Professor
Materials Science & Engr
PHD, Stanford University, 1979

Pharr, George, Assistant Professor
Materials Science & Engr
PHD, Harvard University, 2014

Qian, Xiaofeng, Assistant Professor
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Radovic, Miladin, Associate Professor
Materials Science & Engr
PHD, Drexel University, 2001

Ross Jr, Joseph H, Professor
Materials Science & Engr
PHD, University of Illinois at Urbana-Champaign, 1986

Seminario, Jorge M, Professor
Materials Science & Engr
PHD, Southern Illinois University Carbondale, 1987
MSEN 601 Fundamental Materials Science and Engineering
Credits 3. 3 Lecture Hours.
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; deformation 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/MEEEN 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: MEMA 602/AERO 603.
Cross Listing: MEMA 613/MSEN 610.

MSEN 612/Biol 602 Fundamentals of Transmission Electron Microscopy
Credits 3. 2 Lecture Hours. 6 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.

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/MEEEN 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: MSEN 616/MEEEN 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/MEEEN 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: MEEEN 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.
Atomistic 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:** MEEN 222/MEEN 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:** MEMA 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:** Grade of C or better in ECEN 769/MSEN 660 or MSEN 660/ECEN 769, or MSEN 601 and MEEN 601, or equivalent; or 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 property 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: MSEN 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: MSEN 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.