### MATERIALS SCIENCE & ENGR (MSE)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Prerequisites</th>
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</thead>
<tbody>
<tr>
<td>MSE 101</td>
<td>Introduction to Metallurgy and Materials Science</td>
<td>2</td>
<td>Earth resources, metallurgy, materials science, and manufacturing. (Fall only)</td>
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<tr>
<td>MSE 201</td>
<td>Elements of Materials Science</td>
<td>3</td>
<td>Principles relating properties of metals, ceramics, polymers, and composites to their structures. Prereq: CHEM 111, CHEM 111L.</td>
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<tr>
<td>MSE 204 (s)</td>
<td>Special Topics</td>
<td>Credit arranged</td>
<td></td>
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<tr>
<td>MSE 299 (s)</td>
<td>Directed Study</td>
<td>Credit arranged</td>
<td></td>
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<tr>
<td>MSE 313</td>
<td>Physical Metallurgy</td>
<td>3</td>
<td>Theory, structure, and properties of materials. (Fall only) Prereq: MSE 201.</td>
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<tr>
<td>MSE 313L</td>
<td>Physical Metallurgy Laboratory</td>
<td>1</td>
<td>Metallographic principles and practices, hardness testing, structure-property correlations. One 2-hr lab per week. Prereq or Coreq: MSE 313.</td>
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<tr>
<td>MSE 340</td>
<td>Transport and Rate Processes I</td>
<td>4</td>
<td>Cross-listed with CHE 340 Transport phenomena involving momentum, energy, and mass with applications to process equipment design. Coordinated lecture-lab periods. Prereq: ENGR 335, MATH 310, and CHE 223 or MSE 201.</td>
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<tr>
<td>MSE 393</td>
<td>Materials Engineering Projects</td>
<td>1-3</td>
<td>Problems of a research exploratory nature. Prereq: Permission.</td>
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<tr>
<td>MSE 400 (s)</td>
<td>Seminar</td>
<td>Credit arranged</td>
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<tr>
<td>MSE 404 (s)</td>
<td>Special Topics</td>
<td>Credit arranged</td>
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<tr>
<td>MSE 412</td>
<td>Mechanical Behavior of Materials</td>
<td>3</td>
<td>Theories of elasticity and plasticity, dislocation based plastic deformation, strengthening mechanisms, mechanical properties of solids and relevant testing methods, failure processes and theories, fracture mechanics. Coordinated lecture-lab periods. Prereq: MSE 201 and Junior Standing; or Permission.</td>
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<tr>
<td>MSE 413</td>
<td>Phase Transformation and Kinetics</td>
<td>3</td>
<td>Joint-listed with MSE 513 Free energy minimization algorithms. Construction of phase diagrams for liquid and solid systems. Reaction kinetics in liquid and solid systems. Determination of reaction kinetics parameters (reaction order, activation energy, reaction rate constants, etc.). Coordinated lecture-lab periods. Additional projects/assignments reqd for grad cr. Prereq: CHEM 112, CHEM 112L.</td>
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<tr>
<td>MSE 415</td>
<td>Materials Selection and Design</td>
<td>3</td>
<td>Selection of materials for use in structural applications; consideration of environment, stress conditions, cost, and performance as guide to properties; optimization of choice of materials and fabrication methods; open-ended problems of real applications in various industries. Recommended Preparation: MSE 313 and MSE 456. (Spring only) Prereq: MSE 201 and ENGR 350.</td>
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<tr>
<td>MSE 417</td>
<td>Instrumental Analysis</td>
<td>3</td>
<td>Principles and laboratory experiments in x-ray diffraction, scanning electron microscopy, transmission electron microscopy, thermal analysis, etc. (Fall only) Prereq: Junior/Senior standing in an engineering discipline.</td>
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<tr>
<td>MSE 421</td>
<td>Light Metals</td>
<td>3</td>
<td>Joint-listed with MSE 521 Principles behind the physical and extractive metallurgy of the light metals Al, Mg, Ti, Be; discussion of characteristics and applications of alloys based on these metals. Additional projects/assignments reqd for grad cr. Recommended Preparation: MSE 313.</td>
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<tr>
<td>MSE 423</td>
<td>Corrosion</td>
<td>3</td>
<td>Joint-listed with MSE 523. Engineering aspects of corrosion and its control presented in ways of importance to a practicing engineer. Topics include corrosion economics, detecting and monitoring corrosion, regulations, specifications, safety. Emphasis on corrosion monitoring and corrosion fundamentals: chemical and electrochemical reactions; chemical and electrochemical equilibria—including Pourbaix diagrams; electrochemical kinetics. Selection and use of materials, from stainless steels to plastics. Failure analysis. Additional projects/assignments reqd for graduate credit. (Fall only) Prereq: CHEM 112, CHEM 112L and MSE 201 or CHE 223; or Permission.</td>
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<tr>
<td>MSE 427</td>
<td>Ceramics Materials</td>
<td>3</td>
<td>Joint-listed with MSE 527. Crystallography, ceramic crystal structures, phase diagrams, phase transformation; mechanical properties, thermal properties, electrical and magnetic properties. Additional projects/assignments reqd for graduate credit. Recommended Preparation: MSE 313.</td>
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<tr>
<td>MSE 432</td>
<td>Fundamentals of Thin Film Fabrication</td>
<td>3</td>
<td>Physical deposition, chemical deposition, post deposition process, film characterization, and film properties. (Spring only) Prereq: Senior standing or Permission.</td>
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MSE 434 Fundamentals of Polymeric Materials  
3 credits  
Polymer structure/property relationships and engineering applications. Topics include: overview of polymer chemistry and physics as they inform structure and properties for real-world applications, including sustainability considerations. Coordinated lecture-lab periods.  
Prereq: CHEM 111, CHEM 111L and CHEM 112, CHEM 112L .

MSE 437 Radiation Effects on Materials  
3 credits  
Joint-listed with MSE 537. Cross-listed with NE 437, NE 537. Interactions between radiation and solids.  
Prereq: MSE 201 or Permission .

MSE 438 Fundamentals of Nuclear Materials  
3 credits  
Joint-listed with MSE 538. Cross-listed with NE 438, NE 538. This course is designed for students who wish to learn about nuclear materials and fuels from a materials science viewpoint. Topics to be covered include crystal structure, diffusion, radiation damage processes etc. Students who wish to receive credit for the 500 level course are required to do term-projects and advanced problems. (Spring only)  
Prereq: MSE 201 or NE 450; or Permission .

MSE 453 Process Analysis & Design I  
3 credits  
Cross-listed with CHE 453  
Estimation of equipment and total plant costs, annual costs, profitability decisions, optimization; design of equipment, alternate process systems and economics, case studies of selected processes. CHE 453 and CHE 454/MSE 453 and MSE 454 are to be taken in sequence. (Fall only)  
Prereq: CHE 330, CHE 341, and CHE 423; or MSE 201, MSE 308, MSE 313, MSE 340, and MSE 412 .

MSE 454 Process Analysis & Design II  
3 credits  
Gen Ed: Senior Experience  
Cross-listed with CHE 454  
Estimation of equipment and total plant costs, annual costs, profitability decisions, optimization; design of equipment, alternate process systems and economics, case studies of selected processes. MSE 453 and 454 are to be taken in sequence. (Spring only)  
Prereq: CHE 453 or MSE 453 .

MSE 456 Metallic Materials  
3 credits  
Processes for extracting metals; various classes of metallic alloys; casting, powder metallurgy, mechanical working, and joining of metals. Emphasis on understanding relationship of processing, structure and properties. Some lab demonstration of metal fabrication processes included.  
Prereq: MSE 313 or Permission .

MSE 464 Materials Physics and Engineering  
3 credits  
Joint-listed with MSE 564, Cross-listed with PHYS 464  
Materials for circuits, Magnetism and magnetic materials, Ferroelectric and piezoelectric materials, Semiconductors, Optical properties of semiconductor for optoelectronics, thermal properties, electron band theory, superconductivity. Additional projects/assignments required for graduate credit. (Spring only)  
Prereq: Senior standing in an Engineering or Physics major, or PHYS 305 and PHYS 321;or Permission .

MSE 498 (s) Internship  
Credit arranged.
MSE 523 Corrosion
3 credits
Joint-listed with MSE 423.
Engineering aspects of corrosion and its control presented in ways of importance to a practicing engineer. Topics include corrosion economics, detecting and monitoring corrosion, regulations, specifications, safety. Emphasis on corrosion monitoring and corrosion fundamentals: chemical and electrochemical reactions; chemical and electrochemical equilibria— including Pourbaix diagrams; electrochemical kinetics. Selection and use of materials, from stainless steels to plastics. Failure analysis. Additional projects/assignments reqd for graduate credit. (Fall only)
Prereq: CHEM 112, CHEM 112L and MSE 201 or CHE 223; or Permission.

MSE 525 Electronic Materials
3 credits
Study of major chemical and physical principles affecting properties of solid state engineering materials. Topics include bonding, carrier statistics, band-gap engineering, optical and transport properties, novel materials systems, characterization, magnetism, and comprehensive introduction to physics of solid state devices.
Prereq: Materials Science Engineering graduate student or Permission.

MSE 527 Ceramic Materials
3 credits
Joint-listed with MSE 427.
Crystallography, ceramic crystal structures, phase diagrams, phase transformation; mechanical properties, thermal properties, electrical and magnetic properties. Additional projects/assignments reqd for graduate credit. Recommended Preparation: MSE 313.

MSE 537 Radiation Effects on Materials
3 credits
Joint-listed with MSE 437. Cross-listed with NE 437, NE 537.
Interactions between radiation and solids.
Prereq: MSE 201 or Permission.

MSE 538 Fundamentals of Nuclear Materials
3 credits
Joint-listed with MSE 438. Cross-listed with NE 438, NE 538.
This course is designed for students who wish to learn about nuclear materials and fuels from a materials science viewpoint. Topics to be covered include crystal structure, diffusion, radiation damage processes etc. Students who wish to receive credit for the 500 level course are required to do term-projects and advanced problems. (Spring only)
Prereq: MSE 201 or NE 450; or Permission.

MSE 564 Materials Physics and Engineering
3 credits
Joint-listed with MSE 464, Cross-listed with PHYS 564
Materials for circuits, Magnetism and magnetic materials, Ferroelectric and piezoelectric materials, Semiconductors, Optical properties of semiconductor for optoelectronics, thermal properties, electron band theory, superconductivity. Additional projects/assignments required for graduate credit. (Spring only)
Prereq: Senior standing in an Engineering or Physics major, or PHYS 305 and PHYS 321; or Permission.

MSE 585 Nuclear Fuel Cycles
3 credits
Cross-listed with NE 585
Processes to support the existing LWR fuel cycle. Alternative fuel cycles including U-233, Pu239 and mixed oxide fuels, and advanced reactor concepts. Recycling and recovery of nuclear materials, with emphasis on traditional fast reactor recycle.
Prereq: Permission.

MSE 598 (s) Internship
Credit arranged.

MSE 599 (s) Research
Credit arranged.

MSE 600 Doctoral Research & Dissertation
Credit arranged.