2007-2009 Cal Poly Catalog

Updated Course Descriptions.

See catalog pages as printed for original descriptions.

Materials Engineering Department

MATE–MATERIALS ENGINEERING

MATE 110 Introduction to Materials Engineering Design I (1)

Laboratory work in teams to design, build and test a product. Material from math, science and engineering courses tied together. 1 laboratory.

MATE 120 Introduction to Materials Engineering Design II (1)

Second design laboratory, working in teams on a project that benefits humanity. Issues of engineering ethics, technology and society, the environment and sustainability also studied. 1 laboratory.

MATE 130 Introduction to Materials Engineering Design III (1)

Third design laboratory in a sequence. Includes working in teams on project that benefits humanity. Issues of engineering ethnics, technology and society, the environment and sustainability. 1 laboratory. Prerequisite: MATE 120.

MATE 200 Special Problems for Undergraduates (1-4)

Individual investigation, research, studies, or surveys of selected problems. Total credit limited to 8 units, with a maximum of 4 units per quarter. Prerequisite: Consent of department head.

MATE 210 Materials Engineering (3)

Structure of matter. Physical and mechanical properties of materials including metals, polymers, ceramics, composites, and electronic materials. Equilibrium diagrams. Heat treatments, materials selection and corrosion phenomena. 3 lectures. Prerequisite: CHEM 111, CHEM 124 or CHEM 127, MATH 141, PHYS 131. Recommended concurrent enrollment in MATE 215.

MATE 215 Materials Laboratory I (1)

Laboratory experiments on the heat treatment and resulting properties of metals. Effects of cold deformation of metals. Brittle-ductile fracture behavior, equilibrium phase relationships, corrosion. Mechanical behavior of polymers. Properties of semiconductor devices. 1 laboratory. Prerequisite or concurrent: MATE 210.

MATE 222 Materials Selection for the Life Cycle (4)

Materials and product design, materials selection methodologies using current software, principles of green engineering, eco-design, and sustainability. Life cycle analysis of engineered products using current software. Ecological impact of materials and processes. Case studies used to illustrate concepts. 4 lectures. Prerequisite: ARCH 106 or MATE 210 or consent of instructor.

MATE 225 Materials Laboratory II (1)

Microstructural analysis by qualitative and quantitative metallography. Computer data acquisition for materials processes. 1 laboratory. Prerequisite: MATE 210. Concurrent: MATE 222.

MATE 232 Nanotechnology, Human Biology, Ethics and Society (4)
(Also listed as BIO 232)

Focus on four nanotechnology examples as focal points for themes of nanoscale science and technology, human biology, society, ethics, and systems thinking: gold nanoshells for cancer treatment; molecular manufacturing; tissue engineering of a vital organ; and a microfluidic glucose sensor. The focal points provide natural contexts for learning biology at the cellular level, the molecular level, the organ level and the biological systems level, respectively. 4 lectures. Prerequisite: GE Areas B1, B2, B3.

MATE 235 Materials Laboratory III (1)

Interpretation of microstructures in metals and alloys from manufacturing processes; laboratory methods for revealing and documenting such microstructures. 1 laboratory. Prerequisite: MATE 225. Concurrent: MATE 232.

MATE 310 Noncrystalline Material Systems (4)

Design and synthesis of noncrystalline material systems. Synthesis, processing techniques, properties and fabrication methods of organic and inorganic polymeric materials. 3 lectures, 1 laboratory. Prerequisite: MATE 210. Concurrent: MATE 350.

MATE 330 Hybrid Material Systems (4)

Design of hybrid material systems, including polymer-matrix, ceramic-fiber composites. Materials (matrices, fibers) and manufacturing methods treated in detail. 3 lectures, 1 laboratory. Prerequisite: MATE 210, MATE 350, CE 204 or consent of instructor. Concurrent: MATE 370.

MATE 340 Electronic Materials Systems (4)

Design of electronic materials systems utilizing the basic concepts in electron theory of solids, electrical properties and conduction in materials, magnetic phenomena and optical properties in materials. 3 lectures, 1 laboratory. Prerequisite: MATE 210, PHYS 133, EE 201, EE 251. Concurrent: MATE 360.

MATE 350 Structural Materials Systems (4)

Design of structural materials systems. Topics include continuum mechanics — stress, strain, elasticity, anelasticity, plasticity. 3 lectures, 1 laboratory. Prerequisite: MATE 210, CE 204; MATE 310 should be taken concurrently.

MATE 359 Living in a Material World (4) **GE Area F**
(Also listed as HIST 359)

Evolution of materials (ceramics, metals, polymers, composites, semiconductors) in the context of history. Traces the link between historical and technological developments enabled by materials from the Stone Age to the Electronic Age. 4 lectures. Prerequisite: Completion of GE Area B, and junior standing.

MATE 360 Metallurgical Materials Systems (4)

Mass and energy balances applied to metallurgical materials systems, design of materials products and processes including evaluation of energy needs and input/output stream compositions. 3 lectures, 1 laboratory. Prerequisite: MATE 210, STAT 312. Concurrent: CHEM 305, MATE 340.

MATE 370 Process Design (4)

Design of processes for engineering materials. Topics include kinetics in materials: solid-state diffusion (steady-state and non-steady-state), nucleation and growth kinetics, solid state phase transformations. 3 lectures, 1 laboratory. Prerequisite: MATE 360. Concurrent: MATE 330.

MATE 400 Special Problems for Advanced Undergraduates (1–4)

Individual investigation, research, studies, or surveys of selected problems. Total credit limited to 8 units, with a maximum of 4 units per quarter. Prerequisite: Consent of department head.

MATE 401 Materials Characterization (3)

Metallographic practices for metals and non-metals. Theory and application of quantitative microscopy and image analysis. Fundamental and advanced Scanning Electron Microscopy (SEM) and Energy Dispersive Spectroscopy (EDS) analysis of metals, ceramics, and polymers. Introduction to Differential Scanning Calorimetry (DSC). 3 lectures. Prerequisite: MATE 210, MATE 215. Co-requisite: MATE 406.

MATE 406 Materials Characterization Laboratory (2)

Interpretation of microstructures in metals and non-metals and laboratory methods for revealing and documenting such microstructures. Fundamental and advanced Scanning Electron Microscopy (SEM) and Energy Dispersive Spectroscopy (EDS) analysis of metals, ceramics, and polymers. Introduction to Differential Scanning Calorimetry (DSC). 2 laboratories. Prerequisite: MATE 210, MATE 215. Co-requisite: MATE 401.

MATE 425 Corrosion Engineering (4)

Forms of corrosion. Influences of environmental variables on corrosion. Methods of corrosion control. 3 lectures, 1 laboratory. Prerequisite: CHEM

125 or CHEM 128, MATE 210, MATE 215. *Materials analysis and characterization course or Special topics course.*

MATE 430 Microfabrication (3)

Silicon-based fabrication science and technology. Oxidation, diffusion, ion implantation, etching, chemical and physical vapor deposition, photolithography. 3 lectures. Prerequisite: MATE 210. Prerequisite or concurrent: MATE 360 or permission of instructor. *Materials processing course.*

MATE 435 Microfabrication Laboratory (2)

Basic processes involved in microfabrication; cleanroom protocol, oxidation, diffusion, photolithographic and etching processes, sputtering and evaporation, process development through experimentation, device testing. Each student will be part of a 4-6 person team that will fabricate a micro electronic device or integrated circuit. 2 laboratories. Prerequisite or concurrent: MATE 430, STAT 312 or equivalent. *Materials processing course.*

MATE 440 Welding Metallurgy and Joining of Advanced Materials (3)

Principles, primary variables, and microstructural changes associated with the joining process. Physics of energy transfer. Heat and mass balances in joining, thermodynamic and kinetic justification of solidification and near interface microstructures. Heterogeneous interfaces, adhesion, wetting. Relation between process selection, interface design, microstructure, and properties, weldability. 3 lectures. Prerequisite: MATE 210. *Materials processing course.*

MATE 445 Joining of Advanced Materials Laboratory (2)

Laboratory to accompany MATE 440. Illustration of principles, primary variables, and microstructural changes associated with the joining process. Physics of energy transfer. Heat and mass balances in joining, thermodynamic and kinetic justification of solidification and near interface microstructures. Heterogeneous interfaces, adhesion, wetting. Relation between process selection, interface design, microstructure, and properties, weldability. 2 laboratories. Prerequisite: MATE 210. *Materials processing course.*

MATE 446 Surface Chemistry of Materials (3) (Also listed as CHEM 446)

Surface energy, capillarity, solid and liquid interface. Adsorption, surface areas of solids, contact angles and wetting. Friction, lubrication and adhesion. Relationship of surface to bulk properties of materials. Applications. 3 lectures. Prerequisite: CHEM 306 or consent of instructor. *Special topics course.*

MATE 450 Failure Analysis (4)

Procedures for analyzing failed materials and processes. Actual failure analysis of a component by each student. Topics include fracture, fatigue, wear and overload failures, exposure to techniques of metallography, electron microscopy, energy dispersive x-ray spectroscopy, chemical analysis and heat treatment. 3 lectures, 1 laboratory. Prerequisite: MATE 210, MATE 360, MATE 350. *Materials analysis and characterization course.*

MATE 460 Materials Selection in Mechanical Design (4)

Materials-based approach to mechanical design. Using mechanical and physical properties of materials (performance indices) to select them for design needs (Materials Selection Charts). Detailed background of material properties – information from materials and mechanics. Numer-ous case studies highlight the concepts covered. 4 lectures. Prerequisite: MATE 210, CE 204, or consent of instructor. *Special topics course.*

MATE 481 Corporate Culture (1)

Practical working knowledge of key corporate topics such as leadership, ethics, organizational structure, intellectual property, professional communications, life-long learning, global and social impacts of technology. The product development process. 1 activity. Prerequisite: Senior standing. Co-requisite: MATE 482 for MATE majors.

MATE 482 Senior Project Design I (1)

Foundations of senior project design. Completion of the preliminary stages of selecting a senior project, designing experiments, evaluating realistic constraints, conducting initial experiments, and managing a project timeline. 1 lecture. Prerequisite: Senior standing. Co-requisite: MATE 481 for MATE majors.

MATE 483 Senior Project II (2)

Continuation of senior project. Completion of a senior project experimental component under the guidance of a faculty supervisor. Research methodology, experimental design, experimental work and data analysis. 1 lecture and supervised work. Prerequisite: MATE 482.

MATE 484 Senior Project III (2)

Continuation of MATE 483. Completion of a senior project data analysis and communication under the guidance of a faculty supervisor. Mathematical modeling and technical communication. 1 lecture and supervised work. Prerequisite: MATE 483.

MATE 493 Cooperative Education Experience (2) (CR/NC)

Part-time work experience in business, industry, government, and other areas of student career interest. Positions are paid and usually require relocation and registration in course for two consecutive quarters. Formal report and evaluation by work supervisor required. Credit/No Credit grading only. Total credit limited to 6 units. Prerequisite: Sophomore standing and consent of instructor.

MATE 494 Cooperative Education Experience (6) (CR/NC)

Full-time work experience in business, industry, government, and other areas of student career interest. Positions are paid and usually require relocation and registration in course for two consecutive quarters. Formal report and evaluation by work supervisor required. Credit/No Credit grading only. Total credit limited to 18 units. Prerequisite: Sophomore standing and consent of instructor.

MATE 495 Cooperative Education Experience (12) (CR/NC)

Full-time work experience in business, industry, government, and other areas of student career interest. Positions are paid and usually require relocation and registration in course for two consecutive quarters. A more fully developed formal report and evaluation by work supervisor required. Credit/No Credit grading only. Total credit limited to 24 units. Prerequisite: Sophomore standing and consent of instructor.

MATE 500 Individual Study (1–4)

Advanced study planned and completed under the direction of a member of department faculty. Open only to graduate students who have demonstrated ability to do independent work. Enrollment by petition. Total credit limited to 12 units. Prerequisite: Consent of department head, graduate advisor, or supervising faculty member.

MATE 504 Research and Development in Materials Engineering (4)

Overview of the materials science and engineering field. Current materials research and technologies, such as fuel cells, nanotechnology, etc. Emphasis on independent learning, individual research topics, and presentations. Analysis of information from different media used to comprehend how advancements in materials research and development are made. The Schedule of Classes *will list topic selected.* Total credit limited to 8 units. 4 lectures. Prerequisite: MATE 210 and graduate standing or consent of instructor.

MATE 510 Materials Analysis (4)

Fundamentals of materials surface analysis methods and thin-film microanalytical techniques, including SPM, AES, XPS, SIMS, Raman and FTIR. 4 lectures. Prerequisite: MATE 210, MATE 340.

MATE 520 X-Ray Diffraction (3)

Theory and application of x-ray diffraction as applied to advanced materials problems such as crystal quality and identification, thin film applications and structural transformations at high and low temperatures. Course will cover techniques in sample preparation, operation of equipment and interpretation of diffraction data. 3 lectures. Prerequisite: Graduate status or instructor's permission. *Materials analysis and characterization or Special topics course.*

MATE 522 Advanced Ceramics (5)

Development, utilization, and control of properties in ceramic materials (inorganic-nonmetallic solids). Emphasis on application on processing to

achieve structure and properties. Structure of crystalline ceramics and of glasses. Mechanical, thermal, optical, magnetic, and electrical properties. Application of ceramics in technology. Physical chemistry of ceramics. 4 lectures, 1 seminar. Prerequisite: Graduate standing or permission of instructor.

MATE 525 X-Ray Diffraction Laboratory (2)

X-ray diffraction laboratory experiments of advanced materials problems such as crystal quality and identification, thin film applications and structural transformations at high and low temperatures. Radiation safety training, techniques in sample preparation, operation of equipment and interpre-tation of diffraction data. 2 laboratories. Prerequisite: Graduate standing in engineering or science or instructor's permission. Concurrent: MATE 520. *Materials analysis and characterization or Special topics course.*

MATE 530 Biomaterials (4) (Also listed as BMED 530)

Structure-function relationships for materials in contact with biological systems. Interactions of materials implanted in the body. Histological and hematological considerations including foreign body responses, inflammation, carcinogenicity, thrombosis, hemolysis, immunogenic and toxic properties. Microbial interaction with material surfaces, degradation. 4 lectures. Prerequisite: BIO 213, ENGR 213, MATE 210 and graduate standing or consent of instructor.

MATE 540 Tribology (3)

Wear and degradation of engineering systems. Dry and lubricated wear modes, identification, and prevention. Materials selection. Friction, contact mechanics, and lubrication theory. Case studies of mechanical systems and failure analysis. Wear Modeling and testing. 3 lectures. Prerequisite: MATE 210, MATE 215.

MATE 545 Tribology Laboratory (1)

Wear testing and measurement through various processes including dry sand rubber wheel, cavitation/erosion, and simulated chemical/mechanical polishing. Wear analysis to include wear modeling, materials characterization via metallography, scanning electron microscopy, and surface profilometry. Experiments focus on real engineering systems and their degradation as a result of wear. 1 laboratory. Prerequisite: MATE 210, MATE 215, MATE 235 or consent of instructor. Co-requisite: MATE 540.

MATE 550 Micro Systems (4)

Fundamentals of intelligent systems employing sensors, actuators and intelligent controls. Impact on material properties as devices shrink in the micrometer realm. Applications toward exploring nanotechnology. 4 lectures. Prerequisite: MATE 210, graduate standing or consent of instructor.

MATE 555 Micro Systems Laboratory (2) (Also listed as ME 555)

Design, fabrication, and testing of a microfluidic device. Utilization of a rapid prototype soft lithography processing technique to create micro channels, valves, mixing chambers, etc. for controlling fluid flow dynamics. 2 laboratories. Prerequisite: Senior or graduate standing or consent of instructor. Corequisite: MATE 550. *New course effective Spring 2009.*

MATE 560 Thin-Film Processing (3)

Thin film science and technology: deposition techniques, surface crystal notation, energy and kinetic processes, epitaxy. Schottky barriers and surface states, stress analysis, characterization techniques, electronics devices incorporating thin films. The Schedule of Classes will list topics for selection. Total credit limited to 6 units. 3 lectures. Prerequisite: Graduate standing or permission of instructor. *Materials processing course.*

MATE 565 Thin-Film Processing Laboratory (2)

Thin film processing and analytical techniques: direct current and radio frequency magnetron sputtering, reactive sputtering, co-evaporation, epitaxy, grazing incidence x-ray diffraction, magnetic force imaging. The Schedule of Classes will list topics for selection. Total credit limited to 6 units. 2 laboratories. Concurrent: MATE 560 or consent of instructor. *Materials processing course.*

MATE 570 Advanced Engineering Materials (4)

An advanced treatment of the structure of matter. Physical and mechanical properties of materials including metals, alloys, ceramics, insulating materials, semiconductors, super semiconductors, polymers and composites based on detailed theoretical understanding of material microstructures. Discussions of Equilibrium diagrams, processing approaches, material selection based on thermodynamic and kinetic arguments. Degradation and failure, fitness for purpose. 4 lectures. Prerequisite: Graduate standing or permission of instructor. *Special topics course.*

MATE 571 Selected Advanced Laboratory (1-4)

Directed group laboratory study of selected topics for advanced students. The Schedule of Classes will list title selected. Total credit limited to 8 units. 1-4 laboratories. Prerequisite: Senior or graduate standing or consent of instructor. *New course effective Spring 2008.*

MATE 580 Fracture Mechanics and Failure Mechanisms in Materials (4)

Fracture modes and mechanisms in engineering materials, fracture mechanics fundamentals (stress analysis of cracks, energy analysis of fracture process). Use of fracture mechanics in design. Laboratory gives concentrated exposure to fracture development in materials, fracture surface evaluation, fracture toughness testing. 3 lectures, 1 laboratory. Prerequisite: MATE 350, or graduate standing. *Special topics course.*

MATE 590 Solidification and Densification (4)

Thermodynamics, kinetics and morphologies of solid-liquid interfaces. Heat flow in castings, crystal growth. Solidification mechanics, solute redistribution. Production, characterization and testing of metal powders. Compacting of powder. Sintering with/without liquid phase. Hot pressing, properties of sinterings as a function of processing conditions. Application of theory to the production of useful materials. 4 lectures. Prerequisite: Graduate standing or permission of instructor. *Materials processing or Special topics course.*

MATE 599 Design Project (Thesis) (2) (2) (5)

Each individual or group will be assigned a project for solution under faculty supervision as a requirement for the master's degree, culminating in a written report/thesis. Prerequisite: Graduate standing.