MATERIALS SCIENCE (MATS)

MATS 221, THE SCIENCE, ENGINEERING AND SOCIAL IMPACT OF NANOTECHNOLOGY, 3 Credits

Nanotechnology is an emerging engineering field that manipulates atoms and molecules to fabricate new materials and tiny devices. Properties of nanostructured materials, manufacturing methods, characterization methods, and impact on health and safety. Benefits and concerns about nanotechnology will be assessed. Lec/rec. CROSSLISTED as ENG 221/MATS 221.
Equivalent to: ENGR 221
Recommended: One year of college science.

MATS 321, INTRODUCTION TO MATERIALS SCIENCE, 4 Credits

Crystal structure, microstructure, and physical properties of metals, ceramics, polymers, composites, and amorphous materials. Also includes elementary mechanical behavior and phase equilibria.
Prerequisite: CH 202 with C or better or CH 222 with C or better or CH 232 with C or better or CH 232H with C or better or CH 224H with C or better
Equivalent to: ENGR 321, ENGR 321H, MATS 321H
Available via Ecampus

MATS 321H, INTRODUCTION TO MATERIALS SCIENCE, 4 Credits

Crystal structure, microstructure, and physical properties of metals, ceramics, polymers, composites, and amorphous materials. Also includes elementary mechanical behavior and phase equilibria.
Attributes: HNRS – Honors Course Designator
Prerequisite: CH 202 with C or better or CH 222 with C or better or CH 232 with C or better or CH 232H with C or better or CH 224H with C or better
Equivalent to: ENGR 321, ENGR 321H, MATS 321

MATS 322, MECHANICAL PROPERTIES OF MATERIALS, 3 Credits

Mechanical behavior of materials, relating laboratory test results to material structure, and elements of mechanical analysis.
Prerequisite: (ENGR 213 with C or better or ENGR 213H with C or better) and (ENGR 321 [C] or ENGR 321H [C] or MATS 321 [C])
Equivalent to: ENGR 322

MATS 413, THERMODYNAMICS AND PHASE EQUILIBRIA OF MATERIALS, 4 Credits

Explores the statistical interpretation of entropy, heat capacity, enthalpy of condensed phases, solution thermodynamics, liquid-solid and solid-solid phase equilibria. Considers the principles of thermodynamics governing phase stability with a focus on liquid-solid and solid-solid equilibria, and phase stability in two-component systems. Examines the relationship of Gibbs free energy to phase stability.
Prerequisite: MATS 321 with C or better and (ME 311 [C] or NSE 311 [C] or CHE 311 [C])

MATS 441, PHYSICAL METALLURGY, 3 Credits

Introduction to properties of metals and alloys including solidification, diffusion, solid solutions, intermediate phases, annealing, heat treatment and phase transformation with a focus on ferrous and non-ferrous metal systems. Identifies relationships between material composition, structure, and properties resulting from synthesis, processing or service. Explores the knowledge of ferrous and non-ferrous alloy systems and their significant metallurgical properties and applications.
Prerequisite: MATS 321 with C or better

MATS 445, WELDING METALLURGY, 4 Credits

Theory-based course focused on the metallurgy of welds. Topics covered include welding/joining processes, heat input, diffusion, solidification, phase transformation, materials compatibility and welding defects. This is NOT a practical welding class.
Prerequisite: (MATS 321 with C or better or ENGR 321 with C or better or ENGR 321H with C or better) or MATS 570 with C or better

MATS 455, EXPERIMENTAL TECHNIQUES IN MATERIAL SCIENCE, 4 Credits

Materials processing, characterization, computational and data analysis techniques in materials science. Focus on processing-structure-property relationships. Lec/lab.
Prerequisite: (ENGR 321 with C or better or ENGR 321H with C or better)
Equivalent to: ME 455
This course is repeatable for 8 credits.
Recommended: ME 570

MATS 478, THIN FILM MATERIALS CHARACTERIZATION AND PROPERTIES, 4 Credits

Processing of thin films and characterization of the microstructure; diffusion and solid state reactions; mechanical, magnetic and electronic properties of thin films.
Prerequisite: (ME 311 with C or better or ME 311H with C or better) and (ENGR 321 [C] or ENGR 321H [C] or MATS 321 [C]) and (ENGR 322 [C] or MATS 322 [C])
Equivalent to: ME 478

MATS 499, SPECIAL TOPICS, 1-16 Credits

This course is repeatable for 16 credits.

MATS 545, WELDING METALLURGY, 4 Credits

Theory-based course focused on the metallurgy of welds. Topics covered include welding/joining processes, heat input, diffusion, solidification, phase transformation, materials compatibility and welding defects. This is NOT a practical welding class.
Recommended: (MATS 321 or ENGR 321 or ENGR 321H) or MATS 570

MATS 555, EXPERIMENTAL TECHNIQUES IN MATERIAL SCIENCE, 4 Credits

Materials processing, characterization, computational and data analysis techniques in materials science. Focus on processing-structure-property relationships.
Prerequisite: MATS 570 with C or better
Equivalent to: ME 555
This course is repeatable for 8 credits.
Recommended: ENGR 321 or ENGR 321H

MATS 570, STRUCTURE-PROPERTY RELATIONS IN MATERIALS, 4 Credits

Fundamentals of the interactions between the structure and properties of materials. Atomic bonding and atom interactions. Geometric and algebraic representations of symmetry. Introduction to phase equilibria. Phenomenological background of elasticity and plasticity in materials. Anisotropic materials and tensor representations. Influence of structure on thermal, electrical, and optical properties of materials.
Equivalent to: ME 570

MATS 571, ELECTRONIC PROPERTIES OF MATERIALS, 4 Credits

Development of a quantitative description of the electronic structure of solids starting with the quantum mechanical model of the atom, atomic bonding, and band theory of solids. Quantitative description of the electronic properties of metals, semiconductors, and insulators.
Equivalent to: ME 571
Recommended: CH 545 or ME 570

MATS 578, THIN FILM MATERIALS CHARACTERIZATION AND PROPERTIES, 4 Credits

Processing of thin films and characterization of the microstructure; diffusion and solid state reactions; mechanical, magnetic and electronic properties of thin films.
Equivalent to: ME 578

MATS 581, THERMODYNAMICS OF SOLIDS, 4 Credits

Thermodynamics of solutions and phase equilibrium. Phase diagrams and invariant reactions. Order and disorder in solutions. Applications to advanced materials development. Lec/lab.
Equivalent to: ME 581

MATS 582, RATE PROCESSES IN MATERIALS, 3 Credits

Diffusion in solids, including vacancy and interstitial and short-circuit diffusion. Phase transformations including classic nucleation and growth theory. Applications to materials development.
Prerequisite: MATS 581 with C or better or ME 581 with C or better
Equivalent to: ME 582

MATS 584, ADVANCED FRACTURE OF MATERIALS, 4 Credits

Fracture mechanics will be used as a basis for predicting failure of materials, understanding failure mechanisms, and identifying causes of failure. Course will include discussion of recent journal articles, experimental demonstrations, and analysis of real fracture data.
Equivalent to: ME 584
Recommended: ENGR 322

MATS 587, DISLOCATIONS, DEFORMATION, AND CREEP, 4 Credits

The effects of point, line, and planar defects on plastic deformation and creep behavior in solids will be discussed with emphasis on the role of dislocations and vacancies.
Equivalent to: ME 587
Recommended: ENGR 322

MATS 588, COMPUTATIONAL METHODS IN MATERIALS SCIENCE, 4 Credits

A broad introduction to important materials science simulation methods. These include molecular dynamics, density functional theory, and Monte Carlo methods. Learning is through a mixture of lecture and hands-on lab projects in which students use computational methods to explore and reinforce fundamental concepts in materials science. Lec/lab.
Equivalent to: ME 588
Recommended: Experience with Matlab or Mathematica or an equivalent numerical and programming environment.

MATS 599, SPECIAL TOPICS, 1-16 Credits

This course is repeatable for 16 credits.

MATS 659, PRINCIPLES OF TRANSMISSION ELECTRON MICROSCOPY, 4 Credits

This lecture-only course covers basic principles of transmission electron microscopy (TEM) including instrument components, electron optics, electron diffraction, and the origins and interpretation of image contrast. Spectroscopic techniques are covered, but diffraction and imaging techniques are emphasized. Coverage of experimental techniques will focus on those useful for addressing problems in materials science.
Recommended: MATS 570 and (CH 616 or MATS 555)

MATS 671, ELECTRONIC PROPERTIES OF OXIDES, 3 Credits

Emphasizes band theory of solids applied to metal oxide materials. Reviews metallic oxides, non-stoichiometric semiconductors and associated defect chemistry, electrostatics, linear dielectrics, non-linear dielectrics, electromechanical phenomena including piezoelectricity, and the optical properties of oxides.
Equivalent to: ME 671
Recommended: MATS 571 or PH 575