

## MEDICINE

- 616\*.** **Allergy Clerkship**  
Fall, Spring, Summer. 2 to 12 credits.  
May reenroll for a maximum of 12 credits.  
P: MED 608 R: Grad Professional students  
in College of Human Medicine  
Office and hospital based experience to learn and develop diagnostic skills in allergy with a review of basic therapeutics as they relate to allergic diseases
- 617\*.** **Neurology Clerkship**  
Fall, Spring, Summer. 2 to 12 credits.  
May reenroll for a maximum of 12 credits.  
P: MED 608 R: Grad professional students  
in College of Human Medicine  
A combined office and inpatient experience that will provide the student with an opportunity to learn the concepts of evaluation and management of neurological disease
- 618\*.** **Infectious Diseases Clerkship**  
Fall, Spring, Summer. 2 to 13 credits.  
May reenroll for a maximum of 12 credits.  
P: MED 608 R: Grad Professional Students in College of Human Medicine  
The clerkship emphasizes acquisition in depth of knowledge and skills essential in solution of clinical problems in infectious and immunologic diseases. Integrated basic science input is afforded through relevant seminars
- 620\*.** **Endocrinology and Metabolism Clerkship**  
Fall, Spring, Summer. 2 to 12 credits.  
May reenroll for a maximum of 12 credits.  
P: MED 608 R: Grad Professional Students in College of Human Medicine  
Clinical and/or clinical-research clerkship to allow the student to work closely with patients having endocrine diseases, electrolyte abnormalities, endocrine hypertension or diabetes mellitus
- 626\*.** **Physical Medicine & Rehabilitation Clerkship**  
Fall, Spring, Summer. 2 to 13 credits.  
May reenroll for a maximum of 12 credits.  
P: MED 608 R: Grad Professional Students in College of Human Medicine  
Experience in prescription writing for physical medicine procedures, occupational therapy and rehabilitation skills
- 627\*.** **Rheumatology Clerkship**  
Fall, Spring, Summer. 2 to 12 credits.  
May reenroll for a maximum of 12 credits.  
P: MED 608 R: Grad Professional Students in College of Human Medicine  
Combined office and hospital consultative clerkship which develops diagnostic skills in areas of rheumatic diseases
- 628\*.** **Advanced Internal Medicine**  
Fall, Spring, Summer. 2 to 12 credits.  
May reenroll for a maximum of 12 credits.  
P: MED 608 R: Grad Professional Students in College of Human Medicine  
Clinical experiences which refine diagnostic and management skills in general internal medicine
- 630\*.** **Emergency Medicine Clerkship**  
Fall, Spring, Summer. 2 to 12 credits.  
May reenroll for a maximum of 12 credits.  
P: MED 608 R: Grad Professional Students in College of Human Medicine  
Pathophysiology and other basic concepts will be used to explain the development of emergent conditions. Clinical diagnosis and treatment of emergencies seen in community emergency departments will be discussed
- 632\*.** **Occupational Medicine Clerkship**  
Fall, Spring, Summer. 2 to 12 credits.  
May reenroll for a maximum of 12 credits.  
P: MED 608 R: Grad Professional Students in College of Human Medicine  
Overview of health problems of chemicals and mineral dusts. Occupational history taking. Occupational differential diagnosis of common conditions seen in primary care
- METALLURGY, MECHANICS, AND MATERIALS SCIENCE MMM**
- 160.** **Engineering Communications**  
Fall, Spring. 3(2-3)  
P: MTH 116 or concurrently.  
Computer-aided design and drafting. Freehand sketching. Two and three dimensional visualization. Preparation of spread sheets and technical reports.
- 205.** **Statics**  
Fall, Spring. 3(3-0)  
P: MTH 132.  
Vector description of forces and moments. Two and three dimensional equilibrium of particles and rigid bodies. Analysis of trusses, frames and machines. Coulomb friction.  
QP: MTH 215 QA: MMM 205
- 211.** **Mechanics of Deformable Solids**  
Fall, Spring. 3(3-2)  
P: MMM 205, MTH 133 or concurrently.  
Tension compression and shear stresses. Axially loaded bars. Torsion of circular shafts. Beam theory. Combined stresses. Mohr's circles. Columns.  
QP: MMM 205 MTH 310 MMM 215 QA: MMM 211 MMM 215
- 250.** **Materials Science and Engineering I**  
Fall, Spring. 3(3-2)  
P: CEM 141, MTH 133.  
Structure of metals, ceramics and polymers. Phase diagrams, thermomechanical treatments, physical and mechanical properties, diffusion, microstructure studies, environmental effects.  
QP: CEM 141 MTH 113 QA: MMM 250 MMM 230
- 306.** **Dynamics**  
Fall, Spring. 3(3-0)  
P: MMM 205, MTH 235. R: Open only to College of Engineering students.  
Kinematics of motion. Mass moments of inertia. Kinetics of particles and rigid bodies. Energy and momentum principles.  
QP: MMM 205 MTH 310 QA: MMM 306
- 351.** **Thermochemistry of Materials**  
Fall. 3(3-0)  
P: CEM 152, MTH 224. R: Open only to Materials Science and Engineering majors. Not open to students with credit in CHE 311 or ME 201.  
State variables, laws of thermodynamics, phase and chemical equilibria. Gas and condensed phase relationships, solutions, interfaces, point defects, electrochemistry.  
QP: CEM 152 MTH 215 QA: MMM 330
- 352.** **Diffusion in Solids**  
Spring. 3(3-0)  
P: MMM 250, MMM 351. R: Open only to Materials Science and Engineering majors.  
Diffusion and mass transport. Kinetics of diffusion-controlled processes. Point defects, nucleation and growth, interface motion.  
QP: MMM 330 QA: MMM 452
- 355.** **Mechanical Behavior of Materials**  
Fall. 3(3-0)  
P: MMM 211, MMM 250. C: MMM 375  
R: Open only to Materials Science and Engineering, Mechanical Engineering majors.  
Stress and strain, crystal elasticity, anelasticity and viscoelasticity. Mechanical properties in tension and torsion. Crystallographic aspects of plasticity.  
QP: MMM 211 MMM 250 QA: MMM 350 MMM 351
- 356\*.** **Deformation Mechanisms**  
Spring. 3(3-0)  
P: MMM 355. R: Open only to Materials Science and Engineering majors.  
Elementary dislocation theory, slip and twinning. Deformation of single and polycrystals. Temperature and strain rate effects. Work hardening, solution and particle strengthening. Creep, fatigue and fracture in metals, ceramics and polymers.  
QP: MMM 350 MMM 351 QA: MMM 351 MMM 456
- 365.** **Physical Metallurgy I**  
Fall. 3(3-0)  
P: MMM 250, MMM 351 or concurrently.  
C: MMM 375 R: Open only to Materials Science and Engineering majors.  
Complex binary and ternary phase diagrams. Solidification. Recovery, recrystallization and grain growth. Phase transformations.  
QP: MMM 250 MMM 330 MMM 360 QA: MMM 360 MMM 361
- 366.** **Physical Metallurgy II**  
Spring. 3(3-0)  
P: MMM 365. C: MMM 376 R: Open only to Materials Science and Engineering majors.  
Theory of alloy phases. Surfaces and interfaces. Diffusion controlled phase transformations in ferrous and non-ferrous alloys. Martensitic transformation. Amorphous structures.  
QP: MMM 360 MMM 330 QA: MMM 453 MMM 361
- 375\*.** **Materials Science Laboratory I**  
Fall. 1(0-3)  
P: MMM 355; C: MMM 365 R: Open only to Materials Science and Engineering majors.  
Phase transformations. Recrystallization. Precipitation and aging. Microscopy. Structure-property relations.  
QP: MMM 350 MMM 360 QA: MMM 352 MMM 362
- 376\*.** **Materials Science Laboratory II**  
Spring. 1(0-3)  
P: MMM 356 or concurrently. R: Open only to Materials Science and Engineering majors.  
Strengthening. Yield, creep, and fracture. Plasticity. Thermal activation. Damping. Martensite and shape memory.  
QP: MMM 350 MMM 360 QA: MMM 352 MMM 362
- 380.** **Polymeric Materials**  
Spring. 3(3-0)  
P: CEM 152. R: Open only to Materials Science and Engineering majors.  
Polymers and engineering plastics. Chemical, physical and mechanical properties. Environmental effects on polymers. Manufacturing processes. Coatings.  
QP: CEM 152

**METALLURGY, MECHANICS, AND MATERIALS SCIENCE**

- 401\*.** **Intermediate Mechanics of Deformable Solids**  
 Fall. 3(3-0)  
 P: MMM 211. R: Open only to College of Engineering majors.  
 Stress, strain and linearly elastic behavior. Plane stress and plane strain. Torsion. Yield criteria. Elastoplastic behavior of beams, shafts and cylinders. Unsymmetrical bending. Curved beams.  
 QP: MMM 211 QA: MMM 401
- 402\*.** **Computational Mechanics**  
 Spring. 3(3-0)  
 P: MMM 401, ME 471. R: Open only to College of Engineering majors.  
 Energy methods with applications. Finite element methods. Buckling and stability. Green's functions.  
 QP: MMM 401 QA: MMM 402
- 403\*.** **Intermediate Dynamics**  
 Fall of even-numbered years. 3(3-0)  
 P: MMM 306. R: Open only to College of Engineering majors.  
 Kinematics and dynamics of particle and rigid body systems. Virtual work, Lagrangian method, Euler equations. Basic vibrations of discrete and continuous systems. Elementary wave propagation.  
 QP: MMM 306 QA: MMM 403
- 405\*.** **Experimental Mechanics**  
 Fall of odd-numbered years. 3(2-3)  
 P: MMM 211, MMM 306. R: Open only to College of Engineering majors.  
 Measurement of stress, strain, vibration, and motion using strain gauges, accelerometers, photoelasticity, holography, Moire patterns, laser speckle and electronic imaging. Transducer design.  
 QP: MMM 211 MMM 215MMM 306 QA: MMM 405
- 444\*.** **Introduction to Composite Materials**  
 Spring. 3(3-0)  
 P: MMM 211. R: Open only to College of Engineering majors.  
 Constituents and interfacial bonding. Manufacturing techniques. Microstructure and micromechanics. Theory of anisotropy. Classical laminate theory. Material characterization. Failure and damage. Composite structure design.  
 QP: MMM 211 QA: MMM 444
- 451.** **X-Ray Crystallography**  
 Fall. 3(2-3)  
 P: MMM 250. R: Open only to Materials Science and Engineering seniors and graduate students.  
 General properties, generation and detection of x-rays. Interaction with solids. Crystallography, reciprocal lattice, diffraction analysis and techniques. Single crystal methods, stereographic projection. X-ray microanalysis.  
 QP: MMM 250 QA: MMM 430
- 454.** **Ceramic and Refractory Materials**  
 Fall. 3(3-0)  
 P: MMM 250, MMM 351. R: Open only to Materials Science and Engineering majors.  
 Ceramic and glassy materials. High temperature processes. Mechanical and physical properties of technical ceramics.  
 QP: MMM 250 QA: MMM 420
- 455.** **Theory of Solids**  
 Spring. 3(3-0)  
 P: MMM 451. R: Open only to Materials Science and Engineering majors.  
 Atomic theory of materials. Free electron theory of metals. Electrons in a periodic field. Insulators, semiconductors. Thermal properties. Dielectric and magnetic behavior. Superconductivity.  
 QP: MMM 430 PHY 289 QA: MMM 454
- 465.** **Design and Application of Engineering Materials**  
 Spring. 3(3-0)  
 P: MMM 356, MMM 365. R: Open only to Materials Science and Engineering majors.  
 Fundamental principles of strengthening; toughening, specific strength and stiffness. Material development based on environmental, temperature, wear, damping, fatigue and economic considerations.  
 QP: MMM 330 MMM 456 QA: MMM 476
- 466.** **Failure Analysis**  
 Spring. 3(3-0)  
 P: MMM 211, MMM 250. R: Open only to College of Engineering seniors and graduate students.  
 Modes and causes of failure in mechanical components. Non-destructive evaluation. Legal and economic aspects of materials failure. Analysis illustrated through student projects requiring integration of knowledge from several courses.  
 QP: MMM 211 MMM 215MMM 250 QA: MMM 425 MM 465
- 475.** **Deformation Processing of Materials**  
 Fall of odd-numbered years. 3(3-0)  
 P: MMM 355. R: Open only to Material Science and Engineering, Mechanical Engineering majors.  
 Theories of metal forming. Forging, rolling, extrusion, wire drawing, sheet metal forming, machining, powder pressing, sintering, hot pressing, composite processing.  
 QP: MMM 350 QA: MMM 462 MMM 481
- 476.** **Physical Processing of Materials**  
 Spring of even-numbered years. 3(3-0)  
 P: MMM 365. R: Open only to College of Engineering majors.  
 Heat treatment and properties of ferrous alloys. Casting and solidification. Effects of alloying elements, high strength low alloy steels, hardenability, case hardening. Joining of materials, welding.  
 QP: MMM 350 MMM 360 QA: MMM 461 MMM 463
- 480.** **Chemical Processing of Materials**  
 Fall. 3(3-0)  
 P: MMM 352, or CHE 312. R: Open only to Materials Science and Engineering, and Chemical Engineering seniors and graduate students.  
 Processing of metals, ceramics, and polymers. Material and energy balances. Reduction and oxidation. Extractive technology of iron, steel, and principal non-ferrous metals. Colloidal preparation of ceramics.  
 QP: MMM 330 QA: MMM 480
- 481.** **Manufacturing Systems I**  
 Fall. 3(3-0)  
 P: MMM 205, MMM 250. R: Open only to College of Engineering majors.  
 Manufacturing process planning and design. Discrete parts and assembly processes. Productivity, cost estimation, time standards, materials handling, plant layout principles.  
 QP: MMM 201 MMM 205MMM 230MMM 250 QA: MMM 421 MMM 442
- 482.** **Manufacturing Systems II**  
 Spring. 3(3-0)  
 P: MMM 481. R: Open only to College of Engineering majors.  
 Operations scheduling and control. Applications of artificial intelligence. Optimization of multiple stage manufacturing activities. Manufacturing resource planning. Principles of synchronous manufacturing.  
 QP: MMM 205 MMM 421 QA: MMM 422 MMM 442
- 483.** **Environmental Effects on Materials**  
 Spring of even-numbered years. 3(3-0)  
 P: MMM 352. R: Open only to Materials Science and Engineering majors.  
 Electrochemical processes and kinetics. Metallic corrosion and protection. Degradation of ceramics, polymers and composites.  
 QP: MMM 330 QA: MMM 431
- 490\*.** **Independent Study**  
 Fall, Spring, Summer. 1 to 3 credits.  
 May reenroll for a maximum of 6 credits.  
 R: Open only to Materials Science and Engineering majors. Approval of department.  
 Individualized reading and research.  
 QA: MMM 400
- 491\*.** **Selected Topics**  
 Fall, Spring, Summer. 1 to 3 credits.  
 May reenroll for a maximum of 6 credits.  
 P: Depends upon topic selected.  
 Special topics in Materials Science or Mechanics of current interest and importance.
- 499\*.** **Senior Research and Design Project**  
 Fall, Spring, Summer. 2 to 4 credits.  
 May reenroll for a maximum of 6 credits.  
 R: Open only to Materials Science and Engineering, and Engineering Arts, seniors. Approval of department.  
 Design and analysis to solve a materials related problem.  
 QA: MMM 499
- 801\*.** **Advanced Dynamics**  
 Fall. 3(3-0)  
 P: MMM 403, or approval of department  
 R: Graduate students  
 Dynamics of systems of particles and rigid bodies. Energy and momentum principles. Lagrangian and Hamiltonian methods. Euler angles. Applications in system dynamics and vibrations.  
 QP: MMM 306 QA: MMM 801
- 805\*.** **Experimental Mechanics**  
 Spring. 3(2-3)  
 P: Approval of Department R: Graduate students  
 Measurement of strain, displacement, velocity, acceleration using resistance strain gages, accelerometers, and related methods. Detailed study of strain gages and accelerometers. Transducer design. Basic modal analysis.  
 QA: MMM 805
- 809\*.** **Finite Element Method**  
 Fall. 3(3-0) Interdepartmental with the Department(s) of Agricultural Engineering, Mechanical Engineering.  
 P: Approval of Department R: Graduate students  
 Theory and application of the finite element method to the solution of continuum type problems in heat transfer, fluid mechanics and stress analysis.  
 QA: 809
- 810\*.** **Continuum Mechanics**  
 Fall. 3(3-0)  
 P: MMM 401, MTH 421, or approval of Department  
 Mathematical tools of continuum mechanics, stress principles, kinematics of deformation and motion, fundamental laws and equations, applications in linear elasticity and classical fluids.  
 QA: 810

**METALLURGY, MECHANICS, AND MATERIALS SCIENCE**

- 813\*.** **Linear Elasticity**  
 Spring. 3(3-0)  
 P: MMM 810  
 Fundamentals of isotropic linear elasticity. Solution of plane elasticity problems. St. Venant bending and torsion. Singular solutions. Basic 3-dimensional solutions.  
 QP: MMM 810 QA: MMM 813
- 814\*.** **Mechanics of Composite Materials(MTC)**  
 Fall. 3(3-0) May reenroll for a maximum of 6 credits.  
 P: MMM 813  
 Subtitles: Fiber-reinforced Composite Materials. Laminated Composite Structures.  
 QP: MMM 813 QA: MMM 814
- 814A\*.** **Fiber-reinforced Composite Materials**  
 Fall of odd-numbered years. 3(3-0)  
 P: MMM 813  
 Application of anisotropic elasticity theory to fiber-reinforced composite materials. Effects of inhomogeneity. Failure analysis. Effective properties.  
 QP: MMM 813
- 814B\*.** **Laminated Composite Structures**  
 Fall of even-numbered years. 3(3-0)  
 P: MMM 813  
 Fundamentals of anisotropic elasticity, applications to laminated composite structures, unique states of deformation, stress, vibration and buckling not encountered in isotropic, homogeneous constructions.  
 QP: MMM 813 QA: MMM 814
- 815\*.** **Advanced Strength of Materials**  
 Spring of odd-numbered years. 3(3-0)  
 P: MMM 401  
 General theory of torsion, nonsymmetric bending, transverse shear, thin-walled beams, beams on elastic foundations, thick-walled cylinders. Basic contact mechanics. Failure criteria for solids.  
 QP: MMM 401 QA: MMM 815
- 816\*.** **Fracture Mechanics and Fatigue**  
 Spring of even-numbered years. 3(3-0)  
 P: MMM 813  
 Brittle and ductile fracture. Elastic stress fields near cracks. Elastic-plastic analysis of crack extension. Plastic instability. Cyclic crack propagation. Models of cyclic deformation and fatigue failure. Environmental effects. Case studies.  
 QA: 916 917
- 817\*.** **Plasticity**  
 Spring of odd-numbered years. 3(3-0)  
 P: MMM 813 R: Graduate students  
 Yield conditions, stress-strain relations, plastic potential, hardening theories, torsion, bending. Thick walled shells under internal pressure. Limit analysis. Slip line theory.  
 QP: MMM 813 QA: MMM 817
- 820\*.** **Energy Methods in Mechanics**  
 Spring of even-numbered years. 3(3-0)  
 P: MMM 813 R: Graduate students  
 Calculus of variations. Variational principles in mechanics. Approximate methods. Energy criteria for stability. Applications to structural dynamics.  
 QP: MMM 813 QA: MMM 820
- 831\*.** **Plates and Shells**  
 Fall of odd-numbered years. 3(3-0)  
 Interdepartmental with the Department(s) of Civil Engineering.  
 P: MMM 815  
 Deformation and stress analysis of plates and shells with different types of geometry, thickness, and boundary conditions.  
 QP: MMM 815 CE 804 QA: MMM 912 MMM 909
- 835\*.** **Wave Propagation in Solids**  
 Fall of odd-numbered years. 3(3-0)  
 P: MMM 810  
 Plane waves in elastic media, reflection of waves at interfaces. Surface waves, waveguides. Application to nondestructive evaluation. Introduction to wave propagation in anisotropic and nonelastic solids.  
 QP: MMM 810
- 851\*.** **Thermodynamics of solids**  
 Fall. 3(3-0)  
 P: MMM 351 R: Graduate Students or Honors students  
 Materials Science and Engineering, Mechanics  
 Use of Jacobians. Thermodynamic functions. Thermodynamics of solid-solid phase transformation. Thermoelastic solids, rubber elasticity and stressed solid. Surfaces and interfaces, point defects in solids. Thermodynamics of solids under high pressure.  
 QP: MMM 330 QA: MMM 825
- 855\*.** **Advanced Rate Theory and Diffusion**  
 Spring. 3(3-0)  
 P: MMM 851 R: Graduate students or Honors students  
 Materials Science and Engineering  
 Review of Fick's Laws. Atomistic aspects of diffusion. Defects in solids. Probabilistic basis of random walk. Green's function solutions.  
 QP: MMM 825 QA: MMM 863
- 862\*.** **Dislocation Theory**  
 Fall. 3(3-0)  
 P: MMM 451 R: Graduate students or Honors students  
 Materials Science and Engineering  
 Advanced theory of dislocations and other crystal defects in metals, ceramics, aggregates and ordered compounds. Elasticity theory of straight dislocations, dislocation strain energy, mobility, obstacle interactions, reactions, and core effects.  
 QP: MMM 825 QA: MMM 872
- 865\*.** **Advanced Theory of Solids**  
 Spring. 3(3-0)  
 P: MMM 851 R: Graduate students or Honors students  
 Materials Science and Engineering  
 Quantum mechanics. Free electron theory. Energy bands, semiconductors. Dielectrics and ferroelectrics. Dia-, para-, ferro-, and antiferro-magnetism. Superconductivity. Thermal properties.  
 QP: MMM 825 QA: MMM 861
- 870\*.** **Electron Microscopy in Materials Science**  
 Spring. 3(2-3)  
 P: MMM 451 R: Graduate students or Seniors in MSE  
 MSE or permission of instructor  
 Theory of electron diffraction. Electromagnetic lenses. Image formation in transmission electron microscopy. Defect analysis and diffraction contrast.  
 QP: MMM 430 QA: MMM 832
- 875\*.** **Engineering Ceramics**  
 Fall of odd-numbered years. 3(3-0)  
 P: MMM 454, MMM 455 R: Graduate students or Honors students  
 Materials Science and Engineering  
 Physical properties of engineering ceramics. Transport properties of ceramics, especially in ferrites and garnets. Optical ceramic materials.  
 QP: MMM 420 MMM 454 QA: MMM 849
- 876\*.** **Advanced Polymeric Materials**  
 3(3-0)  
 P: MMM 380 R: Graduate students  
 Engineering  
 Advanced topics in polymer structure and properties. Thermoplastics, thermosets, polyblends and elastomers. Processing techniques. Deformation and mechanical properties. Thermal, optical and chemical properties. Composites.
- 885\*.** **Seminar**  
 Fall, Spring. 1(1-0)  
 R: Graduate students or Honors students  
 Materials Science and Engineering, Mechanics  
 Oral presentation of student's own research or literature survey.  
 QA: MMM 885
- 890\*.** **Special Problems**  
 Fall, Spring, Summer. 1 to 3 credits.  
 May reenroll for a maximum of 6 credits.  
 R: Graduate students or Honors students  
 Materials Science and Engineering, Mechanics  
 Individualized reading and research compatible with the Masters student's interest and ability.  
 QA: MMM 800
- 891\*.** **Selected Topics**  
 Fall, Spring, Summer. 1 to 3 credits.  
 May reenroll for a maximum of 6 credits.  
 P: Depend on topic selected R: Graduate students or Honors students  
 Materials Science and Engineering  
 Special topics in Materials Science or Mechanics of current interest and importance.  
 QA: MMM 890
- 899\*.** **Master's thesis research**  
 Fall, Spring, Summer. 1 to 8 credits.  
 May reenroll for a maximum of 0 credits.  
 R: Masters degree students  
 Materials Science and Engineering, Mechanics  
 Master's thesis research  
 QA: MMM 899
- 905\*.** **Optical Methods of Measurement**  
 Fall of even-numbered years. 3(2-3)  
 P: Approval of Department R: Graduate students  
 Measurement of dimension, position, motion, strain, using optical methods including holography, speckle interferometry, moire, photoelasticity, laser Doppler, electronic imaging, model analysis. Necessary optics theory is presented.  
 QA: MMM 806
- 909\*.** **Boundary Element Method**  
 Spring of odd-numbered years. 3(3-0)  
 P: MMM 813  
 Theory and application of the boundary element method to the solution of continuum type problems in heat transfer, fluid mechanics and stress analysis. Computer applications.
- 915\*.** **Nonlinear Elasticity**  
 Spring of even-numbered years. 3(3-0)  
 P: MMM 813  
 Kinematics and kinetics of large deformations. Incompressible and compressible finite elasticity. Solution of basic problems. Nonuniqueness, stability and buckling. Singular fields near cracks and flaws.  
 QP: MMM 813 QA: MMM 915
- 918\*.** **Thermoelasticity and Viscoelasticity**  
 Spring of even-numbered years. 3(3-0)  
 P: MMM 810, MTH 422  
 Thermomechanics of solids. Theory of thermoelasticity. Boundary value problems in thermoelasticity. Linear and nonlinear viscoelasticity. Model representation. Boltzmann superposition. Correspondence principle.  
 QP: MMM 810, MTH 422 QA: MMM 918
- 922\*.** **Micromechanics**  
 Spring of odd-numbered years. 3(3-0)  
 P: MMM 813 and approval of Department  
 R: Graduate students  
 Models of microstructures. Inclusion problems. Eigenstrain method. Upper and lower bounds. Methods of statistical elasticity. Approximate methods. Mechanics of random networks. Percolation models of damage.  
 QP: MMM 813 QA: MMM 900

**METALLURGY, MECHANICS, AND MATERIALS SCIENCE**

**960\*.** **Advanced Physical and Mechanical Properties of Materials(MTC)**  
 Fall. 3(3-0) May reenroll for a maximum of 9 credits.  
 P: Depend on subtitle R: Graduate students *Materials Science and Engineering, Mechanics*  
 Subtitles: Microcracking in Brittle Materials. Anisotropic Crystalline Properties. Surfaces, Interfaces and Thin Film Structures.

**960A\*.** **Microcracking in Brittle Materials**  
 Fall. 3(3-0)  
 P: MMM 454, MMM 875 R: Graduate students *Materials Science and Engineering, Mechanics*  
 Microcracking mechanisms and the effect of microcracks on mechanical, thermal and electrical properties. Microcracking theories. Experimental investigations of microcracks.

**960B\*.** **Anisotropic Crystalline Properties**  
 Fall. 3(3-0)  
 P: MMM 451, MMM 851 R: Graduate students *Materials Science and Engineering, Mechanics*  
 Crystallography. Tensor representation. Magnetic susceptibility. Electric polarization. Stress and strain. Thermal expansion. Piezoelectricity. Elasticity. Transport properties.

**960C\*.** **Surfaces, Interfaces and Thin Film Structures**  
 Fall. 3(3-0)  
 P: MMM 851, MMM 855, MMM 860 R: Graduate students *Materials Science and Engineering*  
 Fundamental thermodynamic, kinetic, and mechanical aspects of surfaces, boundary structures, and thin films, with application to current and emerging techniques for control of surface and interface properties and fabrication of thin film structures.

**970\*.** **Advanced Analytical Techniques(MTC)**  
 Spring. 3(3-0) May reenroll for a maximum of 9 credits.  
 P: Depends on subtitle R: Graduate students *Materials Science and Engineering*  
 Subtitles: Advanced Techniques in Electron Microscopy. Advanced Analytical Methods in Materials Science. Advanced X-ray Methods.

**970A\*.** **Advanced Techniques in Electron Microscopy**  
 Spring. 3(3-0)  
 P: MMM 870 R: Graduate students MSE or permission of instructor  
 Advanced experimental methods in transmission electron microscopy. Includes, microanalytical, chemical, microbeam, diffraction and lattice imaging techniques.  
 QP: MMM 832

**970B\*.** **Advanced Analytical Methods in Materials Science**  
 Spring. 3(3-0)  
 P: MMM 451, MMM 870 R: Graduate students *Materials Science and Engineering*  
 Advanced diffraction, fluorescence, spectrographic and microimaging techniques and their application to problems of structure determination and compositional analysis in materials science.  
 QP: MMM 430 MMM 832

**970C\*.** **Advanced X-ray Methods**  
 Spring. 3(3-0)  
 P: MMM 451 R: Graduate students *Materials Science and Engineering*  
 Theoretical basis for advanced X-ray techniques useful in crystal structure analysis and materials research.  
 QP: MMM 430

**980\*.** **Advanced Processing Techniques(MTC)**  
 Spring. 3(3-0) May reenroll for a maximum of 9 credits.  
 P: Depend on subtitle R: Graduate students *Materials Science and Engineering*  
 Subtitles: Ceramic Processing. High Temperature Deformation and Processing. Laser and plasma processing.

**980A\*.** **Ceramic Processing**  
 Spring. 3(3-0)  
 P: MMM 851, MMM 875 R: Graduate students *Materials Science and Engineering*  
 Fundamental aspects of ceramic powder processing with emphasis upon recent developments and the underlying principles involved. The class is organized in the order of the processing stream from making the powder to consolidation.  
 QP: MMM 824 MMM 849

**980B\*.** **High Temperature Deformation and Processing**  
 Spring. 3(3-0)  
 P: MMM 851, MMM 860 R: Graduate students *Materials Science Engineering*  
 Theoretical and design principles needed to understand and control creep, superplasticity, cavitation, recrystallization, and texture changes are discussed for metal, alloy, intermetallic, ceramic and composite systems.  
 QP: MMM 825 MMM 872

**980C\*.** **Laser and Plasma Processing**  
 Spring. 3(3-0)  
 Application of laser and plasma technology in materials processing. Optical and surface properties. Thin films. Heat and mass flow. Heat-treating. Cutting, drilling, and joining.

**990\*.** **Special Problems**  
 Fall, Spring, Summer. 1 to 3 credits.  
 May reenroll for a maximum of 6 credits.  
 R: Graduate students *Materials Science and Engineering, Mechanics*, Individualized reading and research compatible with that expected of Doctoral candidates.  
 QA: MMM 900

**991\*.** **Selected Topics**  
 Fall, Spring, Summer. 1 to 3 credits.  
 May reenroll for a maximum of 6 credits.  
 P: Depend on topic selected R: Graduate Students *Materials Science and Engineering, Mechanics*  
 Special advanced topics in Materials Science and Engineering, and Mechanics.

**999\*.** **Doctoral Dissertation Research**  
 Fall, Spring, Summer. 1 to 12 credits.  
 May reenroll for a maximum of 0 credits.  
 R: Doctoral students *Materials Science and Engineering, Mechanics*  
 Doctoral dissertation research  
 QA: MMM 999

**MICROBIOLOGY AND PUBLIC HEALTH MPH**

**101\*.** **Preview of Microbiology**  
 Fall. 1(1-0)  
 R: Open only to freshmen and sophomores.  
 Not open to students with credit in a microbiology course.  
 Overview of modern microbiology, emphasizing impact on society.  
 QA: MPH 101

**205.** **Allied Health Microbiology**  
 Fall. 3(3-0)  
 P: CEM 141 or CEM 151.  
 Microbial structure, function, growth, death, and control related to medical and public health concerns. Host-parasite relationships, immunology, action of major pathogenic groups. Commercial applications of microbiology.  
 QP: CEM 141

**206.** **Allied Health Microbiology Laboratory**  
 Fall. 1(0-2)  
 P: MPH 205 or concurrently.  
 Fundamentals of microbiological techniques including microscopy, staining, aseptic technique, culture media, identification, control with disinfectants and antibiotics, and safety in the microbiological laboratory.  
 QP: MPH 200

**301\*.** **Introductory Microbiology**  
 Spring. 3(3-0)  
 P: CEM 251.  
 Fundamentals of microbiology, including microbial structure and function, nutrition and growth, death and control. Importance and applications of major microbial groups.  
 QP: CEM 241 QA: MPH 301 MPH 303

**302\*.** **Introductory Microbiology Laboratory**  
 Spring. 1(0-3)  
 P: MPH 301 or concurrently.  
 Methodology of microbiology: microscopy, staining, aseptic technique, culture media, quantification, and laboratory safety.  
 QP: MPH 301 ORMPH 303 CONCURR QA: MPH 302 MPH 304

**401\*.** **Prokaryotic Physiology and Genetics**  
 Fall. 4(4-0)  
 P: MPH 301; BCH 461 or concurrently.  
 Prokaryotic cell structure and function, macromolecular synthesis and control, unique metabolic pathways, and genetics of bacteria and bacteriophages.  
 QP: MPH 303 ORMPH 301 BCH 451 QA: MPH 407 MPH 421

**403\*.** **Eukaryotic Cells and Viruses**  
 Spring. 4(4-0)  
 P: BCH 462 or concurrently.  
 Molecular analyses of eukaryotic cell structure and function, growth and division. Cell-cell communication and signalling. Virus structure and replication strategies, virus-cell interactions.  
 QP: MPH 303 BCH 453 QA: MPH 403 MPH 413

**408\*.** **Advanced Microbiology Laboratory**  
 Fall. 3(1-6)  
 P: MPH 302; MPH 401 or concurrently.  
 R: Open only to Microbiology majors.  
 Microbiological techniques and procedures to study physiology and genetics of bacteria and bacteriophages. Collection and critical assessment of quantitative data and written communication of results.  
 QP: MPH 303 QA: MPH 304 MPH 306

**425\*.** **Microbial Ecology**  
 Spring. 3(3-0) Interdepartmental with the Department(s) of Crop and Soil Sciences.  
 P: MPH 301  
 Microbial population and community interactions; microbial activities in natural systems, including associations with plants or animals  
 QP: MPH 301 ORMPH 303 QA: MPH 426 MPH 426A