

# Metallurgical and Materials Engineering Courses

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## Courses

### **MME 5191. Individual Studies.**

Individual Studies (0-0-1) Individual variable credit research, design, or analysis on advanced phases of metallurgical and materials engineering problems conducted under the direct supervision of a faculty member. A maximum of 3 credit hours may be applied towards the MS degree.

**Department:** Metallurgical & Materials Eng.

**1 Credit Hour**

**1 Total Contact Hour**

0 Lab Hours

0 Lecture Hours

1 Other Hour

### **MME 5194. Graduate Research.**

Graduate Research (0-0-1) Individual variable credit research of contemporary topics in metallurgical and materials engineering.

**Department:** Metallurgical & Materials Eng.

**1 Credit Hour**

**1 Total Contact Hour**

0 Lab Hours

0 Lecture Hours

1 Other Hour

### **MME 5195. Graduate Seminar.**

Graduate Seminar (1-0) Conferences and discussions of various, contemporary topics in metallurgical and materials engineering by faculty, graduate students, and speakers from industry, government, or other academic institutions or departments. The program is organized to encourage the development of communication skills at a professional level for graduate students. Required of all graduate students during each semester of full-time enrollment. Up to 3 credits can be applied to the degree.

**Department:** Metallurgical & Materials Eng.

**1 Credit Hour**

**1 Total Contact Hour**

0 Lab Hours

1 Lecture Hour

0 Other Hours

### **MME 5245. Electron Microscopy Appl.**

Course will provide detailed instruction and hands on experience in the use of electron microscopy instrumentation (such as TEM, STEM, SEM/EDS). Aspects related to interpretation of contrast mechanisms, general instrument operation, benefits and disadvantages of different types of instruments as well as sample preparation will be covered. Keywords: materials characterization, microstructure, electronic.

**Department:** Metallurgical & Materials Eng.

**2 Credit Hours**

**4 Total Contact Hours**

3 Lab Hours

1 Lecture Hour

0 Other Hours

### **MME 5294. Graduate Research.**

Graduate Research (0-0-2) Individual variable-credit research of contemporary topics in metallurgical and materials engineering.

**Department:** Metallurgical & Materials Eng.

**2 Credit Hours**

**4 Total Contact Hours**

0 Lab Hours

2 Lecture Hours

2 Other Hours

**MME 5302. Matls Extrac, Synth, & Process.**

Materials Extraction, Synthesis, and Processing (3-0) Thermodynamic, thermochemical, electrochemical kinetic, and phase equilibrium fundamentals and fundamental structures and properties of materials applied to examples of ferrous and non-ferrous extraction and processing. Examples include copper extraction, refinement, processing, alloying and performance; iron and steel making and iron alloy processing, metal and ceramic powder processing, and contemporary materials synthesis and processing. Keywords: Materials chemistry, electrochemistry, hydrometallurgy, pyrometallurgy.

**Department:** Metallurgical & Materials Eng.

**3 Credit Hours**

**3 Total Contact Hours**

0 Lab Hours

3 Lecture Hours

0 Other Hours

**MME 5304. Phase Transformations & Micros.**

Phase Transforming and Microstructures (3-0) The theory of the nucleation and growth kinetics of solid materials, solid-solid transformations and mechanisms. Rate processes, decomposition and ordering reactions and microstructures. Diffusionless transformations, eutectoid, and martensitic transformations are covered along with associated microstructural morphologies and property/ performance control by microstructure control in materials. Prerequisite: MME 3406 and 3407, or equivalent, MME 5401, or department approval.

**Department:** Metallurgical & Materials Eng.

**3 Credit Hours**

**3 Total Contact Hours**

0 Lab Hours

3 Lecture Hours

0 Other Hours

**MME 5306. Advanced Materials Processing.**

Advanced Materials Processing: The course provides an overview of important and novel processing methods used for the manufacture of advanced structural and functional semi-finished components, including the metals, polymers, ceramics, and their composites.

**Department:** Metallurgical & Materials Eng.

**3 Credit Hours**

**3 Total Contact Hours**

0 Lab Hours

3 Lecture Hours

0 Other Hours

**Major Restrictions:**

Restricted to majors of MME

**Classification Restrictions:**

Restricted to class of GR

**Prerequisite(s):** (MME 5304 w/C or better AND MME 5403 w/C or better)

**MME 5308. Mechanical Behavior of Matls.**

Mechanical Behavior of Materials (3-0) The underlying principles of elastic and plastic deformation of metals, ceramics, polymers, and composite materials will be developed. Topics include dislocation theory, slip, twinning, microstructures, high and low temperature deformation behavior (tensile properties, creep and fatigue) of crystal line and amorphous materials. Offered in alternate years.

**Department:** Metallurgical & Materials Eng.

**3 Credit Hours**

**3 Total Contact Hours**

0 Lab Hours

3 Lecture Hours

0 Other Hours

**MME 5310. Advanced Failure Analysis.**

Advanced Failure Analysis (3-0) An advanced study of structural failure processes to include topics in fracture mechanics, fatigue, and environmental assisted cracking. Analysis of failures using metallographic, electron microscopy, and microanalytic techniques will be covered. Fracture of specific materials; steels, nonferrous alloys, composites, and nonmetallics will be included. Offered in alternate years.

**Department:** Metallurgical & Materials Eng.

**3 Credit Hours**

**3 Total Contact Hours**

0 Lab Hours

3 Lecture Hours

0 Other Hours

**MME 5311. Ceramics.**

Understanding the development, utilization and control of ceramic materials properties based on microstructure.

**Department:** Metallurgical & Materials Eng.

**3 Credit Hours**

**3 Total Contact Hours**

0 Lab Hours

3 Lecture Hours

0 Other Hours

**MME 5313. Advanced Matrls & Composites.**

Advanced Materials and Composites (3-0) Properties and structures of composite materials and design of composite systems to yield desired combinations of properties. Metal, ceramic, and polymer composite systems as well as high-performance alloy system or microcomposites. Applications of materials and composite fundamentals to manufacturing and processing. Offered in alternate years. Prerequisites: MME 5401 and 5403 or department approval.

**Department:** Metallurgical & Materials Eng.

**3 Credit Hours**

**3 Total Contact Hours**

0 Lab Hours

3 Lecture Hours

0 Other Hours

**MME 5314. Polymer Engineering.**

Polymer Engineering: The course provides a basic introduction to the field of polymer science. Basic concepts of organic chemistry address typical polymerization and copolymerization reactions. The characterization of polymer molecules include discussions of thermodynamic solutions, solubility parameters, colligative properties and scanning electron microscopy. Concepts on the structure and properties of bulk polymers emphasize its relationship to molecular characteristics and manufacturing processes.

**Department:** Metallurgical & Materials Eng.

**3 Credit Hours**

**3 Total Contact Hours**

0 Lab Hours

3 Lecture Hours

0 Other Hours

**MME 5315. Metallography and Micro Inter..**

Metallography and Microstructure Interpretation: Metallographic sample preparation and microstructural characterization for various metals, alloys and/or material systems. Use of tools necessary for analysis including sectioning, mounting, polishing and etching using standard metallographic procedures. Metallographic samples prepared in class will be evaluated using stereomicroscopy, optical and electron microcopy for microstructural interpretation. Introduction to chemical analysis using optical emission spectroscopy and X-ray fluorescence for positive material identification.

**Department:** Metallurgical & Materials Eng.

**3 Credit Hours**

**5 Total Contact Hours**

3 Lab Hours

2 Lecture Hours

0 Other Hours

**MME 5321. Engineering Alloys.**

Engineering Alloys: The study of the selection and specification of engineering alloys for use in industrial applications. Topics related to ferrous and nonferrous metals in the cast, wrought, powder and particulate state will be covered. Mill test reports (MTR) and how to interpret them as well as interpreting compliance with various specification entities to include ASTM, API, ABS, etc. are inherent.

**Department:** Metallurgical & Materials Eng.

**3 Credit Hours**

**3 Total Contact Hours**

0 Lab Hours

3 Lecture Hours

0 Other Hours

**MME 5331. Biomaterials.**

This course discusses various aspects pertaining to the selection, processing, testing (in vitro and in vivo) and performance of hard and soft biomaterials, orthopedic devices, and cardiovascular, ophthalmologic and dental applications. The biocompatibility and surgical applicability of metallic, polymeric and ceramic implants and prosthetic devices are discussed. The physicochemical interactions between the implant material and the physiological environment will be described. Biomaterials in maxillofacial, orthopedic dental, ophthalmic and neuromuscular applications will be emphasized. Prerequisite: Department approval required. Restricted to level of DR, GR.

**Department:** Metallurgical & Materials Eng.

**3 Credit Hours**

**3 Total Contact Hours**

0 Lab Hours

3 Lecture Hours

0 Other Hours

**MME 5333. Biofabrication.**

This course focuses on using cells, proteins, biomaterials and/or other bioactive elements as building blocks to fabricate advanced biological models, medical therapeutic products and non-medical biological systems. Prerequisite: Department approval. Restricted to level of DR, GR.

**Department:** Metallurgical & Materials Eng.

**3 Credit Hours**

**3 Total Contact Hours**

0 Lab Hours

3 Lecture Hours

0 Other Hours

**MME 5342. Hydrometallurgy.**

Hydrometallurgy: The study of metal extraction process in aqueous solutions from ore or concentrates.

**Department:** Metallurgical & Materials Eng.

**3 Credit Hours**

**3 Total Contact Hours**

0 Lab Hours

3 Lecture Hours

0 Other Hours

**MME 5350. Material Joining Technologies.**

Material Joining Technologies: Fundamentals of materials joining theory and application. A variety of technologies will be covered, to include: welding, brazing, soldering, adhesives, etc. for metals, ceramics, polymers, composites and electronic materials. Emphasis will be on both the theoretical principles of each process and practical aspects of the technique and/or equipment.

**Department:** Metallurgical & Materials Eng.

**3 Credit Hours**

**3 Total Contact Hours**

0 Lab Hours

3 Lecture Hours

0 Other Hours

**MME 5351. Non-Destructive Examination.**

Non-Destructive Examination: Introduction and theory of ultrasonic testing, such as phased array and shear wave techniques, dye penetration inspection, interpretation of radiographs, wet/dry magnetic particle inspection, chemical analysis using X-ray fluorescence and in-situ metallography techniques (replication).

**Department:** Metallurgical & Materials Eng.

**3 Credit Hours**

**3 Total Contact Hours**

0 Lab Hours

3 Lecture Hours

0 Other Hours

**MME 5352. Root Cause Analysis.**

Root Cause Analysis: Using analytical techniques to determine underlying causes and causal factors related to materials, component and systemic problems. Analytical tools and techniques will be used to identify problems and track data used to determine the root and proximate cause and to implement corrective actions.

**Department:** Metallurgical & Materials Eng.

**3 Credit Hours**

**3 Total Contact Hours**

0 Lab Hours

3 Lecture Hours

0 Other Hours

**MME 5353. Fracture Mechanics.**

Fracture Mechanics: Mechanisms of fracture for brittle and ductile materials using linear elastic and elastic-plastic fracture mechanics. ASTM standard fracture testing, numerical methods, and creep, fatigue, and dynamic fractures of metallic and non-metallic materials.

**Department:** Metallurgical & Materials Eng.

**3 Credit Hours**

**3 Total Contact Hours**

0 Lab Hours

3 Lecture Hours

0 Other Hours

**MME 5390. Special Topics.**

Special Topics: Advanced topics of contemporary interest in metallurgical and materials engineering. May be repeated for credit when topic varies.

**Department:** Metallurgical & Materials Eng.

**3 Credit Hours**

**3 Total Contact Hours**

0 Lab Hours

3 Lecture Hours

0 Other Hours

**MME 5391. Individual Studies.**

Individual Studies (0-0-3) Individual variable credit research, design, or analysis on advanced phases of metallurgical and materials engineering problems conducted under the direct supervision of a faculty member. A maximum of 3 credit hours may be applied towards the M.S. degree.

**Department:** Metallurgical & Materials Eng.

**3 Credit Hours**

**3 Total Contact Hours**

0 Lab Hours

0 Lecture Hours

3 Other Hours

**MME 5394. Graduate Research.**

Graduate Research (0-0-3) Individual variable-credit research of contemporary topics in metallurgical and materials engineering.

**Department:** Metallurgical & Materials Eng.

**3 Credit Hours**

**3 Total Contact Hours**

0 Lab Hours

0 Lecture Hours

3 Other Hours

**MME 5396. Graduate Projects.**

Graduate Projects (0-0-3) Individual research design, or analysis on advanced phases of engineering problems conducted under the direct supervision of a faculty member. The courses, including a written report, are requested of all students in the non-thesis option.

**Department:** Metallurgical & Materials Eng.

**3 Credit Hours**

**3 Total Contact Hours**

0 Lab Hours

0 Lecture Hours

3 Other Hours

**MME 5397. Graduate Projects.**

Graduate Projects (0-0-3) Individual research, design, or analysis on advanced phases of engineering problems conducted under the direct supervision of a faculty member. The courses, including a written report, are required of all students in the non-thesis option.

**Department:** Metallurgical & Materials Eng.

**3 Credit Hours**

**3 Total Contact Hours**

0 Lab Hours

0 Lecture Hours

3 Other Hours

**Prerequisite(s):** (MME 5396 w/P or better)

**MME 5398. Thesis.**

Thesis (0-0-3)

**Department:** Metallurgical & Materials Eng.

**3 Credit Hours**

**3 Total Contact Hours**

0 Lab Hours

0 Lecture Hours

3 Other Hours

**MME 5399. Thesis.**

Thesis (0-0-3) Prerequisite: MME 5398.

**Department:** Metallurgical & Materials Eng.

**3 Credit Hours**

**3 Total Contact Hours**

0 Lab Hours

0 Lecture Hours

3 Other Hours

**Prerequisite(s):** (MME 5398 w/P or better)

**MME 5401. Microstruc & Microchem Charac.**

Microstructural and Microchemical Characterization of Materials (3-3) An interdisciplinary approach to the theory and applications of techniques for characterizing chemical (microchemical) and microstructural features of solid materials. Techniques that will be stressed include X-ray diffraction, optical metallography, scanning and transmission electron microscopy (emphasizing analytical transmission electron microscopy), electron probe microanalysis, and surface and near surface surface microanalysis (Auger electron spectroscopy, ESCA, SIMS, etc.). Sample preparation techniques will be covered and students will be encouraged to examine materials which may have some application to their research problems. Keywords: characterization, electrons, atomic, structure, electronic

**Department:** Metallurgical & Materials Eng.

**4 Credit Hours**

**6 Total Contact Hours**

3 Lab Hours

3 Lecture Hours

0 Other Hours

**MME 5403. Adv Concepts in Matls Sci Engr.**

Advanced Concepts in Materials Science and Engineering (4-0) A blend of contemporary solid state physics and chemistry emphasizing structure and properties and including processing (synthesis) and performance, illustrated by various classes of materials: structural, electronic, magnetic, photonic, and superconducting. Fundamental issues and applications will include: crystal structure and crystal chemistry; disorder/order imperfections; phase equilibria, phase diagrams, phase transformation; reaction rates, kinetics, thermodynamics; microstructures in processing and performance; materials design/materials by design. Prerequisites: MME 2306, MME 2308, and MME 3406.

**Department:** Metallurgical & Materials Eng.

**4 Credit Hours**

**4 Total Contact Hours**

0 Lab Hours

4 Lecture Hours

0 Other Hours

**MME 5494. Graduate Research.**

Graduate Research (0-0-4) Individual variable-credit research of contemporary topics in metallurgical and materials engineering. Prerequisite: Department approval.

**Department:** Metallurgical & Materials Eng.

**4 Credit Hours**

**4 Total Contact Hours**

0 Lab Hours

0 Lecture Hours

4 Other Hours

**MME 5594. Graduate Research.**

Graduate Research (0-0-5) Individual variable-credit research of contemporary topics in metallurgical and materials engineering. Prerequisite: Department approval.

**Department:** Metallurgical & Materials Eng.

**5 Credit Hours**

**5 Total Contact Hours**

0 Lab Hours

0 Lecture Hours

5 Other Hours

**MME 5694. Graduate Research.**

Graduate Research (0-0-6) Individual variable-credit research of contemporary topics in metallurgical and materials engineering. Prerequisite: Department approval.

**Department:** Metallurgical & Materials Eng.

**6 Credit Hours**

**6 Total Contact Hours**

0 Lab Hours

0 Lecture Hours

6 Other Hours

**MME 6191. Individual Studies.**

Individual Studies (0-0-1) Individual variable credit research, design, or analysis on advanced phases of metallurgical and materials engineering problems conducted under the direct supervision of a faculty member. A maximum of 3 credit hours may be applied towards the MS degree.

**Department:** Metallurgical & Materials Eng.

**1 Credit Hour**

**1 Total Contact Hour**

0 Lab Hours

0 Lecture Hours

1 Other Hour

**MME 6194. Graduate Research.**

Graduate Research (0-0-1) Individual variable credit research of contemporary topics in metallurgical and materials engineering.

**Department:** Metallurgical & Materials Eng.

**1 Credit Hour**

**1 Total Contact Hour**

0 Lab Hours

0 Lecture Hours

1 Other Hour

**MME 6195. Graduate Seminar.**

Graduate Seminar (1-0) Conferences and discussions of various, contemporary topics in metallurgical and materials engineering by faculty, graduate students, and speakers from industry, government, or other academic institutions or departments. The program is organized to encourage the development of communication skills at a professional level for graduate students. Required of all graduate students during each semester of full-time enrollment. Up to 3 credits can be applied to the degree.

**Department:** Metallurgical & Materials Eng.

**1 Credit Hour**

**1 Total Contact Hour**

0 Lab Hours

1 Lecture Hour

0 Other Hours

**MME 6294. Graduate Research.**

Graduate Research (0-0-2) Individual variable-credit research of contemporary topics in metallurgical and materials engineering.

**Department:** Metallurgical & Materials Eng.

**2 Credit Hours**

**4 Total Contact Hours**

0 Lab Hours

2 Lecture Hours

2 Other Hours

**MME 6302. Matls Extrac, Synth, & Process.**

Materials Extraction, Synthesis, and Processing (3-0) Thermodynamic, thermochemical, electrochemical kinetic, and phase equilibrium fundamentals and fundamental structures and properties of materials applied to examples of ferrous and non-ferrous extraction and processing. Examples include copper extraction, refinement, processing, alloying and performance; iron and steel making and iron alloy processing, metal and ceramic powder processing, and contemporary materials synthesis and processing. Keywords: Materials chemistry, electrochemistry, hydrometallurgy, pyrometallurgy.

**Department:** Metallurgical & Materials Eng.

**3 Credit Hours**

**3 Total Contact Hours**

0 Lab Hours

3 Lecture Hours

0 Other Hours

**MME 6304. Phase Transformations & Micros.**

Phase Transforming and Microstructures (3-0) The theory of the nucleation and growth kinetics of solid materials, solid-solid transformations and mechanisms. Rate processes, decomposition and ordering reactions and microstructures. Diffusionless transformations, eutectoid, and martensitic transformations are covered along with associated microstructural morphologies and property/ performance control by microstructure control in materials.

**Department:** Metallurgical & Materials Eng.

**3 Credit Hours**

**3 Total Contact Hours**

0 Lab Hours

3 Lecture Hours

0 Other Hours

**MME 6308. Mechanical Behavior of Matls.**

Mechanical Behavior of Materials (3-0) The underlying principles of elastic and plastic deformation of metals, ceramics, polymers, and composite materials will be developed. Topics include dislocation theory, slip, twinning, microstructures, high and low temperature deformation behavior (tensile properties, creep and fatigue) of crystal line and amorphous materials. Offered in alternate years.

**Department:** Metallurgical & Materials Eng.

**3 Credit Hours**

**3 Total Contact Hours**

0 Lab Hours

3 Lecture Hours

0 Other Hours

**MME 6313. Advanced Matrls & Composites.**

Advanced Materials and Composites (3-0) Properties and structures of composite materials and design of composite systems to yield desired combinations of properties. Metal, ceramic, and polymer composite systems as well as high-performance alloy system or microcomposites. Applications of materials and composite fundamentals to manufacturing and processing. Offered in alternate years.

**Department:** Metallurgical & Materials Eng.

**3 Credit Hours**

**3 Total Contact Hours**

0 Lab Hours

3 Lecture Hours

0 Other Hours

**MME 6390. Special Topics.**

Special Topics: Advanced topics of contemporary interest in metallurgical and materials engineering. May be repeated for credit when topic varies.

**Department:** Metallurgical & Materials Eng.

**3 Credit Hours**

**3 Total Contact Hours**

0 Lab Hours

3 Lecture Hours

0 Other Hours

**MME 6391. Individual Studies.**

Individual Studies (0-0-3) Individual variable credit research, design, or analysis on advanced phases of metallurgical and materials engineering problems conducted under the direct supervision of a faculty member. A maximum of 3 credit hours may be applied towards the M.S. degree.

**Department:** Metallurgical & Materials Eng.

**3 Credit Hours**

**3 Total Contact Hours**

0 Lab Hours

0 Lecture Hours

3 Other Hours



**MME 6394. Graduate Research.**

Graduate Research (0-0-3) Individual variable-credit research of contemporary topics in metallurgical and materials engineering.

**Department:** Metallurgical & Materials Eng.

**3 Credit Hours**

**3 Total Contact Hours**

0 Lab Hours

0 Lecture Hours

3 Other Hours

**MME 6396. Graduate Projects.**

Graduate Projects (0-0-3) Individual research design, or analysis on advanced phases of engineering problems conducted under the direct supervision of a faculty member. The courses, including a written report, are requested of all students in the non-thesis option.

**Department:** Metallurgical & Materials Eng.

**3 Credit Hours**

**3 Total Contact Hours**

0 Lab Hours

0 Lecture Hours

3 Other Hours

**MME 6397. Graduate Projects.**

Graduate Projects (0-0-3) Individual research, design, or analysis on advanced phases of engineering problems conducted under the direct supervision of a faculty member. The courses, including a written report, are required of all students in the non-thesis option.

**Department:** Metallurgical & Materials Eng.

**3 Credit Hours**

**3 Total Contact Hours**

0 Lab Hours

0 Lecture Hours

3 Other Hours

**Prerequisite(s):** (MME 5396 w/P or better)

**MME 6401. Microstruc & Microchem Charac.**

Microstructural and Microchemical Characterization of Materials (3-3) An interdisciplinary approach to the theory and applications of techniques for characterizing chemical (microchemical) and microstructural features of solid materials. Techniques that will be stressed include X-ray diffraction, optical metallography, scanning and transmission electron microscopy (emphasizing analytical transmission electron microscopy), electron probe microanalysis, and surface and near surface surface microanalysis (Auger electron spectroscopy, ESCA, SIMS, etc.). Sample preparation techniques will be covered and students will be encouraged to examine materials which may have some application to their research problems. Keywords: characterization, electrons, atomic, structure, electronic

**Department:** Metallurgical & Materials Eng.

**4 Credit Hours**

**6 Total Contact Hours**

3 Lab Hours

3 Lecture Hours

0 Other Hours

**MME 6403. Adv Concepts in Matls Sci Engr.**

Advanced Concepts in Materials Science and Engineering (4-0) A blend of contemporary solid state physics and chemistry emphasizing structure and properties and including processing (synthesis) and performance, illustrated by various classes of materials: structural, electronic, magnetic, photonic, and superconducting. Fundamental issues and applications will include: crystal structure and crystal chemistry; disorder/order imperfections; phase equilibria, phase diagrams, phase transformation; reaction rates, kinetics, thermodynamics; microstructures in processing and performance; materials design/materials by design.

**Department:** Metallurgical & Materials Eng.

**4 Credit Hours**

**4 Total Contact Hours**

0 Lab Hours

4 Lecture Hours

0 Other Hours

**MME 6494. Graduate Research.**

Graduate Research (0-0-4) Individual variable-credit research of contemporary topics in metallurgical and materials engineering.

**Department:** Metallurgical & Materials Eng.

**4 Credit Hours**

**4 Total Contact Hours**

0 Lab Hours

0 Lecture Hours

4 Other Hours

**MME 6594. Graduate Research.**

Graduate Research (0-0-5) Individual variable-credit research of contemporary topics in metallurgical and materials engineering.

**Department:** Metallurgical & Materials Eng.

**5 Credit Hours**

**5 Total Contact Hours**

0 Lab Hours

0 Lecture Hours

5 Other Hours

**MME 6694. Graduate Research.**

Graduate Research (0-0-6) Individual variable-credit research of contemporary topics in metallurgical and materials engineering.

**Department:** Metallurgical & Materials Eng.

**6 Credit Hours**

**6 Total Contact Hours**

0 Lab Hours

0 Lecture Hours

6 Other Hours