Fall 2020 Course Descriptions as of 03/30/2020 08:12 PM

Information in Browse Course Catalog is subject to change. Information is term specific. Please refer to the appropriate term when searching for course content. Key to Course Descriptions may be found at: **http://rcs.registrar.arizona.edu/course_descriptions_key**.

Materials Science & Engr (MSE)

MSE 110: Solid State Chemistry (4 units)
Description: Fundamental principles of the chemistry of condensed states of matter including metals, polymers, molecular solids and ceramics.
Grading basis: Regular Grades
Career: Undergraduate
Flat Fee: $20

Course Components:	Discussion	May Be Offered
	Laboratory	May Be Offered
	Lecture	Required

Course typically offered:
Main Campus: Fall, Spring
Online Campus: Fall, Spring

Recommendations and additional information: CHEM 151.

MSE 170A1: Connections: A Study of Science, Technology and Innovation (3 units)
Description: Basic aspects of physics, chemistry, and astronomy are integrated to show how technology evolves from science, interconnecting events, and accidents of time. Who would have imagined that modern communications, movies, printing presses, and computers have their roots in the stirrup, cannon, 12th century underwear, and the water wheel. We explore the science and technology that has given us today's society and examine opportunities for today and the future.
Grading basis: Regular Grades
Career: Undergraduate

Course Components:	Discussion	May Be Offered
	Lecture	Required

Course typically offered:
Main Campus: Fall, Spring

Enrollment requirement: Enrollment not allowed if you have previously taken NATS 101 "Connections: A Study of Science, Technology and Innovation " (Topic 3).
General Education: NATS 101

MSE 170A2: Energy Systems and Sustainability (3 units)
Description: If historical trends continue, by the end of this century the world's population will have nearly doubled, and demand for energy will have quadrupled. How are we going to maintain that growth? Are we going to do it safely, cleanly, and sustainably? These issues, explored in this class, are a window on our future, our lifestyle, employment opportunities, and our national security.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Discussion — May Be Offered
Lecture — Required
Equivalent to: ABE 170A2, CHEE 170A1, ENVS 170A1, GC 170A1, GEOG 170A1
Course typically offered:
Main Campus: Fall, Spring

Enrollment requirement: Enrollment barred if you've taken NATS101 "Earth Envr:Intr Phys Geo", "Intro to Environ Sci", "Intro to Global Change", "Sci, Tech & Environ", "Sustain Society", or 'Energy Sys & Sustainability" or ABE170A2, CHEE170A1, ENVS170A1, GC170A1, or GEOG170A1.
General Education: NATS 101

MSE 199: Independent Study (1 - 3 units)
Description: Qualified students working on an individual basis with professors who have agreed to supervise such work.
Grading basis: Alternative Grading: S, P, F
Career: Undergraduate
Course Components: Independent Study — Required
Repeatable: Course can be repeated a maximum of 99 times.
Course typically offered:
Main Campus: Fall, Spring

-SA represents a Student Abroad & Student Exchange offering
-CC represents a Correspondence Course offering
May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

MSE 220: Make It...Green! 3-D Printing and the Environment (3 units)
Description: 3-D Printing (also known as Additive Manufacturing (AM)) involves the direct conversion of 3D computer aided designs into physical objects with applications impacting such fields as aerospace, architecture, microelectronics, medicine, and space exploration. It represents a revolution in the manufacturing and distribution of products and systems to the consumer while offering a dramatic potential for reduction in the environmental impact of product design, development, and realization. The course will provide students with direct experience in 3-D printing methods through hands-on, group projects focusing on this unique and growing manufacturing methodology. Students will examine the environmental ramifications of 3-D printing for the large and small-scale production of objects by exploring its impact on the primary stages of the product lifecycle.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Spring

Recommendations and additional information: Two courses from Tier One, Natural Sciences.
Field trip: none.
General Education: Tier 2 Natural Sciences

MSE 222: Introduction to Materials Science and Engineering I (3 units)
Description: Introduction to the structure of materials and how structure influences properties. Elementary crystallography, crystal chemistry, and microstructure effects are covered. Examples are taken from all classes of materials: metals, semiconductors, ceramics, polymers, glasses, and composites.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Fall
Online Campus: Fall

Recommendations and additional information: CHEM 151 or CHEM 103A; MSE 110 or CHEM 152; MATH 122B or MATH 125

MSE 223L: Materials Processing Laboratory (2 units)
Description: This course offers a series of laboratory modules involving materials processing including polymers, metals, ceramics, electronic materials, glasses and thin films.
Grading basis: Regular Grades
Career: Undergraduate
Flat Fee: $40
Course Components: Laboratory Required
Repeatable: Course can be repeated a maximum of 2 times.
Course typically offered:
Main Campus: Spring
Online Campus: Spring

MSE 223R: Introduction to Materials Science & Engineering II (3 units)
Description: This course is a continuation of MSE 222 and covers processing of materials as well as their electrochemical, electrical, optical, thermal and magnetic properties.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Spring
Online Campus: Spring

Recommendations and additional information: MSE 222 or MSE 331R.

MSE 225: Energy Systems and Sustainability (3 units)
Description: If historical trends continue, by the end of this century the world's population will have nearly doubled, and the demand for energy will have quadrupled. How are we going to maintain that growth? Are we going to do it safely, cleanly, and sustainably? These issues, explored in this class, are a window on our future, our lifestyle, employment opportunities, and our national security.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Equivalent to: ENGR 225
Also offered as: ENGR 225
Course typically offered:
Main Campus: Fall, Spring

Recommendations and additional information: Admission to UA.
General Education: Tier 2 Natural Sciences

MSE 250: Glass Processing: An Engineering and Historical Approach (2 units)
Description: You will learn to blow and form glass vessels and objects in the lab, and in lecture we will investigate the structure, composition, coloring and technological history of glass. You will practice some of the off-hand furnace glassblowing techniques that have been practiced for the last 2000 years. This course is intended for freshman and sophomore engineers interested in exploring Materials Science and Engineering.
Grading basis: Regular Grades
Career: Undergraduate
Flat Fee: $100
Course Components: Laboratory Required
Lecture May Be Offered
Course typically offered:
Main Campus: Spring

MSE 257A: The Organic Chemistry and Materials Science of Art and Archaeological Objects (3 units)
Description: We explore the roles of organic chemistry and materials science in the formulation, ageing and conservation of art and archaeological objects. Topics include color and bonding theories, and the organic molecules in paints, paper, gels, dyes, textiles, adhesives and polymers.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Equivalent to: ANTH 257A, CHEM 257A, ENGR 257A
Also offered as: ANTH 257A, CHEM 257A, ENGR 257A
Course typically offered:
Main Campus: Fall

General Education: Tier 2 Natural Sciences
Honors Course: Honors Contract
Honors Course: Honors Contract

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May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

MSE 257B: Materials Science of Art and Archaeological Objects (3 units)
Description: The methods, content and practice pertinent to the study of art and archaeology. Materials science provides one of the keys for interpreting objects in their historical and cultural context.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Equivalent to: ANTH 257B, ENGR 257B
Also offered as: ANTH 257B, ENGR 257B
Course typically offered:
Main Campus: Fall

Recommendations and additional information: Two courses from Tier One, Natural Sciences (Catalog numbers 170A, 170B, 170C). An optional lab: MSE 258, ANTH 258, or ENGR 258. May be taken concurrently.
General Education: Tier 2 Natural Sciences

MSE 258: Laboratory for Materials Science of Art and Archaeological Objects (1 unit)
Description: Laboratory exercises involving the materials science of art and archaeological objects.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Laboratory Required
Equivalent to: ANTH 258, ENGR 258
Also offered as: ANTH 258, ENGR 258
Course typically offered:
Main Campus: Spring

Recommendations and additional information: Two courses from Tier One, Natural Sciences (Catalog numbers 170A, 170B, 170C). Concurrent registration, MSE 257B, ANTH 257B, or ENGR 257B.
General Education: Tier 2 Natural Sciences

MSE 280: Introduction to Computer Methods in Materials Science and Engineering (2 units)
Description: This course provides an introduction to scientific and engineering computing for studying the structure-property-processing relations of materials. Using MATLAB as the primary programming language, electronic, phononic, thermodynamic and transport properties of solid-state materials will be modeled. Data analysis, data visualization and efficient software coding practices will be emphasized.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Fall
Online Campus: Fall

Enrollment requirement: MSE 110 and MATH 129

MSE 293: Internship (1 - 6 units)
Description: Specialized work on an individual basis, consisting of training and practice in actual service in a technical, business, or governmental establishment.
Grading basis: Alternative Grading: S, P, F
Career: Undergraduate
Course Components: Independent Study Required
Course typically offered:
Main Campus: Fall, Spring, Summer

MSE 299: Independent Study (1 - 3 units)
Description: Qualified students working on an individual basis with professors who have agreed to supervise such work.
Grading basis: Alternative Grading: S, P, F
Career: Undergraduate
Course Components: Independent Study Required
Repeatable: Course can be repeated a maximum of 99 times.
Course typically offered:
Main Campus: Fall, Spring, Summer

MSE 299H: Honors Independent Study (1 - 3 units)
Description: Qualified students working on an individual basis with professors who have agreed to supervise such work.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Independent Study Required
Repeatable: Course can be repeated a maximum of 99 times.
Course typically offered:
Main Campus: Fall, Spring

Enrollment requirement: Student must be active in the Honors College.
Honors Course: Honors Course
Honors Course: Honors Course

MSE 300: Chemical Science of Semidonductor Processing for Manufacturing I (3 units)
Description: The chemistry of materials, reactions, and unit operations in semiconductor manufacturing.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Fall, Spring

Recommendations and additional information: Participant in an approved UA DL partnership with Intel Corporation.

MSE 301: Chemical Science of Semiconductor Processing for Manufacturing II (3 units)
Description: The chemistry of materials, reactions, and unit operations in semiconductor manufacturing II.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Fall, Spring

Recommendations and additional information: Participant in an approved UA DL partnership with Intel Corporation.

MSE 302: Defect Analysis for Manufacturing (3 units)
Description: The chemistry of defect formation, adhesion, and prevention in semiconductor manufacturing.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Fall, Spring

Recommendations and additional information: Participant in an approved UA DL partnership with Intel Corporation.

MSE 303: DC and RF Plasma Engineering for Engineering (3 units)
Description: Fundamental concepts and techniques of fluid mechanics, electromagnetism, and thermodynamics required to understand the environment of non-thermal, low-temperature, and equilibrium plasmas used in semiconductor manufacturing. Plasma chemistry and surface processes that occur during both plasma depostition and etching.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Fall, Spring

Recommendations and additional information: Participant in an approved UA DL partnership with Intel Corporation.

MSE 304: Silicon CMOS Reliability Physics for Engineering (3 units)
Description: This course examines the fundamental reliability mechanisms of concern for CMOS silicon devices as well as the intrinsic and extrinsic reliability mechanisms. Case studies will be reviewed to demonstrate how to utilize this knowledge to design experiments and to formulate accurate risk assessments.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Fall, Spring

Recommendations and additional information: Participant in an approved UA Distance Learning partnership with Intel Corporation.
Enrollment requirement: Adv Stdg: Engineering.

MSE 331R: Fundamentals of Materials for Engineers (3 units)
Description: Principles which underlie and relate the behavior, properties and processing of materials to their engineering applications.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Fall, Spring

Recommendations and additional information: CHEM 151 and PHYS 103.
Enrollment requirement: Adv Stdg: Engineering.

MSE 345: Thermodynamics (4 units)
Description: Introduction to the laws of thermodynamics, entropy, free energy, and the concept of equilibrium as applied to materials for conventional and advanced technological applications.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Discussion May Be Offered
Lecture Required
Course typically offered:
Main Campus: Fall
Online Campus: Fall

Recommendations and additional information: MATH 129, CHEM 151, or consult department before enrolling.
Enrollment requirement: MATH 129, CHEM 151, MSE 110 or CHEM 152 or department consent., and Adv Stdg: Engineering

MSE 360L: Materials Laboratory (1 unit)
Description: Laboratory experiments on physical, electrical and optical properties of materials.
Grading basis: Regular Grades
Career: Undergraduate
Flat Fee: $30
Course Components: Laboratory Required
Course typically offered:
Main Campus: Spring
Online Campus: Spring

Enrollment requirement: Adv Stdg: Engineering.

MSE 365: Physical Properties of Materials (3 units)
Description: Introductory solid-state theory for describing thermal, electrical, optical and magnetic properties of materials.
Grading basis: Regular Grades
Career: Undergraduate

Course Components:	Discussion	May Be Offered
	Laboratory	May Be Offered
	Lecture	Required

Course typically offered:
Main Campus: Spring
Online Campus: Spring

Recommendations and additional information: Pre-requisite MSE 222 or MSE 223R, or concurrent enrollment in OPTI 240, or department consent.
Enrollment requirement: Adv Stdg: Engineering.

MSE 370: Mechanical Behavior of Materials (3 units)
Description: This course covers the fundamental principles of elasticity, plasticity and fracture mechanics in order to develop an understanding of the response of metals, ceramics, glasses, polymers and composites to external mechanical forces.
Grading basis: Regular Grades
Career: Undergraduate

Course Components:	Lecture	Required

Course typically offered:
Main Campus: Fall
Online Campus: Fall

Enrollment requirement: Adv Stdg: Engineering. MSE 222 AND MSE 223R.

MSE 397B: Workshop (1 - 3 units)
Description: The practical application of theoretical learning within a group setting and involving an exchange of ideas and practical methods, skills, and principles.
Grading basis: Regular Grades
Career: Undergraduate

Course Components:	Workshop	Required

Also offered as: GEN 397B
Course typically offered:
Main Campus: Fall, Spring

Enrollment requirement: Adv Stdg: Engineering.

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MSE 399: Independent Study (1 - 3 units)
Description: Qualified students working on an individual basis with professors who have agreed to supervise such work.
Grading basis: Alternative Grading: S, P, F
Career: Undergraduate
Course Components: Independent Study Required
Repeatable: Course can be repeated a maximum of 99 times.
Course typically offered:
Main Campus: Fall, Spring, Summer

Enrollment requirement: Adv Stdg: Engineering.

MSE 399H: Honors Independent Study (1 - 3 units)
Description: Qualified students working on an individual basis with professors who have agreed to supervise such work.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Independent Study Required
Repeatable: Course can be repeated a maximum of 99 times.
Course typically offered:
Main Campus: Fall, Spring

Enrollment requirement: Adv Stdg: Engineering. Honors active.
Honors Course: Honors Course
Honors Course: Honors Course

MSE 404: Optical Spectroscopy of Materials (3 units)
Description: The course provides a survey of Optical Spectroscopic Methods and underlying phenomena for the study of materials.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Repeatable: Course can be repeated a maximum of 2 times.
Equivalent to: ECE 404, OPTI 404
Also offered as: ECE 404, OPTI 404
Co-convened with: MSE 504
Course typically offered:
Main Campus: Spring (odd years only)

Recommendations and additional information: PHYS 141 or PHYS 241, MATH 223, MSE 110, and ECE 360.
Enrollment requirement: Adv Stdg: Engineering.

MSE 405A: Introduction to Archaeological Conservation (3 units)
Description: Course introduces the principles of archaeological conservation, techniques, for characterizing artifact materials and burial conditions, methods for documentation, stabilizing, removal and packing of delicate finds in the field, and controlled excavation of block lifts in the lab.
Grading basis: Student Option ABCDE/PF
Career: Undergraduate
Course Components: Laboratory — May Be Offered
Lecture — Required
Equivalent to: ANTH 495C, MSE 405A, MSE 495C
Also offered as: ANTH 405A
Co-convened with: MSE 505A
Course typically offered:
Main Campus: Summer

Recommendations and additional information: Consent of instructor.
Home department: School of Anthropology

MSE 411: Mineral Processing (3 units)
Description: [Taught alternate years beginning Fall 2002] Physical and chemical unit operations used to separate and recover the economic minerals and metals from their ores. The modern scientific and engineering background for the operations are presented as well as economic aspects. Includes field trips to major mining operations in Tucson area.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture — Required
Equivalent to: MSE 411
Also offered as: MNE 411
Co-convened with:
Course typically offered:
Main Campus: Fall

Recommendations and additional information: CHEM 103A, CHEM 103B, CHEM 104A, CHEM 104B or consent of instructor.
Field trip: Field trip
Home department: Mining & Geologicl Engineering
Enrollment requirement: Adv Stdg: Engineering.

MSE 412: Physical Chemistry of Materials (3 units)
Description: Physical and chemical topics of interest to material scientists including surface chemistry, electrochemistry and chemical kinetics.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Co-convened with: MSE 512
Course typically offered:
Main Campus: Fall

Recommendations and additional information: MSE 345.
Enrollment requirement: Adv Stdg: Engineering.

MSE 414: Solidification of Castings (3 units)
Description: Principles of metal castings while applying fundamentals of transport phenomena and materials science and engineering. Students work in teams on three projects that provide experience in engineering design and hands-on use of the Metal Casting Laboratory. Taught every two years.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Laboratory May Be Offered
Lecture Required
Course typically offered:
Main Campus: Fall (odd years only)

Recommendations and additional information: AME 432 or CHEE 305, MSE 415; MSE 331r or MSE 110.
Field trip: Field trip
Enrollment requirement: Adv Stdg: Engineering.

MSE 415: Transport Phenomena and Kinetics in Materials Processing (4 units)
Description: Principles of heat transfer, diffusion, mass transfer and kinetics, as applied to materials processing.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Discussion May Be Offered
Lecture Required
Course typically offered:
Main Campus: Spring
Online Campus: Spring

Recommendations and additional information: MSE 222 or MSE 331R; MSE 345, MATH 254.
Enrollment requirement: Adv Stdg: Engineering.

MSE 424: Physics and Chemistry of Ceramic Materials (3 units)
Description: Ceramic crystal structures, crystal chemistry, phase equilibria and sintering theory.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Co-convened with: MSE 524
Course typically offered:
Main Campus: Spring (even years only)

Recommendations and additional information: MSE 222, MSE 345 or consult department before enrolling.
Enrollment requirement: Adv Stdg: Engineering.

MSE 425: Sol-gel Science (3 units)
Description: An in-depth review of the chemistry and physics of sol-gel processes used in materials science and engineering.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Also offered as: OPTI 425
Co-convened with: MSE 525
Course typically offered:
Main Campus: Fall

Recommendations and additional information: CHEM 151.
Enrollment requirement: Adv Stdg: Engineering.

MSE 430: Organic Electronic Materials and Devices (3 units)
Description: Fundamental relationships between molecular structure and optical, electronic, and transport properties of organic semiconductors, with a focus on changes in properties from single molecules to aggregates to bulk solids. Emphasis will also be given to interfaces and experimental characterization strategies. Material characteristics will be studied in the context of devices where organic materials show promising performance: transistors, displays/lighting, photovoltaics, energy storage, and bioelectronics/sensor applications.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Co-convened with: MSE 530
Course typically offered:
Main Campus: Fall

Recommendations and additional information: CHEM 151 or CHEM 141/143 or CHEM 161/163. MSE 110 or CHEM 152. MSE 365 or PHYS 371 or CHEM 480B
Enrollment requirement: Adv Stdg: Engineering.

MSE 434: Electrical and Optical Properties of Materials (3 units)
Description: Properties of semiconducting materials as related to crystal structure, interatomic bonding and defect structures.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Equivalent to: ECE 434, OPTI 434
Also offered as: ECE 434, OPTI 434
Co-convened with:
Course typically offered:
Main Campus: Fall

Recommendations and additional information: PHYS 241.
Enrollment requirement: Adv Stdg: Engineering.

MSE 435: Corrosion and Degradation (3 units)
Description: The science of corrosion and degradation reactions and its application to engineering problems.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Equivalent to: CHE 435, CHEE 435, ENGR 435
Also offered as: CHEE 435, ENGR 435
Co-convened with: MSE 535
Course typically offered:
Main Campus: Fall (odd years only)

Recommendations and additional information: MSE 331R; MSE 412; or CHEM 480B.
Enrollment requirement: Adv Stdg: Engineering.

MSE 437: Surface Science (3 units)
Description: Fundamental material, electrical, and chemical properties of solid metal, semiconductor, insulator, and organic surfaces applied to selected gas/solid surface chemical reactions important in semiconductor processing and heterogeneous catalysis. This course is designed to introduce students to the chemistry and physics of solid surfaces and interfaces with an emphasis on the gas/solid interface. The first half of the course will be devoted to learning the fundamental material, electrical, and chemical properties of solid surfaces. The fundamentals will be applied in the second half of the course to topics in chemical catalysis and integrated circuit manufacture.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Equivalent to: CHEM 437, MSE 437
Also offered as: CHEE 437, CHEM 437
Co-convened with: MSE 537
Course typically offered:
Main Campus: Spring

Home department: Chemical & Environmental Engineering
Enrollment requirement: Adv Stdg: Engineering or major or minor in Chemistry, Physics or Optical Sciences. Junior or Senior status.

MSE 440: Metal Additive Manufacturing (3 units)
Description: Metal additive manufacturing is a technology experiencing rapid adoption across a number of industries where high design complexity, customization and rapid turn times are desirable such as aerospace, biomedical, motorsports and functional prototyping. This course will examine the various industrially relevant metal additive manufacturing processes, the fundamental interactions between processing parameters, alloy chemistries, materials structures and application, and the post processing operations and computation tools used to obtain finished parts that meet engineering design intent.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Co-convened with: MSE 540
Course typically offered:
Main Campus: Fall

Recommendations and additional information: MSE 110 or MSE 222 or MSE 331r
Field trip: None.
Enrollment requirement: Adv Stdg: Engineering.

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-CC represents a Correspondence Course offering
May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

MSE 446: Semiconductor Processing (3 units)
Description: Silicon and compound semiconductor materials preparation, bulk crystal growth, wafering, epitaxial growth, photolithography, doping, ion implantation, etching, oxidation, metallization, silicon and compound semiconductor device processing.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Equivalent to: ECE 446, NEE 446
Also offered as: ECE 446
Co-convened with: MSE 546
Course typically offered:
Main Campus: Fall
Online Campus: Fall

Enrollment requirement: Adv Stdg: Engineering.

MSE 447L: Semiconductor Processing Laboratory (2 units)
Description: The objective of the course is to teach five different unit operations that are relevant to the fabrication of semiconductor devices. The unit operations that will be covered are: Thermal Oxidation, Lithography, Deposition, Plasma Etching, and Surface Preparation (Cleaning and Wet Etching).
Grading basis: Regular Grades
Career: Undergraduate
Flat Fee: $100
Course Components: Laboratory Required
Co-convened with: MSE 547L
Course typically offered:
Main Campus: Spring

Recommendations and additional information: Background in semiconductor/MEMS processing or equivalent work experience.
Enrollment requirement: Adv Stdg: Engineering.

MSE 450: Materials Selection for the Environment (3 units)
Description: Technological, economic, and environmental concerns often result in conflicting requirements contributing to materials selection for a given application. These issues are explored in the context of designing with materials for reduced environmental impact and long-term sustainability. Tools and methodologies useful in this decision-making process are introduced, including material eco-attributes and property indices, life cycle assessment, and audits of environmental impact and energy consumption.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Equivalent to: MNE 450
Co-convened with: MSE 550
Course typically offered:
Main Campus: Spring

Recommendations and additional information: MSE 110 or equivalent; MSE 222 or MSE 331R or equivalent.

MSE 455: Physical Metallurgy and Processing of Alloys (3 units)
Description: Brief review of metallic crystal structures, application of binary diagrams, equilibrium and nonequilibrium solidification, effects of alloy elements on important transformations in steel, isothermal transformation diagrams and continuous cooling diagrams. Processing aspects include heat treating, heat transfer during cooling and quenching, segregation effects, and surface hardening techniques.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Co-convened with: MSE 555
Course typically offered:
Main Campus: Fall (even years only)

Recommendations and additional information: MSE 223R or MSE 331R.
Enrollment requirement: Adv Stdg: Engineering.

MSE 460: Materials Science of Polymers (3 units)
Description: Introduction to physical properties of polymers. Microstructure, crystallization, rheology, relaxation and mechanical properties.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Equivalent to: GEN 460, MNE 460
Co-convened with: MSE 560
Course typically offered:
Main Campus: Spring
Online Campus: Spring

Recommendations and additional information: MSE 223R or MSE 331R.
Enrollment requirement: Adv Stdg: Engineering.

MSE 461: Biological and Synthetic Materials (3 units)
Description: Discussion of structure and properties of biological materials and composites, such as bone, teeth and elastin. Synthetic materials as substitutes for biological materials, biocompatibility.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Also offered as: BME 461
Co-convened with: MSE 561
Course typically offered:
Main Campus: Fall

Recommendations and additional information: CHEM 151.
Enrollment requirement: Adv Stdg: Engineering.

MSE 462: Materials Aspects of Composite Materials (3 units)
Description: Topics of intensive current development in polymer science. In each case, the relation between molecular structure, morphology and properties will be explored. Shows how polymers can be designed and tuned to have the properties needed to fulfill specialized functions. Topics will focus on composite materials, including high modulus fibers, polymer, metal and ceramic matrices.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Co-convened with: MSE 562
Course typically offered:
Main Campus: Spring

Recommendations and additional information: MSE 460.
Enrollment requirement: Adv Stdg: Engineering.

MSE 464: New Materials for Healthcare (3 units)
Description: Use of new materials with specially designed bioactive function and bio-nano structures, surfaces and properties for healthcare applications including: tissue engineering, regenerative medicine, stem cell engineering and protein therapeutics.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Co-convened with: MSE 564
Course typically offered:
Main Campus: Spring

Recommendations and additional information: MSE 461.
Enrollment requirement: Adv Stdg: Engineering.

MSE 465: Microelectronic Packaging Materials (3 units)
Description: Design of microelectronic packaging systems based on the electrical, thermal and mechanical properties of materials. Chip, chip package, circuit board and system designs are considered.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Equivalent to: ECE 465
Also offered as: ECE 465
Co-convened with: MSE 565
Course typically offered:
Main Campus: Spring

Enrollment requirement: Adv Stdg: Engineering.

MSE 468: Heritage Conservation Science (3 units)
Description: This course provides an overview of current problems in conservation science and the methods that have been used to solve them. Case studies of the underlying phenomena that cause materials to be weak, short-lived and poorly constructed will be presented. The relationship between degradation mechanism and the analytical techniques that best characterize them will be discussed. Topics will focus on some solutions to long-term preservation that include controlling environment, developing monitoring proxies, and modeling and testing of methods for mitigation and treatment.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Co-convened with: MSE 568
Course typically offered:
Main Campus: Spring

Recommendations and additional information: MSE 257B, MSE 258, or equivalent.
Enrollment requirement: Adv Stdg: Engineering.

MSE 470: Technology of Polymers and Ceramics (3 units)
Description: Processing and properties of polymers and ceramics in a wide range of technological applications. Discussion of patent literature.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Co-convened with: MSE 570
Course typically offered:
Main Campus: Fall

Recommendations and additional information: MSE 223R or MSE 331R.
Enrollment requirement: Adv Stdg: Engineering.

MSE 471: The Formation and Structure of Glass (3 units)
Description: The glass transition, Kauzmann's paradox, kinetic theory of glass formation, physics and chemistry of glass making, glass structure, thermal properties.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Co-convened with: MSE 571
Course typically offered:
Main Campus: Spring

Recommendations and additional information: MSE 365.
Enrollment requirement: Adv Stdg: Engineering.

MSE 471L: The Formation and Structure of Glass Lab (2 units)
Description: You will learn to blow glass and to heat treat glass vessels and objects. You will experiment with solution and precipitation colors and heat treatments to produce phase separating visual effects. You will experiment with and optimize some of the off-hand furnace glassblowing techniques that have been in practice for the last 2000 years.
Grading basis: Regular Grades
Career: Undergraduate
Flat Fee: $100
Course Components: Laboratory Required
Co-convened with: MSE 571L
Course typically offered:
Main Campus: Spring

Recommendations and additional information: Concurrent registration with MSE 471 required.
Enrollment requirement: Adv Stdg: Engineering.

MSE 480: Advanced Characterization Methods in Materials Science and Engineering (3 units)
Description: An introduction, through a combination of lectures and laboratory experiences, to both established and new techniques for microstructural characterization of materials.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Lecture Required
Co-convened with: MSE 580
Course typically offered:
Main Campus: Spring
Online Campus: Spring

Enrollment requirement: Adv Stdg: Engineering.

MSE 488: Scanning Electron Microscopy (3 units)
Description: Theoretical and practical aspects of electron-beam microanalysis. Lab emphasizes projects and independent research using scanning electron microscopy and energy dispersive X-ray analysis.
Grading basis: Regular Grades
Career: Undergraduate
Flat Fee: $100
Course Components: Lecture Required
Also offered as: ENGR 488
Co-convened with: MSE 588
Course typically offered:
Main Campus: Spring

Recommendations and additional information: Consult department before enrolling.
Enrollment requirement: Adv Stdg: Engineering.

MSE 489: Transmission Electron Microscopy of Materials (3 units)
Description: Transmission electron microscopy in materials characterization. Specimen preparation; instrumental techniques; interpretation of micrographs and diffraction patterns, micro- and nano-analysis in transmission electron microscopy.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Laboratory May Be Offered
Lecture Required
Co-convened with: MSE 589
Course typically offered:
Main Campus: Fall

Recommendations and additional information: MSE 480 or consult department before enrolling.
Enrollment requirement: Adv Stdg: Engineering.

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MSE 491: Preceptorship (1 - 3 units)
Description: Specialized work on an individual basis, consisting of instruction and practice in actual service in a department, program, or discipline. Teaching formats may include seminars, in-depth studies or laboratory work.
Grading basis: Alternative Grading: S, P, F
Career: Undergraduate
Course Components: Independent Study Required
Repeatable: Course can be repeated a maximum of 99 times.
Course typically offered:
Main Campus: Fall, Spring, Summer

Enrollment requirement: Adv Stdg: Engineering.

MSE 493: Internship (1 - 3 units)
Description: Specialized work on an individual basis, consisting of training and practice in actual service in a technical, business, or governmental establishment.
Grading basis: Alternative Grading: S, P, F
Career: Undergraduate
Course Components: Independent Study Required
Repeatable: Course can be repeated a maximum of 99 times.
Course typically offered:
Main Campus: Fall, Spring, Summer

Enrollment requirement: Adv Stdg: Engineering.
Student Engagement Activity: Professional Development
Student Engagement Competency: Professionalism

MSE 496A: Special Topics in Materials Science and Engineering (3 units)
Description: The development and exchange of scholarly information, usually in a small group setting. The scope of work shall consist of research by course registrants, with the exchange of the results of such research through discussion, reports, and/or papers.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Seminar Required
Repeatable: Course can be repeated a maximum of 4 times.
Co-convened with: MSE 596A
Course typically offered:
Main Campus: Fall, Spring

Enrollment requirement: Adv Stdg: Engineering.

MSE 498: Senior Capstone (1 - 3 units)
Description: A culminating experience for majors involving a substantive project that demonstrates a synthesis of learning accumulated in the major, including broadly comprehensive knowledge of the discipline and its methodologies. Senior standing required.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Independent Study Required
Repeatable: Course can be repeated for a maximum of 6 units.
Course typically offered:
Main Campus: Fall, Spring
Online Campus: Fall, Spring

Enrollment requirement: Adv Stdg: Engineering.
Student Engagement Activity: Discovery
Student Engagement Competency: Innovation and Creativity

MSE 498H: Honors Thesis (3 units)
Description: An honors thesis is required of all the students graduating with honors. Students ordinarily sign up for this course as a two-semester sequence. The first semester the student performs research under the supervision of a faculty member; the second semester the student writes an honors thesis.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Independent Study Required
Repeatable: Course can be repeated for a maximum of 9 units.
Course typically offered:
Main Campus: Fall, Spring

Enrollment requirement: Adv Stdg: Engineering. Honors active.
Honors Course: Honors Course
Honors Course: Honors Course
Student Engagement Activity: Discovery
Student Engagement Competency: Innovation and Creativity
Writing Emphasis: Writing Emphasis Course

MSE 499: Independent Study (1 - 3 units)
Description: Qualified students working on an individual basis with professors who have agreed to supervise such work.
Grading basis: Alternative Grading: S, P, F
Career: Undergraduate
Course Components: Independent Study Required
Repeatable: Course can be repeated a maximum of 99 times.
Course typically offered:
Main Campus: Fall, Spring, Summer

Enrollment requirement: Adv Stdg: Engineering.

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MSE 499H: Honors Independent Study (3 units)
Description: Qualified students working on an individual basis with professors who have agreed to supervise such work.
Grading basis: Regular Grades
Career: Undergraduate
Course Components: Independent Study Required
Repeatable: Course can be repeated a maximum of 99 times.
Course typically offered:
Main Campus: Fall, Spring

Enrollment requirement: Adv Stdg: Engineering. Honors active.
Honors Course: Honors Course
Honors Course: Honors Course

MSE 502: Research Proposal Preparation (3 units)
Description: Organization and planning of a specific research initiative in consultation with a potential advisor.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Repeatable: Course can be repeated a maximum of 2 times.
Equivalent to: ENGR 502
Also offered as: ENGR 502
Course typically offered:
Main Campus: Spring
Online Campus: Spring

MSE 503: Applied Surface Chemistry (3 units)
Description: Fundamentals of surface phenomena, characterization of solid-vapor, solid-liquid and liquid-vapor interfaces, applications in ceramics, electronic and biomedical materials processing.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Fall (even years only)
Online Campus: Fall (even years only)

Recommendations and additional information: A basic course in physical chemistry.

MSE 504: Optical Spectroscopy of Materials (3 units)
Description: The course provides a survey of Optical Spectroscopic Methods and underlying phenomena for the study of materials. Graduate-level requirements include an individual research project with written report.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Repeatable: Course can be repeated a maximum of 2 times.
Also offered as: ECE 504, OPTI 504
Co-convened with: MSE 404
Course typically offered:
Main Campus: Spring (odd years only)

MSE 505A: Introduction to Archaeological Conservation (3 units)
Description: Course introduces the principles of archaeological conservation, techniques, for characterizing artifact materials and burial conditions, methods for documentation, stabilizing, removal and packing of delicate finds in the field, and controlled excavation of block lifts in the lab. Graduate-level requirements include an additional research paper on an assigned topic on aspects of archaeological conservation.
Grading basis: Regular Grades
Career: Graduate
Course Components: Laboratory May Be Offered
Lecture Required
Equivalent to: ANTH 595C, MSE 505A, MSE 595C
Also offered as: ANTH 505A
Co-convened with: MSE 405A
Course typically offered:
Main Campus: Summer

Recommendations and additional information: Consent of instructor.
Home department: School of Anthropology

MSE 510: Thermodynamic Characterization of Materials (3 units)
Description: Advanced treatment of thermodynamics as applied to materials. Special topics include surfaces, interfaces, phase transformations.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Fall
Online Campus: Fall

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May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

MSE 511: Mineral Processing (3 units)
Description: [Taught alternate years beginning Fall 2002] Physical and chemical unit operations used to separate and recover the economic minerals and metals from their ores. The modern scientific and engineering background for the operations are presented as well as economic aspects. Includes field trips to major mining operations in Tucson area. Graduate-level requirements include an advanced research project.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Equivalent to: MSE 511
Also offered as: MNE 511
Co-convened with: MSE 411
Course typically offered:
Main Campus: Fall
Online Campus: Fall

Recommendations and additional information: Knowledge of chemistry or consent of instructor
Field trip: Field trips
Home department: Mining & Geologicl Engineering

MSE 512: Physical Chemistry of Materials (3 units)
Description: Physical and chemical topics of interest to material scientists including surface chemistry, electrochemistry and chemical kinetics. Graduate-level requirements include a research paper or project.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Co-convened with: MSE 412
Course typically offered:
Main Campus: Fall

MSE 513: Planetary Materials (3 units)
Description: This course discusses chemical thermodynamics and applies it to the origins and history of planetary materials. The types of planetary materials will be discussed together with an overview of the chemical setting of their origins. We will discuss thermodynamic formalism, the various chemical pathways through which planetary materials are believed to have formed, the characterization and numerical methods we use to quantify such origins, and we will consider several case studies.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Also offered as: PTYS 513
Course typically offered:
Main Campus: Spring

Home department: Materials Science & Engineering

MSE 515: Microelectronics Manufacturing and the Environment (3 units)
Description: This course will focus on presentation of the basic semiconductor processes which have direct environmental implications. Graduate-level requirements will include extended written analysis and oral presentation, which goes beyond the requirements for the students enrolled in CHEE 415.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Equivalent to: ECE 515, MSE 515
Also offered as: CHEE 515, ECE 515
Course typically offered:
Main Campus: Fall

Home department: Chemical & Environmental Engineering

MSE 524: Physics and Chemistry of Ceramic Materials (3 units)
Description: Ceramic crystal structures, crystal chemistry, phase equilibria and sintering theory. Graduate-level requirements include an advanced topic term paper.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Co-convened with: MSE 424
Course typically offered:
Main Campus: Spring (even years only)
Online Campus: Spring (even years only)

MSE 525: Sol-gel Science (3 units)
Description: An in-depth review of the chemistry and physics of sol-gel processes used in materials science and engineering. Graduate-level requirements include original research proposal.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Also offered as: OPTI 525
Co-convened with: MSE 425
Course typically offered:
Main Campus: Fall

MSE 526: Nanoscale Analysis of Materials Using Transmission Electron Microscopy (3 units)
Description: This course discusses the theory and practice of transmission electron microscopy as applied to crystalline solids. Topics to be covered include electron scattering and diffraction, image formation, energy-dispersive X-ray spectroscopy and electron energy-loss spectroscopy. Weekly lectures will be accompanied by several laboratory practical sessions. Emphasis will be placed on quantitative analysis of material structure and composition as well as the identification of unknown materials.
Grading basis: Regular Grades
Career: Graduate
Flat Fee: $100
Course Components: Lecture Required
Also offered as: PTYS 526
Course typically offered:
Main Campus: Fall (even years only)

Home department: Planetary Sciences

MSE 530: Organic Electronic Materials and Devices (3 units)
Description: Fundamental relationships between molecular structure and optical, electronic, and transport properties of organic semiconductors, with a focus on changes in properties from single molecules to aggregates to bulk solids. Emphasis will also be given to interfaces and experimental characterization strategies. Material characteristics will be studied in the context of devices where organic materials show promising performance: transistors, displays/lighting, photovoltaics, energy storage, and bioelectronics/sensor applications.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Co-convened with: MSE 430
Course typically offered:
Main Campus: Fall

MSE 531A: Engineering Materials: Properties and Selection (3 units)
Description: Correlations between structure, properties, processing conditions, and performance of materials and how to select materials in the design of safe and efficient components or structures.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Fall
Online Campus: Fall

MSE 534: Advanced Topics in Optical and Electronic Materials (3 units)
Description: Topics to be selected from opto-electronics, wave guides, non-linear optics, nano-materials and semiconductor materials
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Repeatable: Course can be repeated a maximum of 3 times.
Equivalent to: ECE 534, OPTI 534
Also offered as: ECE 534, OPTI 534
Co-convened with:
Course typically offered:
Main Campus: Spring (even years only)
Online Campus: Spring (even years only)

MSE 535: Corrosion and Degradation (3 units)
Description: The science of corrosion and degradation reactions and its application to engineering problems. Graduate-level requirements include a term paper.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Equivalent to: CHE 535, CHEE 535
Also offered as: CHEE 535
Co-convened with: MSE 435
Course typically offered:
Main Campus: Fall (odd years only)

MSE 537: Surface Science (3 units)
Description: Fundamental material, electrical, and chemical properties of solid metal, semiconductor, insulator, and organic surfaces applied to selected gas/solid surface chemical reactions important in semiconductor processing and heterogeneous catalysis. This course is designed to introduce students to the chemistry and physics of solid surfaces and interfaces with an emphasis on the gas/solid interface. The first half of the course will be devoted to learning the fundamental material, electrical, and chemical properties of solid surfaces. The fundamentals will be applied in the second half of the course to topics in chemical catalysis and integrated circuit manufacture. Graduate-level requirements include completion of two projects of their choice with the approval of the instructor.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Equivalent to: CHEM 537, MSE 537
Also offered as: CHEE 537, CHEM 537
Co-convened with: MSE 437
Course typically offered:
Main Campus: Spring

Home department: Chemical & Environmental Engineering

MSE 540: Metal Additive Manufacturing (3 units)
Description: Metal additive manufacturing is a technology experiencing rapid adoption across a number of industries where high design complexity, customization and rapid turn times are desirable such as aerospace, biomedical, motorsports and functional prototyping. This course will examine the various industrially relevant metal additive manufacturing processes, the fundamental interactions between processing parameters, alloy chemistries, materials structures and application, and the post processing operations and computation tools used to obtain finished parts that meet engineering design intent.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Co-convened with: MSE 440
Course typically offered:
Main Campus: Fall

Field trip: None

MSE 546: Semiconductor Processing (3 units)
Description: Silicon and compound semiconductor materials preparation, bulk crystal growth, wafering, epitaxial growth, photolithography, doping, ion implantation, etching, oxidation, metallization, silicon and compound semiconductor device processing. Graduate-level requirements include an additional research paper requiring independent research.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Equivalent to: ECE 546
Also offered as: ECE 546
Co-convened with: MSE 446
Course typically offered:
Main Campus: Fall
Online Campus: Fall

MSE 547L: Semiconductor Processing Laboratory (2 units)
Description: The objective of the course is to teach five different unit operations that are relevant to the fabrication of semiconductor devices. The unit operations that will be covered are: Thermal Oxidation, Lithography, Deposition, Plasma Etching, and Surface Preparation (Cleaning and Wet Etching). Graduate students will be required to analyze the data at a greater depth, interpret the results and fit the data to mathematical models.
Grading basis: Regular Grades
Career: Graduate
Flat Fee: $100
Course Components: Laboratory Required
Co-convened with: MSE 447L
Course typically offered:
Main Campus: Spring

Recommendations and additional information: Background in semiconductor/MEMS processing or equivalent work experience.

MSE 550: Materials Selection for the Environment (3 units)
Description: Technological, economic, and environmental concerns often result in conflicting requirements contributing to materials selection for a given application. These issues are explored in the context of selecting materials for reduced environmental impact and long-term sustainability. The course will introduce concepts, tools, and methodologies useful in the analysis of material candidates that expands upon traditional, property-centric selection criteria to aid in the development of environmentally informed material solutions. Key concepts will be illustrated using real-world case studies. Graduate-level requirements include differentiated test and homework content and a research paper/presentation on sustainable material selection.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Co-convened with: MSE 450
Course typically offered:
Main Campus: Spring
Online Campus: Spring

MSE 551: Integrated Computational Materials Science and Engineering (3 units)
Description: Computational methods in integrated computational materials science and engineering ranging from quantum models to dynamical atomistic classical methods to continuum modeling of materials, includes multi scale simulation methodologies.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Fall
Online Campus: Fall

MSE 554: Electronic Packaging Principles (3 units)
Description: Introduction to problems encountered at all levels of packaging: thermal, mechanical, electrical, reliability, materials and system integration. Future trends in packaging.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Equivalent to: AME 554, MSE 554
Also offered as: ECE 554
Course typically offered:
Main Campus: Fall

Home department: Electrical & Computer Engr

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MSE 555: Physical Metallurgy and Processing of Alloys (3 units)
Description: Brief review of metallic crystal structures, application of binary diagrams, equilibrium and nonequilibrium solidification, effects of alloy elements on important transformations in steel, isothermal transformation diagrams and continuous cooling diagrams. Processing aspects include heat treating, heat transfer during cooling and quenching, segregation effects, and surface hardening techniques. Graduate-level requirements include a research term paper or computer model.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Co-convened with: MSE 455
Course typically offered:
Main Campus: Fall (even years only)

MSE 560: Materials Science of Polymers (3 units)
Description: Introduction to physical properties of polymers. Microstructure, crystallization, rheology, relaxation and mechanical properties. Graduate-level requirements include additional computational and written exercises.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Co-convened with: MSE 460
Course typically offered:
Main Campus: Spring
Online Campus: Spring

MSE 561: Biological and Synthetic Materials (3 units)
Description: Discussion of structure and properties of biological materials and composites, such as bone, teeth and elastin. Synthetic materials as substitutes for biological materials, biocompatibility. Graduate-level requirements include additional computational and written exercises.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Equivalent to: BME 561
Also offered as: BME 561
Co-convened with: MSE 461
Course typically offered:
Main Campus: Fall

MSE 562: Materials Aspects of Composite Materials (3 units)
Description: Topics of intensive current development in polymer science. In each case, the relation between molecular structure, morphology and properties will be explored. Shows how polymers can be designed and tuned to have the properties needed to fulfill specialized functions. Topics will focus on composite materials, including high modulus fibers, polymer, metal and ceramic matrices. Graduate-level requirements include additional computational and written exercises.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Co-convened with: MSE 462
Course typically offered:
Main Campus: Spring

MSE 564: New Materials for Healthcare (3 units)
Description: Use of new materials with specially designed bioactive function and bio-nano structures, surfaces and properties for healthcare applications including: tissue engineering, regenerative medicine, stem cell engineering and protein therapeutics. Graduate-level requirements include a 15 page term paper and presentation for 30% of grade.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Co-convened with: MSE 464
Course typically offered:
Main Campus: Spring

MSE 565: Microelectronic Packaging Materials (3 units)
Description: Design of microelectronic packaging systems based on the electrical, thermal and mechanical properties of materials. Chip, chip package, circuit board and system designs are considered. Graduate-level requirements include an additional term paper.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Equivalent to: ECE 565
Also offered as: ECE 565
Co-convened with: MSE 465
Course typically offered:
Main Campus: Spring

MSE 568: Heritage Conservation Science (3 units)
Description: This course provides an overview of current problems in conservation science and the methods that have been used to solve them. Case studies of the underlying phenomena that cause materials to be weak, short-lived and poorly constructed will be presented. Graduate-level requirements include presentation of research project to the class coupled with written report.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Co-convened with: MSE 468
Course typically offered:
Main Campus: Spring

MSE 570: Technology of Polymers and Ceramics (3 units)
Description: Processing and properties of polymers and ceramics in a wide range of technological applications. Discussion of patent literature. Graduate-level requirements include the writing and presentation of an additional term paper.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Co-convened with: MSE 470
Course typically offered:
Main Campus: Fall

MSE 571: The Formation and Structure of Glass (3 units)
Description: The glass transition, Kauzmann's paradox, kinetic theory of glass formation, physics and chemistry of glass making, glass structure, thermal properties. Graduate-level requirements include a research paper or project.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Co-convened with: MSE 471
Course typically offered:
Main Campus: Spring

MSE 571L: The Formation and Structure of Glass Lab (2 units)
Description: You will learn to blow glass and to heat treat glass vessels and objects. You will experiment with solution and precipitation colors and heat treatments to produce phase separating visual effects. You will experiment with and optimize some of the off-hand furnace glassblowing techniques that have been in practice for the last 2000 years. Graduate-level requirements include a lab notebook, project report and presentation.
Grading basis: Regular Grades
Career: Graduate
Flat Fee: $100
Course Components: Laboratory Required
Co-convened with: MSE 471L
Course typically offered:
Main Campus: Spring

Recommendations and additional information: Concurrent registration with MSE 571 required.

MSE 572: Kinetics Processes in Materials Science (3 units)
Description: Survey of the kinetics of fundamental processes of importance in materials science. Chemical reaction rate theory of activated processes, diffusion and diffusion controlled processes, kinetics of nucleation and growth, JMA theory, precipitation kinetics, rates of gas-solid reactions, adsorption, and relaxation phenomena.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Course typically offered:
Main Campus: Spring
Online Campus: Spring

Recommendations and additional information: MSE 510.

MSE 574: Archaeometry: Scientific Methods in Art and Archaeology (3 units)
Description: Critical survey of scientific methods used in archaeology and art history. Emphasis on the potential and limitations of these techniques for reconstructing human behavior. Graduate-level requirements include one substantial critical review of the literature on some archaeological application of archaeometry.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Equivalent to: CLAS 574, MSE 574, NES 574
Also offered as: ANTH 574, CLAS 574, MENA 574
Course typically offered:
Main Campus: Fall, Spring

Home department: School of Anthropology

MSE 580: Advanced Characterization Methods in Materials Science and Engineering (3 units)
Description: An introduction, through a combination of lectures and laboratory experiences, to both established and new techniques for microstructural characterization of materials. Graduate-level requirements include an additional term paper.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Co-convened with: MSE 480
Course typically offered:
Main Campus: Spring
Online Campus: Spring

MSE 588: Scanning Electron Microscopy (3 units)
Description: Theoretical and practical aspects of electron-beam microanalysis. Lab emphasizes projects and independent research using scanning electron microscopy and energy dispersive X-ray analysis. Graduate-level requirements include additional lab work.
Grading basis: Regular Grades
Career: Graduate
Flat Fee: $100
Course Components: Lecture Required
Co-convened with: MSE 488
Course typically offered:
Main Campus: Spring

MSE 589: Transmission Electron Microscopy of Materials (3 units)
Description: Transmission electron microscopy in materials characterization. Specimen preparation; instrumental techniques; interpretation of micrographs and diffraction patterns, micro- and nano-analysis in transmission electron microscopy. Graduate-level requirements include an additional term paper and presentation.
Grading basis: Regular Grades
Career: Graduate
Course Components: Lecture Required
Co-convened with: MSE 489
Course typically offered:
Main Campus: Fall

MSE 595A: Materials (1 unit)
Description: The exchange of scholarly information and/or secondary research, usually in a small group setting. Instruction often includes lectures by several different persons. Research projects may or may not be required of course registrants.
Grading basis: Alternative Grading: S, P, F
Career: Graduate
Course Components: Colloquium Required
Repeatable: Course can be repeated a maximum of 99 times.
Course typically offered:
Main Campus: Fall, Spring

MSE 596A: Special Topics in Materials Science and Engineering (3 units)
Description: The development and exchange of scholarly information, usually in a small group setting. The scope of work shall consist of research by course registrants, with the exchange of the results of such research through discussion, reports, and/or papers. Graduate-level requirements include demonstration of a higher standard of effort in the required reports and will be graded accordingly.
Grading basis: Regular Grades
Career: Graduate
Course Components: Seminar Required
Co-convened with: MSE 496A
Course typically offered:
Main Campus: Fall, Spring
Online Campus: Fall

MSE 596S: Technology and Social Theory (3 units)
Description: Seminar in technology and social theory.
Grading basis: Regular Grades
Career: Graduate
Course Components: Seminar Required
Equivalent to: ANTH 596S, ENGR 596S, MSE 596S, SOC 596S
Also offered as: ANTH 596S, ENGR 596S, GWS 596S, SOC 596S
Course typically offered:
Main Campus: Fall

Home department: Gender and Women's Studies

MSE 599: Independent Study (1 - 6 units)
Description: Qualified students working on an individual basis with professors who have agreed to supervise such work. Graduate students doing independent work which cannot be classified as actual research will register for credit under course number 599, 699, or 799.
Grading basis: Alternative Grading: S, P, F
Career: Graduate
Course Components: Independent Study Required
Repeatable: Course can be repeated a maximum of 99 times.
Course typically offered:
Main Campus: Fall, Spring, Summer

MSE 693: Internship (1 - 3 units)
Description: Specialized work on an individual basis, consisting of training and practice in actual service in a technical, business, or governmental establishment.
Grading basis: Alternative Grading: S, P, F
Career: Graduate
Course Components: Independent Study Required
Repeatable: Course can be repeated a maximum of 99 times.
Course typically offered:
Main Campus: Fall, Spring, Summer

MSE 697B: Applied Mathematics Laboratory (3 units)
Description: The practical application of theoretical learning within a group setting and involving an exchange of ideas and practical methods, skills, and principles.
Grading basis: Regular Grades
Career: Graduate
Course Components: Workshop Required
Equivalent to: MSE 697B, PHYS 697B
Also offered as: MATH 697B, PHYS 697B
Course typically offered:
Main Campus: Spring

Recommendations and additional information: Applied math core or equivalent.
Home department: Mathematics

MSE 699: Independent Study (1 - 6 units)
Description: Qualified students working on an individual basis with professors who have agreed to supervise such work. Graduate students doing independent work which cannot be classified as actual research will register for credit under course number 599, 699, or 799.
Grading basis: Alternative Grading: S, P, F
Career: Graduate
Course Components: Independent Study Required
Repeatable: Course can be repeated a maximum of 99 times.
Course typically offered:
Main Campus: Fall, Spring, Summer

MSE 900: Research (1 - 9 units)
Description: Individual research, not related to thesis or dissertation preparation, by graduate students.
Grading basis: Alternative Grading: S, P, F
Career: Graduate
Course Components: Independent Study Required
Repeatable: Course can be repeated a maximum of 99 times.
Course typically offered:
Main Campus: Fall, Spring, Summer

MSE 909: Master's Report (1 - 6 units)
Description: Individual study or special project or formal report thereof submitted in lieu of thesis for certain master's degrees.
Grading basis: Alternative Grading: S, P, F
Career: Graduate
Course Components: Independent Study Required
Course typically offered:
Main Campus: Fall, Spring, Summer

MSE 910: Thesis (1 - 8 units)
Description: Research for the master's thesis (whether library research, laboratory or field observation or research, artistic creation, or thesis writing). Maximum total credit permitted varies with the major department.
Grading basis: Alternative Grading: S, P, F
Career: Graduate
Course Components: Independent Study Required
Repeatable: Course can be repeated a maximum of 99 times.
Course typically offered:
Main Campus: Fall, Spring, Summer

-SA represents a Student Abroad & Student Exchange offering
-CC represents a Correspondence Course offering
May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.

MSE 920: Dissertation (1 - 9 units)
Description: Research for the doctoral dissertation (whether library research, laboratory or field observation or research, artistic creation, or dissertation writing).
Grading basis: Alternative Grading: S, P, F
Career: Graduate
Course Components: Independent Study Required
Repeatable: Course can be repeated a maximum of 99 times.
Course typically offered:
Main Campus: Fall, Spring, Summer

-SA represents a Student Abroad & Student Exchange offering
-CC represents a Correspondence Course offering
May Be Offered Departments may offer this component in some semesters. See the Schedule of Classes for term-specific offerings.