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 disease  

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 12 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 research clerkship to allow the student to work closely with patients having endocrine diseases, electrolyte abnormalities, endocrine hypertension or diabetes mellitus  

625. Physical Medicine & Rehabilitation 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  
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 exposure 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 emergency 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  

160. Engineering Communications  
Fall, Spring. 3(3-2)  
P: Either CEM 116 or concurrently.  
Computer-aided design and drafting. Freehand sketching. Two and three dimensional visualization. Preparation of spread sheets and technical reports  

305. Statistics  
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.  

311. Mechanics of Deformable Solids  
Fall, Spring. 3(3-2)  
P: MTH 205, MTH 133 or concurrently.  

350. Materials Science and Engineering  
Fall, Spring. 3(3-2)  
P: CEM 141, MTH 133  
Structure of metals, ceramics and polymers. Phase diagram, thermomechanical treatments, physical and mechanical properties, diffusion, microstructure studies, environmental effects.  

356. Dynamics  
Fall, Spring. 3(3-0)  
P: MTH 205, MTH 235  
R: Open only to College of Engineering students.  

351. Thermodynamics and Materials  
Fall. 3(3-0)  
P: CEM 152, MTH 234  
R: Open only to Materials Science and Engineering majors.  
State variables, laws of thermodynamics, phase and chemical equilibria. Gas and condensed phase relationships, solutions, interfaces, point defects, electrochemistry.  

352. Diffusion in Solids  
Fall. 3(3-0)  
P: MTH 205, MTH 351  
R: Open only to Materials Science and Engineering majors.  

355. Mechanical Behavior of Materials  
Fall. 3(3-0)  
P: MTH 211, MTH 250, C; MTH 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.  

356. Deformation Mechanisms  
Spring. 3(3-0)  
P: MTH 250  
R: Open only to Materials Science and Engineering majors.  

358. Physical Metallurgy I  
Fall. 3(3-0)  
P: MTH 250, MTH 351 or concurrently.  
C: MTH 375  
R: Open only to Materials Science and Engineering majors.  

359. Physical Metallurgy II  
Spring. 3(3-0)  
P: MTH 250, C; MTH 375  
R: Open only to Materials Science and Engineering majors.  

360. Materials Science Laboratory I  
Fall. 1(0-3)  
P: MTH 250, C; MTH 356  
R: Open only to Materials Science and Engineering majors.  

361. Materials Science Laboratory II  
Spring. 1(0-3)  
P: MTH 250 or concurrently.  
R: Open only to Materials Science and Engineering majors.  

362. Polymers and Materials Science  
Spring. 3(3-0)  
P: CEM 152  
R: Open only to Materials Science and Engineering majors.  

P: CEM 125  

Courses with an asterisk (*) have not been approved by the University Committee on Curriculum.  
E-121
Fall. 3(3-0) P: MMM 211. R: Open only to College of Engineering majors.
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.
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.
QP: MMM 306 QA: MMM 403

405. Experimental Mechanics
Fall of odd-numbered years. 3(2-3) P: MMM 211, MMM 305. R: Open only to College of Engineering majors.
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.
QP: MMM 211 QA: MMM 444

451. X-Ray Crystallography
Fall. 3(3-0) P: MMM 250. R: Open only to Materials Science and Engineering seniors and graduate students.
QP: MMM 250 QA: MMM 451

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 241. R: Open only to Materials Science and Engineering majors.
QP: MMM 430 PHY 289 QA: MMM 454

465. Design and Application of Engineering Materials
Spring. 3(3-0) P: MMM 305, 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 MMM 465

475. Deformation Processing of Materials
Fall of odd-numbered years. 3(3-0) P: MMM 355. R: Open only to Materials 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.
QP: MMM 350 MMM 350 QA: MMM 461 MMM 463

490. Chemical Processing of Materials
Fall. 3(3-0) P: MMM 352, or CHE 312. R: Open only to Materials Science and Engineering, Chemical Engineering seniors and graduate students.
QP: MMM 330 QA: MMM 480

491. Manufacturing Systems I
Fall. 3(3-0) P: MMM 265, 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.
QP: MMM 205 MMM 421 QA: MMM 442 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.
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.
QP: 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.
QP: MMM 499

499. Senior Research and Design Project
Spring. 3(2-3) P: 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. QA: MMM 306 QA: MMM 801

805. Engineering Mechanics
Spring. 3(3-3) P: Approval of Department R: Graduate students.
QP: 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: 808

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.
QP: QA: 810
813*. Linear Elasticity
Spring, 3(3-0)
P: MMM 810
QP: MMM 810 QA: MMM 813

814*. Mechanics of Composite Materials (NTC)
Fall, 3(3-0) May reenroll for a maximum of 6 credits.
P: MMM 813
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
QP: MMM 813

815*. Advanced Theory of Finite Elements
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
QA: 916 917

820*. Energy Methods in Mechanics
Spring of even-numbered years. 3(3-0)
P: MMM 813 R: Graduate students
QP: MMM 813 QA: MMM 820

831*. Plates and Shells
Fall of odd-numbered years. 3(3-0)
Interdepartmental with the Department of Civil Engineering.
P: MMM 815
Deformation and stress analyses of plates and shells with different types of geometry, thickness, and boundary conditions.
QP: MMM 813 CE 804 QA: MMM 912 MMM 899

835*. Wave Propagation in Solids
Fall of odd-numbered years. 3(3-0)
P: MMM 810
Plane wave in anisotropic 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 851 R: Graduate Students or Honors students Materials Science and Engineering, Mechanics
QP: MMM 830 QA: MMM 825

855*. Advanced Rate Theory and Diffusion
Spring, 3(3-0)
P: MMM 855 R: Graduate students or Honors students Materials Science and Engineering, Mechanics
QP: MMM 825 QA: MMM 863

862*. Dislocation Theory
Fall. 3(3-0)
P: MMM 862 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)
QP: MMM 825 QA: MMM 861

870*. Electron Microscopy in Materials Science
Spring, 3(3-0)
P: MMM 870 R: Graduate students or Honors students Materials Science and Engineering
QP: MMM 840 QA: MMM 832

875*. Engineering Ceramics
Fall of odd-numbered years. 3(3-0)
P: MMM 875 R: Graduate students or Honors students Materials Science and Engineering
Physical properties of engineering ceramics. Transport properties of ceramics, especially in ferroics and garnets. Optical ceramic materials.
QP: MMM 420 MMM 454 QA: MMM 849

876*. Advanced Polymeric Materials
Spring, 3(3-0)
P: MMM 876 R: Graduate students Engineering
Advanced topics in polymer structure and properties. Thermomechanical properties. Processing techniques. Deformation and mechanical properties. Thermal, optical and chemical properties. Composites.
QP: MMM 876 QA: MMM 909

885*. Seminar
Fall, Spring, 1(1-0)
P: 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.
P: Graduate students or Honors students Materials Science and Engineering, Mechanics
Special topics in Materials Science or Mechanics of current interest and importance.
QA: MMM 890

901*. 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, Mechanics
QA: MMM 890

905*. Optical Methods of Measurement
Fall of even-numbered years. 3(3-0)
P: Approval of Department R: Graduate students
Measurement of dimension, position, motion, strain, using optical methods including holography, speckle interferometry, moire, photelasticity, laser doppler, electronic imaging, model analysis. Necessary optical theory is presented.
QA: MMM 905

919*. 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
QA: MMM 813 QA: MMM 915

918*. Thermomechanics and Viscoelasticity
Spring of even-numbered years. 3(3-0)
P: MMM 810, MTH 422
QP: MMM 810, MTH 422 QA: MMM 918

920*. Micromechanics
Spring of odd-numbered years. 3(3-0)
P: MMM 813 and approval of Department R: Graduate students
QP: MMM 813 QA: MMM 900
960*. Advanced Physical and Mechanical Properties of Materials (MTC) Spring. 3(3-0) May reenroll for a maximum of 9 credits.
P: Depend on syllabus. Graduate students Materials Science and Engineering, Mechanics

960A*. Microcracking in Brittle Materials Fall. 3(3-0) F: MME 454, MME 875 R: Graduate students Materials Science and Engineering, Mechanics
Microcracking mechanisms and the effect of microcracks on mechanical, thermal, and electrical properties. May reenroll for a maximum of 9 credits.
P: Depend on syllabus. Graduate students Materials Science and Engineering, Mechanics

960B*. Anisotropic Crystalline Properties Fall. 3(3-0) F: MME 451, MME 851 R: Graduate students Materials Science and Engineering, Mechanics
P: Depend on syllabus. Graduate students Materials Science and Engineering, Mechanics

960C*. Surfaces, Interfaces and Thin Film Structures Fall. 3(3-0) F: MME 851, MME 855, MME 860 R: Graduate students Materials Science and Engineering, Mechanics
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.
P: Depend on syllabus. Graduate students Materials Science and Engineering, Mechanics

970*. Advanced Analytical Techniques (MTC) Spring. 3(3-0) May reenroll for a maximum of 9 credits.
P: Depend on syllabus. Graduate students Materials Science and Engineering, Mechanics

970A*. Advanced Techniques in Electron Microscopy Spring. 3(3-0) F: MME 870 R: Graduate students Materials Science and Engineering
Advanced experimental methods in transmission electron microscopy. Microanalysis, microanalysis, chemical, microbeam, diffraction, and lattice imaging techniques.
P: Depend on syllabus. Graduate students Materials Science and Engineering, Mechanics

970B*. Advanced Analytical Methods in Materials Science Spring. 3(3-0) F: MME 451, MME 870 R: Graduate students Materials Science and Engineering
Advanced analytical techniques. Theoretical basis for advanced X-ray techniques useful in crystal structure analysis and materials research.
P: Depend on syllabus. Graduate students Materials Science and Engineering, Mechanics

980*. Advanced Processing Techniques (MTC) Spring. 3(3-0) May reenroll for a maximum of 9 credits.
F: Graduate students Materials Science and Engineering, Mechanics
P: Depend on syllabus. Graduate students Materials Science and Engineering, Mechanics

980A*. Ceramic Processing Spring. 3(3-0) F: MME 851, MME 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.
P: MME 824 MME 849

980B*. High Temperature Deformation and Processing Spring. 3(3-0) F: MME 851, MME 860 R: Graduate students Materials Science and 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.
P: MME 825 MME 872

980C*. Laser and Plasma Processing Spring. 3(3-0) F: MME 851, MME 860 R: Graduate students Materials Science and Engineering
P: Depend on syllabus. Graduate students Materials Science and Engineering, Mechanics

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

991*. Selected Topics Fall, Spring, Summer. 1 to 3 credits. May reenroll for a maximum of 6 credits.
F: Graduate students Materials Science and Engineering, Mechanics
P: Depend on syllabus. Graduate students Materials Science and Engineering, Mechanics

999*. Doctoral Dissertation Research Fall, Spring, Summer. 1 to 12 credits. May reenroll for a maximum of 9 credits.
F: Doctoral students Materials Science and Engineering, Mechanics
R: Doctoral students Materials Science and Engineering, Mechanics

Microbiology and Public Health

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

200. Allied Health Microbiology Fall. 3(3-0) F: CEM 151 R: 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.
P: MME 101

204. Allied Health Microbiology Laboratory Fall. 1(0-3) F: MME 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.
P: MME 200

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

222*. Introductory Microbiology Laboratory Spring. 1(0-3) F: MME 301 or concurrently.
Methodology of microbiology: microscopy, staining, aseptic technique, culture media, quantification, and laboratory safety.
P: MME 301 OR MME 303 OR MME 304

401*. Prokaryotic Physiology and Genetics Fall. 4(4-0) F: MME 301; BCH 461 or concurrently.
Prokaryotic cell structure and function, macromolecular synthesis and control, unique metabolic pathways, and genetics of bacteria and bacteriophages.
P: MME 303 OR MME 301 OR BCH 451 QA: MME 302 MME 421

402*. Eukaryotic Cells and Viruses Spring. 4(4-0) F: 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.
P: MME 303 BCH 453 QA: MME 402 MME 413

496*. Advanced Microbiology Laboratory Fall. 3(1-6) F: MME 302; MME 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.
P: MME 303 QA: MME 304 MME 306

425*. Microbiological Ecology Spring. 3(3-0) Interdepartmental with the Department(s) of Crop and Soil Sciences.
P: MME 301
Microbial population and community interactions; microbial activities in natural systems, including associations with plants or animals.
P: MME 301 OR MME 303 OR MME 314 QA: MME 426 MME 426A

E-124 Courses with an asterisk (*) have not been approved by the University Committee on Curriculum.