MATERIALS ENGINEERING
(MAT E)

Any experimental courses offered by MAT E can be found at:
registrar.iastate.edu/faculty-staff/courses/explistings/ (http://
www.registrar.iastate.edu/faculty-staff/courses/explistings/)

Courses primarily for undergraduates:

MAT E 101: Materials Science & Engineering Learning Community
Seminar
Cr. R. F.
Introduction to the Materials Science & Engineering Department
and resources available to support student success. Offered on a
satisfactory-fail basis only.

MAT E 170: Numeric, Symbolic, and Graphical Methods for Materials
Engineering
Cr. 3. S.
Prereq: ENGR 160
Introduction to computer-based problem solving techniques including
data analysis, data visualization, and materials simulation using
spreadsheet, array, and symbolic methods that are necessary for
materials science. Introduction to 3D CAD with consideration for additive
manufacturing techniques.

MAT E 214: Structural Characterization of Materials
(2-2) Cr. 3. F.S.
Prereq: MAT E 215; PHYS 231
Structural characterization of materials. Techniques include optical and
electron microscopy, x-ray diffraction, and thermal analysis. Identification
of materials type, microstructure, and crystal structure.

MAT E 215: Introduction to Materials Science and Engineering I
(3-0) Cr. 3. F.S.
Prereq: (CHEM 167 or CHEM 177); MATH 165
Introduction to the structure and properties of engineering materials.
Structure of crystalline solids and imperfections. Atomic diffusion.
Mechanical properties and failure of ductile and brittle materials.
Dislocations and strengthening mechanisms. Phase equilibria, phase
transformations, microstructure development, and heat treatment
principles of common metallurgical systems including steels and
aluminum alloys. Engineering applications. Only one of MAT E 215, MAT
E 273, or MAT E 392 may count toward graduation.

MAT E 215L: Introduction to Materials Science and Engineering I - Lab
(0-2) Cr. 1. F.S.
Prereq: Credit or concurrent enrollment in MAT E 215 or MAT E 273 or MAT E
392
Materials Engineering majors only. Laboratory exercise in materials.

MAT E 216: Introduction to Materials Science and Engineering II
(3-0) Cr. 3. F.S.
Prereq: (MAT E 215 or MAT E 273 or MAT E 392); credit or concurrent
enrollment in PHYS 232
Materials Engineering majors only. Fundamentals of ceramic, polymeric,
and composite materials; degradation, electronic, thermal, magnetic, and
optical properties of materials. Materials for energy, biomaterials, and
nanomaterials.

MAT E 216L: Introduction to Materials Science and Engineering II - Lab
(0-2) Cr. 1. F.S.
Prereq: Credit or concurrent enrollment in MAT E 216
Materials Engineering majors only. Laboratory exercise in materials.

MAT E 220: Globalization and Sustainability
(Cross-listed with ANTHR, ENV S, GLOBE, M E, SOC). (3-0) Cr. 3. F.S.
An introduction to understanding the key global issues in sustainability.
Focuses on interconnected roles of energy, materials, human resources,
economics, and technology in building and maintaining sustainable
systems. Applications discussed will include challenges in both the
developed and developing world and will examine the role of technology
in a resource-constrained world. Cannot be used for technical elective
credit in any engineering department.
Meets International Perspectives Requirement.

MAT E 273: Principles of Materials Science and Engineering
(3-0) Cr. 3. F.S.
Prereq: (CHEM 167 or CHEM 177); MATH 165
Introduction to the structure and properties of engineering materials.
Structure of crystalline solids and imperfections. Atomic diffusion.
Mechanical properties and failure of ductile and brittle materials.
Dislocations and strengthening mechanisms. Phase equilibria, phase
transformations, microstructure development, and heat treatment
principles of common metallurgical systems including steels and
aluminum alloys. Structure and mechanical properties of ceramic,
polymeric and composite materials. Thermal properties of materials.
Corrosion and degradation. Basic electronic properties of materials.
Engineering applications. Only one of MAT E 215, MAT E 273, or MAT E
392 may count toward graduation.
MAT E 301: Materials Engineering Professional Planning
Cr. R. S.
Prereq: Sophomore classification in Materials Engineering
Preparation for a career in industry or advanced study in graduate school; Lectures and guest speakers discuss various topics, including: experiential learning, resumes, interviewing, leadership, networking, professional ethics, and graduate school opportunities. Offered on a satisfactory-fail basis only.

MAT E 311: Thermodynamics in Materials Engineering
(3-0) Cr. 3. F.
Prereq: CHEM 178; (MAT E 215 or MAT E 273 or MAT E 392); credit or concurrent enrollment in (MAT E 216 and MATH 267)
Basic laws of thermodynamics applied to phase equilibria, transformations, and reactions in multicomponent multiphase materials systems; thermodynamic descriptions of heterogeneous systems; binary and ternary phase diagrams; interfaces, surfaces, and defects.

MAT E 314: Kinetics and Phase Equilibria in Materials
(3-0) Cr. 3. S.
Prereq: MAT E 214; MAT E 216; MAT E 311
Kinetic phenomena and phase equilibria relevant to the origins and stability of microstructure in metallic, ceramic and polymeric systems. Application of thermodynamics to the understanding of stable and metastable phase equilibria, interfaces and their effects on stability: defects and diffusion, empirical rate equations for transformation kinetics, driving forces and kinetics of nucleation, diffusional and diffusionless phase transformations.

MAT E 317: Introduction to Electronic Properties of Ceramic, Metallic, and Polymeric Materials
(3-0) Cr. 3. F.
Prereq: MAT E 216; PHYS 232

MAT E 319: Mechanics of Structures and Materials
(3-0) Cr. 3. S.
Prereq: PHYS 231; credit or concurrent enrollment in MATH 166
Fundamentals of engineering mechanics as applied to materials. Forces and moments; stresses in loaded bodies; elasticity and stress analysis including stress / strain relationships. Only one of MAT E 319 or E M 324 may be used for graduation requirements.

MAT E 321: Introduction to Ceramic Science
(3-0) Cr. 3. F.
Prereq: MAT E 216
Ceramic crystal structures, defects, diffusion and transport. Phase equilibria and microstructures. Thermal, electronic, optical and magnetic properties of ceramics.

MAT E 322: Introduction to Ceramic Processing
(2-3) Cr. 3. S.
Prereq: MAT E 321

MAT E 332: Semiconductor Materials and Devices
(Cross-listed with E E). (3-0) Cr. 3. S.
Prereq: CPR E and E E majors: E E 230; MAT E majors: MAT E 317
Introduction to semiconductor material and device physics. Quantum mechanics and band theory of semiconductors. Charge carrier distributions, generation/recombination, transport properties. Physical and electrical properties and fabrication of semiconductor devices such as MOSFETs, bipolar transistors, laser diodes and LEDs.

MAT E 334: Electronic & Magnetic Properties of Metallic Materials
(3-0) Cr. 3. Alt. S., offered odd-numbered years.
Prereq: MAT E 317

MAT E 341: Metals Processing
(3-0) Cr. 3. F.
Prereq: MAT E 215 or MAT E 273 or MAT E 392
Theory and practice of metal processing, including: extractive metallurgy; casting and solidification; welding and joining; deformation processes (e.g., forging, extrusion); powder metallurgy; and additive manufacturing.
MAT E 342: Structure/Property Relations in Nonferrous Metals  
(3-0) Cr. 3. S.  
Prereq: MAT E 215 or MAT E 273 or MAT E 392  
Processing of metals and alloys to obtain desired mechanical properties by manipulation of their microstructure and composition of constituent phase(s). Relevance of defects to mechanical properties, plastic flow. Strengthening mechanisms in metals and alloys. Microstructure, heat treatment and mechanical properties of engineering alloys. Metal-matrix composites.

MAT E 348: Solidification Processes  
(Cross-listed with I E). (2-2) Cr. 3. S.  
Prereq: I E 248 and MAT E 273, or MAT E 215  
Theory and applications related to metal casting, welding, polymer processing, powder metallurgy, and composites manufacturing, and related rapid manufacturing processes.

MAT E 350: Polymers and Polymer Engineering.  
(3-0) Cr. 3. S.  
Prereq: MAT E 216 or MAT E 273 or MAT E 392  
Fundamental concepts of soft matter, including polymer, colloid and surfactant. Their physical and chemical properties, rheology and production methods. Applications of polymers in the chemical industry. Related topics in surface, diffusion and stability.

MAT E 351: Introduction to Polymeric Materials  
(3-0) Cr. 3. F.  
Prereq: MAT E 216  
Introduction to polymeric materials, synthesis, structure and properties. Relationship between polymer composition, processing and properties.

MAT E 362: Principles of Nondestructive Testing  
(Cross-listed with E M). (3-0) Cr. 3. S.  
Prereq: PHYS 132 or PHYS 232  
Radiography, ultrasonic testing, magnetic particle inspection, eddy current testing, dye penetrant inspection, and other techniques. Physical bases of tests, materials to which applicable, types of defects detectable, calibration standards, and reliability safety precautions.

MAT E 362L: Nondestructive Testing Laboratory  
(Cross-listed with E M). (0-3) Cr. 1. S.  
Prereq: Credit or concurrent enrollment in E M 362 or MAT E 362  
Application of nondestructive testing techniques to the detection and sizing of flaws in materials and to the characterization of material’s microstructure. Included are experiments in hardness, dye penetrant, magnetic particle, x-ray, ultrasonic and eddy current testing. Field trips to industrial laboratories.

MAT E 391: Introduction to US Women's Roles in Industry and Preparation for Summer Study  
(3-0) Cr. 3. S.  
Prereq: Permission of Instructor  
Introduction to the historical role of women as related to US industry, family and community with emphasis on the years 1830 - 1945, but also related to the current climate. Topics completed in 392 with arranged lectures at Brunel University. Orientation for Brunel summer study program. Offered on a satisfactory-fail basis only. Credit for graduation allowable only upon completion of summer study abroad program.

MAT E 392: Principles of Materials Science and Engineering  
(3-0) Cr. 3. S S.  
Prereq: (CHEM 167 or CHEM 177); MATH 165; MAT E 391  

MAT E 413: Materials Design and Professional Practice I  
(3-0) Cr. 3. F.S.  
Prereq: Senior classification  
Fundamentals of materials engineering design, information sources, team behavior, professional preparation, and materials selection. Analysis of design problems, development of solutions, selected case studies. Oral presentation skills. Preparations for continued project in MAT E 414. MAT E 413-414 sequence is intended for students in their final two semesters before graduation.

MAT E 414: Materials Design and Professional Practice II  
(2-2) Cr. 3. F.S.  
Prereq: MAT E 413  
Team projects specified by either industry or academic partners. Written and oral final project reports. Integration of materials processing, structure/composition, properties and performance principles in materials engineering problems. Multi-scale design of materials, materials processing, case studies including cost analysis, ethics, risk and safety.
MAT E 418: Mechanical Behavior of Materials
(3-0) Cr. 3. F.S.
Prereq: MAT E 216; credit or concurrent enrollment in MAT E 319
Mechanical behavior of ceramics, metals, polymers, and composites. Relationships between materials processing and atomic aspects of elasticity, plasticity, creep, fracture, and fatigue. Life prediction, stress-and failure analysis.

MAT E 419: Magnetism and Magnetic Materials
(Dual-listed with M S E 519). (Cross-listed with E E). (3-0) Cr. 3. Alt. F., offered odd-numbered years.
Prereq: E E 311 or MAT E 317 or PHYS 364

MAT E 425: Glass Science and Engineering
(2-3) Cr. 3. F.
Prereq: MAT E 321
Composition, structure, properties manufacturing, and applications of inorganic glasses. Mechanical, structural, thermal, optical, ionic, electronic, and biological applications of inorganic glasses, especially silicate glasses. Contemporary topics in glass science and engineering such as glass optical fiber communication and flat panel display technologies. Laboratory exercises in the preparation and characterization of silicate glasses.

MAT E 432: Microelectronics Fabrication Techniques
(Dual-listed with M S E 532). (Cross-listed with E E). (2-4) Cr. 4.
Prereq: CPR E and E E majors: E E 230; MAT E majors: MAT E 317
Techniques used in modern integrated circuit fabrication, including diffusion, oxidation, ion implantation, lithography, evaporation, sputtering, chemical-vapor deposition, and etching. Process integration. Process evaluation and final device testing. Extensive laboratory exercises utilizing fabrication methods to build electronic devices. Use of computer simulation tools for predicting processing outcomes. Recent advances in processing CMOS ICs and micro-electro-mechanical systems (MEMS).

MAT E 433: Advanced Ceramics and Electronic Materials
(3-0) Cr. 3. S.
Prereq: MAT E 317, MAT E 321

MAT E 437: Electronic Properties of Materials
(Dual-listed with M S E 537). (Cross-listed with E E). Cr. 3. S.
Prereq: E E 332 or MAT E 317 or PHYS 322

MAT E 443: Physical Metallurgy of Ferrous Alloys
(3-0) Cr. 3. F.
Prereq: MAT E 311

MAT E 444: Corrosion and Failure Analysis
(2-2) Cr. 3. S.
Prereq: MAT E 215 or MAT E 273 or MAT E 392
Failure analysis. Characteristics of common types of metallic failures, case studies of failures, designing to reduce failure risk. Corrosion and corrosion control of metallic systems. Corrosion fundamentals, classification of different types of metallic corrosion, corrosion properties of various engineering alloys, corrosion control.

MAT E 452: Scanning and Auger Electron Microscopy
(Dual-listed with M S E 552). (2-3) Cr. 3. F.
Prereq: PHYS 232
MAT E 453: Physical and Mechanical Properties of Polymers
(Dual-listed with M S E 553). (2-3) Cr. 3. F.
Prereq: MAT E 351
Overview of polymer chemical composition, microstructure, thermal and mechanical properties, rheology, and principles of polymer materials selection. Intensive laboratory experiments include chemical composition studies, microstructural characterization, thermal analysis, and mechanical testing.

MAT E 454: Polymer Composites and Processing
(Dual-listed with M S E 554). (3-0) Cr. 3. S.
Prereq: MAT E 351
Basic concepts in polymer composites, blends, and block copolymers. Phase separation and miscibility, microstructures and mechanical behavior. Fiber reinforced and laminated composites. Viscosity, rheology, viscoelasticity of polymers. Polymer melt processing methods such as injection molding and extrusion; selection of suitable processing methods and their applications.

MAT E 456: Biomaterials
(Dual-listed with M S E 556). (Cross-listed with B M E). (3-0) Cr. 3. F.
Prereq: CHEM 178; (MAT E 216 or MAT E 273 or MAT E 392)
Presentation of the basic chemical and physical properties of biomaterials, including metals, ceramics, and polymers, as they are related to their manipulation by the engineer for incorporation into living systems. Role of microstructure properties in the choice of biomaterials and design of artificial organs, implants, and prostheses.

MAT E 457: Chemical and Physical Metallurgy of Rare Earth Metals
(Dual-listed with M S E 557). (3-0) Cr. 3. Alt. S., offered even-numbered years.
Prereq: CHEM 325 or MAT E 311
Electronic configuration, valence states, minerals, ores, beneficiation, extraction, separation, metal preparation and purification. Crystal structures, phase transformations and polymorphism, and thermochemical properties of rare earth metals. Chemical properties: inorganic and organometallic compounds, alloy chemistry, nature of the chemical bonding. Physical properties: mechanical and elastic properties, magnetic properties, resistivity, and superconductivity.

MAT E 458: Eddy Current Nondestructive Evaluation
(Dual-listed with M S E 588). (Cross-listed with E E). (3-0) Cr. 3. Alt. F., offered odd-numbered years.
Prereq: MATH 265 and (MAT E 216 or MAT E 273 or MAT E 392 or E E 311 or PHYS 364)
Electromagnetic fields of various eddy current probes. Probe field interaction with conductors, cracks and other material defects. Ferromagnetic materials. Layered conductors. Elementary inversion of probe signals to characterize defects. Special techniques including remote-field, transient, potential drop nondestructive evaluation and the use of Hall sensors. Practical assignments using a 'virtual' eddy current instrument will demonstrate key concepts.

MAT E 490: Independent Study
Cr. arr. Repeatable.
Prereq: Permission of Department
Investigation of individual research or special topics. Independent study that is being proposed to be used toward graduation or minor requirements. This course requires an approved proposal to the MSE Department’s Undergraduate Curriculum Committee prior to the beginning of the semester.

MAT E 490H: Independent Study: Senior Honors Project
Cr. arr. F.S.SS.
Prereq: Permission of Department
Independent study that is being proposed to be used for an honors project. This course requires an approved proposal to the College of Engineering Honors Committee.

MAT E 499: Undergraduate Research Opportunity
Cr. R. Repeatable, maximum of 12 times. F.S.SS.
Prereq: Permission of Department
Independent study working in research lab with faculty member. Designed to allow students opportunity to gain experience that may assist them in obtaining future employment. Offered on a satisfactory-fail basis only. The course cannot be applied toward any graduation requirements.