

MATERIALS ENGINEERING (MAT E)

Any experimental courses offered by MAT E can be found at:

registrar.iastate.edu/faculty-staff/courses/explistsings/ (<http://www.registrar.iastate.edu/faculty-staff/courses/explistsings/>)

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

Materials Engineering majors only. Introduction to electronic properties of materials and their practical applications. Classical conduction models and electronic properties of metallic and ceramic materials. Elementary quantum mechanics and band theory of electron states in solids. Quantum theory of metallic conduction. Elementary semiconductor theory and devices. Polarization and dielectric properties of materials. Electron conduction in polymeric systems.

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

Synthesis and characterization of ceramic powders. Colloidal phenomena, rheology of suspensions, ceramic forming methods, and drying. High temperature ceramic reactions, liquid and solid-state sintering, grain growth, microstructure development. Processing/microstructure/property relationships.

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 LED's.

MAT E 334: Electronic & Magnetic Properties of Metallic Materials

(3-0) Cr. 3. Alt. S., offered odd-numbered years.

Prereq: MAT E 317

Electronic conduction in metals and the properties of conducting materials. Quantum mechanical behavior of free electrons and electrons in potentials wells, bonds and lattices. Development of the band theory of electron states in solids and the Free and Nearly Free Electron models. Density-of-states in energy bands and the Fermi-Dirac statistics of state occupancy. Quantum mechanical model of metallic conduction; Brillouin zones and Fermi surfaces. Additional topics include the thermal properties of metals, electron phase transitions in metallic alloys and the BCS theory of superconductivity. Classical and quantum mechanical treatment of the origins of magnetism in materials; orbital and spin angular momentum. Theory of magnetic behavior in dia-, para-magnetic, ferromagnetic materials.

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. SS.

Prereq: (CHEM 167 or CHEM 177); MATH 165; MAT E 391

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. Meets International Perspectives Requirement.

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

Magnetic fields, flux density and magnetization. Magnetic materials, magnetic measurements. Magnetic properties of materials. Domains, domain walls, domain processes, magnetization curves and hysteresis. Types of magnetic order, magnetic phases and critical phenomena. Magnetic moments of electrons, theory of electron magnetism. Technological application, soft magnetic materials for electromagnets, hard magnetic materials, permanent magnets, magnetic recording technology, magnetic measurements of properties for materials evaluation.

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

Charged point defects and formation equations. Non-stoichiometric conductors, dielectric, ferroelectric, and piezoelectric materials and applications. Optical properties, optical spectra of materials, optoelectronic devices. Magnetic and superconducting materials. Contemporary topics in advanced ceramics.

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

Magnetic fields, flux density and magnetization. Magnetic materials, magnetic measurements. Magnetic properties of materials. Domains, domain walls, domain processes, magnetization curves and hysteresis. Types of magnetic order, magnetic phases and critical phenomena. Magnetic moments of electrons, theory of electron magnetism. Technological application, soft magnetic materials for electromagnets, hard magnetic materials, permanent magnets, magnetic recording technology, biomedical applications of magnetism, magnetic evaluation of materials.

MAT E 443: Physical Metallurgy of Ferrous Alloys

(3-0) Cr. 3. F.

Prereq: MAT E 311

Production and processing of ferrous metals. Extraction of pig iron from ore. Steelmaking processes. Equilibrium and nonequilibrium phases in the Fe-C system. Properties and processing of cast irons, plain carbon and alloy steels, stainless and specialty steels. Transformation diagrams, hardenability, and surface treatments. Continuous casting, forging, hot rolling, quenching, and tempering as they apply to ferrous materials. Cost and mechanical performance considerations in cast iron and steel selection and heat treatment.

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

Characterization of materials using scanning electron microscope (SEM), electron microprobe, and auger spectrometer. Compositional determination using energy and wavelength dispersive x-ray and Auger spectroscopies. Specimen preparation. Laboratory covers SEM operation.

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 488: 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.