# Materials Engineering - MATL

## Courses

**MATL 2100** **INTRODUCTION TO MATERIALS SCIENCE (3)** LEC. 3. The science of solid materials and the relationship between this science and material properties.

**MATL 2210** **MATERIALS FOR SUSTAINABLE ENERGY PRODUCTION AND STORAGE (1)** LEC. 1. Pr. CHEM 1030. Technologies for sustainable energy production and storage, renewable energy conversion, associated materials challenges.

**MATL 2220** **MATERIALS AND THE ENVIRONMENT (1)** LEC. 1. Pr. CHEM 1030. Environmental impact of the production, use and disposal of materials.

**MATL 2230** **MINERAL RESOURCES: PROCESSING AND AVAILABILITY (1)** LEC. 1. Pr. CHEM 1030. Mineral resources for engineering materials; processing and availability of mineral resources.

**MATL 3100** **ENGINEERING MATERIALS - METALS (3)** LEC. 3. Pr. MATL 2100. The relationship among processing, microstructure, properties and engineering applications of metallic materials.

**MATL 3101** **METALLOGRAPHY LABORATORY (1)** LAB. 3. Coreq. MATL 3100. The use of microstructural characterization to understand the relationship between microstructure and properties of metallic materials.

**MATL 3200** **ENGINEERING MATERIALS POLYMERS (3)** LEC. 3. Pr. CHEM 1040. The synthesis, processing, structure and properties of polymers and polymer matrix composites.

**MATL 3201** **POLYMER AND COMPOSITES LABORATORY (1)** LAB. 3. Coreq. MATL 3200. A hands-on lab course on the synthesis, processing, structure and properties of polymers and polymer matrix composites.

**MATL 3300** **ENGINEERING MATERIALS - CERAMICS (3)** LEC. 3. Pr. MATL 2100. The engineering of ceramic materials. Structural property relationships of crystalline and glassy ceramics will be included.

**MATL 4100** **THERMODYNAMICS AND KINETICS OF MATERIALS (3)** LEC. 3. Pr. CHEM 1040 and ENGR 2200. Laws of thermodynamics to describe phase equilibria and phase transformations in one-component and multi-component systems, mechanisms of diffusion, the interplay of thermodynamic driving forces and kinetics of mass transfer in materials systems.


**MATL 4930** **DIRECITED STUDIES (1-6)** IND. SU. Departmental approval. Areas of interest within Materials Engineering. Course may be repeated for a maximum of 6 credit hours.

**MATL 4980** **SENIOR DESIGN PROJECT (3)** LEC. 1. LAB. 6. Students select, design, schedule, fabricate and perform an engineering design project related to Materials Engineering.

**MATL 4997** **HONORS THESIS (1-6)** IND. Pr. Honors College. Departmental approval. Individual student directed research and writing of honors thesis. Course may be repeated for a maximum of 6 credit hours.

**MATL 5100** **THERMODYNAMICS OF MATERIALS SYSTEMS (3)** LEC. 3. Pr. CHEM 1040 and ENGR 2200. Departmental approval. Application of thermodynamics to describe phase stability, crystal imperfections, solubility, oxidation, surface, and interface energy and transformations.

**MATL 5200** **CRYSTALLOGRAPHY (2)** LEC. 2. Pr. PHYS 1610 or PHYS 1617. Departmental approval. Principles of crystallography, reciprocal lattice X-ray diffraction techniques.

**MATL 5201** **X-RAY DIFFRACTION LABORATORY (1)** LAB. 3. Coreq. MATL 5200. Laboratory on the use of x-ray diffraction for materials characterization.

**MATL 5300** **PHASE TRANSFORMATIONS IN MATERIAL PROCESSING (3)** LEC. 3. Pr. MATH 2650 and ENGR 2200. Departmental approval. Principles that govern phase transformations in materials systems and control of nucleation and growth, microstructure and morphology.
MATL 5400 PHYSICS OF SOLIDS (3) LEC. 3. Pr. PHYS 1610 or PHYS 1617. Departmental approval. The physics of solid-state materials, including the electronic, optical and magnetic properties of materials.

MATL 5500 NUMERICAL SIMULATION OF MATERIALS PROCESSING (3) LEC. 3. Pr. MATL 5100 and P/C MATL 5300. Departmental approval. Fundamental principles and applications of computer-aided simulation of transport phenomena in materials processing systems.


MATL 5720 BIOMEDICAL APPLICATIONS OF POLYMERIC MATERIALS (3) LEC. 3. LAB. 13. Pr. P/C BIOL 1030 or P/C CHEM 2070. Study of polymers used in the body for the purposes of aiding healing, correcting abnormalities, and restoring lost function.

MATL 5750 MICROSTRUCTURE AND MECHANICS OF SKELETAL TISSUES (3) LEC. 3. Pr. MATL 2100 and (ENGR 2070 or MECH 3130). Molecular and cellular microstructural influence over the viscoelastic deformation of the skeletal tissues of bone muscle, ligament, tendon and cartilage; mechanics of failure and biomechanical injury mechanisms; consideration of the physiological processes of adaptive remodeling and healing of tissues; recent developments in orthopedic implant materials.

MATL 5970 INTERMEDIATE SPECIAL TOPICS (1-3) LEC. 1-3. Departmental approval. Regular course addressing an advanced specialized area of Materials Engineering not covered by regularly offered courses. Course may be repeated with change in topics.

MATL 6100/6106 THERMODYNAMICS OF MATERIALS SYSTEMS (3) LEC. 3. Departmental approval. Application of thermodynamics to describe phase stability, crystal imperfections, solubility, oxidation, surface and interface energy and transformations.

MATL 6200/6206 CRYSTALLOGRAPHY (2) LEC. 2. Departmental approval. Principles of crystallography, reciprocal lattice X-ray diffraction techniques.

MATL 6201 X-RAY DIFFRACTION LABORATORY (1) LAB. 3. Coreq. MATL 6200. Laboratory on the use of x-ray diffraction for materials characterization.

MATL 6300/6306 PHASE TRANSFORMATIONS IN MATERIAL PROCESSING (3) LEC. 3. Departmental approval. Principles that govern phase transformations in materials systems and control of nucleation and growth, microstructure, and morphology.

MATL 6400/6406 PHYSICS OF SOLIDS (3) LEC. 3. Departmental approval. The physics of solid-state materials, including the electronic, optical, and magnetic properties of materials.

MATL 6500/6506 NUMERICAL SIMULATION OF MATERIALS PROCESSING (3) LEC. 3. Departmental approval. Fundamental principles and applications of computer-aided simulation of transport phenomena in materials processing systems.


MATL 6720/6726 BIOMEDICAL APPLICATIONS OF POLYMERIC MATERIALS (3) LEC. 3. LAB. 13. Study of polymers used in the body for the purposes of aiding healing, correcting abnormalities, and restoring lost function.

MATL 6750/6756 MICROSTRUCTURE AND MECHANICS OF SKELETAL TISSUES (3) LEC. 3. Departmental approval. Molecular and cellular microstructural influence over the viscoelastic deformation of the skeletal tissues of bone muscle, ligament, tendon and cartilage; mechanics of failure and biomechanical injury mechanisms; consideration of the physiological processes of adaptive remodeling and healing of tissues; recent developments in orthopedic implant materials.

MATL 6970/6976 INTERMEDIATE SPECIAL TOPICS IN MATERIALS ENGINEERING (1-3) LEC. 3. Departmental approval. Regular course addressing an advanced specialized area of Materials Engineering not covered by regularly offered courses. Course may be repeated with change in topics.
MATL 7050/7056 DEFORMATION AND FAILURE OF ENGINEERING MATERIALS (3) LEC. 3. Departmental approval. Coreq. MATL 6200. Theoretical presentation of the fundamental principles of deformation and failure in materials systems.

MATL 7110/7116 PHYSICAL METALLURGY AND APPLICATIONS IN METAL FABRICATION (3) LEC. 3. Departmental approval. The physical metallurgy underlying processing-structure- property relationships in metals and alloys, with examples from joining processes.

MATL 7120/7126 ADVANCED CERAMIC MATERIALS (3) LEC. 3. Departmental approval. Processing, structure-property relationships and applications of advanced ceramics. Structural and functional applications of ceramics.

MATL 7130/7136 ADVANCED POLYMER SCIENCE AND TECHNOLOGY (3) LEC. 3. Departmental approval. Recent developments in both functional and structural polymers including approaches to synthesis, processing techniques, high-strength materials, electronic polymers, optic polymers, and medical polymers.

MATL 7140/7146 ADVANCED COMPOSITE MATERIALS (3) LEC. 3. Departmental approval. Processing, mechanics structure and properties of composite materials. Emphasis will be placed on an understanding of processing-structure-property relationships in polymer-, ceramic-, and metal-matrix composites.


MATL 7210/7216 PLASTIC DEFORMATION AND STRENGTHENING OF METALLIC MATERIALS (3) LEC. 3. Departmental approval. Mechanisms of plastic deformation and strengthening in metals and alloys. The role of dislocations in plastic deformation.

MATL 7220/7226 RADIATION EFFECTS ON MATERIALS (3) LEC. 3. Departmental approval. Theoretical and experimental treatment of the radiation effects and damage in materials as related to the nuclear industry.

MATL 7230/7236 HIGH TEMPERATURE MATERIALS PERFORMANCE (3) LEC. 3. Departmental approval. Theoretical and experimental treatment of the behavior of metals at high temperature.

MATL 7310/7316 SOLIDIFICATION PROCESSING (3) LEC. 3. Departmental approval. Theoretical science and engineering principles that apply to semiconductor crystal growth, ingot solidification, metal casting, welding and rapid solidification processes.

MATL 7320/7326 THIN FILM SCIENCE AND TECHNOLOGY (3) LEC. 3. Departmental approval. Structure, properties, characterization, processing and application of thin films.

MATL 7330/7336 MATERIALS FOR ENERGY STORAGE (3) LEC. 3. Introduction of various electrochemical energy storage devices (Batteries, Supercapacitor, etc) and discussion of advancement in development of materials for these devices. Instructor’s consent required for prerequisites.

MATL 7410/7416 CHEMICAL SENSORS (3) LEC. 3. Departmental approval. Fundamentals and application of chemical sensors. Includes electrolyte, semiconductor and acoustic wave-based sensors.

MATL 7420/7426 SMART MATERIALS AND STRUCTURES (3) LEC. 3. Departmental approval. An introduction to the principles and applications of various sensor, actuator and functionality smart material systems and structures.

MATL 7430/7436 DIELECTRIC MATERIALS AND DEVICES (3) LEC. 3. Pr. (MATL 6100 or MATL 6106) and (MATL 6400 or MATL 6406). Departmental approval. Processing, structure, properties, and application of dielectrics, including physics of dielectrics, material/device design/fabrication processes, and application of dielectric materials in high-technological industry.

MATL 7440/7446 MATERIALS PROCESSES MICRO AND NANOSYSTEMS (3) LEC. 3. Departmental approval. Materials, processes, and principles involved in manufacturing of micro and nanoelectromechanical systems. Properties of materials used in micromachined transducers as a related to current and potential micro and nanofabrication processes.

MATL 7450/7456 HIGH TEMPERATURE ELECTROCHEMICAL DEVICES (3) LEC. 3. Departmental approval. Principles of solid-state electrochemistry, application to temperature devices including chemical sensors, fuel cells and batteries.

MATL 7510/7516 ELECTRON MICROSCOPY (3) LEC. 3. Departmental approval. Theory, instrumentation, techniques and applications of scanning and transmission electron microscopy.
MATL 7511 ELECTRON MICROSCOPY LABORATORY (1) LAB. 3. Coreq. MATL 7510. Laboratory on the use of electron microscopy for materials characterization.


MATL 7610/7616 ENGINEERING ASPECTS OF BIOLOGICAL AND CHEMICAL DETECTION (3) LEC. 3. Departmental approval. Biological and chemical scientific concepts related to biological and chemical threat agents. Existing and developing detection technologies, trends and needs for the future detection systems. Physical principles behind the detection technologies. Evaluation of detection device or system performance.

MATL 7620/7626 NANO/MICRO FLUIDIC SYSTEMS (3) LEC. 3. Departmental approval. Basic understanding of nano/microfluidics (typical volumes are nanoliters or picoliters) and practical applications in materials science and engineering, biotechnology, and other interdisciplinary fields of engineering and science.

MATL 7630/7636 NANOMATERIALS FOR BIOTECHNOLOGY (3) LEC. 3. Departmental approval. Basic understanding of nanobiotechnology and practical applications in the interdisciplinary fields of Materials Science and Engineering and biotechnology/medicine including nanostructured biomolecules and bioarrays as well as biomolecular nanoelectronics.

MATL 7950 MATERIALS ENGINEERING SEMINAR (0) SEM. SU. Required during each semester of residency, but cannot be used toward minimum requirements for graduate degree in Materials Engineering. Content changes each semester and consists of off-campus speakers and presentations by graduate students and faculty.

MATL 7960/7966 DIRECTED READINGS IN MATERIALS ENGINEERING (1-6) IND. SU. Departmental approval. May be taken more than one semester. Up to 6 hours may count toward the minimum degree requirements. Course may be repeated with change in topics.

MATL 7970/7976 SPECIAL TOPICS IN MATERIALS ENGINEERING (1-3) LEC. Departmental approval. Regular course addressing an advanced specialized area of Materials Engineering not covered by regularly offered courses. Course may be repeated with change in topics.

MATL 7980/7986 MASTER MATERIALS ENGINEERING PROJECT (3) LEC. 3. SU. Special design project report directed by major faculty. Topics to be determined by the student's graduate committee.

MATL 7990/7996 RESEARCH AND THESIS (1-15) MST. Individual master's thesis research. Course may be repeated with change in topics.

MATL 8990/8996 RESEARCH AND DISSERTATION (1-15) DSR. Individual doctoral dissertation research. Course may be repeated with change in topics.