MATERIALS PHYSICS & ENGINEERING (MPEN)

MPEN 6290 Computation Material Sci & Eng (3)
Computational Materials Science and Engineering: This course will cover theories, implementations, and applications of common quantum mechanical software for computational study of materials. State-of-the-art computational methods will be introduced for materials research with emphasis on the atomic and nano scales and hands-on modeling on PCs and supercomputers. The class is aimed at beginning graduate students and upper level undergraduate students, and will introduce a variety of computational methods used in different fields of materials science. The main focus is quantum mechanical methods with a short overview of atomistic methods for modeling materials. These methods will be applied to the properties of real materials, such as electronic structure, mechanical behavior, diffusion and phase transformations. Computational design of materials using materials database via high-throughput and machine learning methods will also be covered.

MPEN 6350 Kinetics of Material Systems (3)
This course covers all aspects of kinetics in material systems. Topics include thermodynamics, steady state and time dependent diffusion, phase transformations, statistical mechanics, structure evolution, boundaries and interfaces, solidification, and precipitation effects.

MPEN 6360 Structure of Materials (3)
The properties of matter depend on which of the about 100 different kinds of atoms they are made of and how they are bonded together in different crystal structures; specifically, the atomic structure primarily affects the chemical, physical, thermal, electrical, magnetic, and optical properties of materials. Metals behave differently than ceramics, and ceramics behave differently than polymers. Students will learn the different states of condensed matter and develop a set of tools for describing the crystalline structure of all of them. They will gain a better understanding of the principles of structure common to all materials. Key concepts, such as symmetry theory will be introduced introduced and applied to provide a common viewpoint for describing structures of ceramic, metallic, and polymeric materials and the latter includes optical microscopy, electron optics, x-ray diffraction and some surface analytical techniques. Structure-sensitive properties of real materials will also be introduced.

MPEN 6370 Processing of Biomaterials (3)
Processing of biomaterials gives an overview of the most advanced techniques to process biomaterials into structures that satisfy next generation applications. All materials classes will be covered including polymers, ceramics, metals, composites and cells and tissues. In each case, the material-specific processing and the properties and potential applications will be covered.

MPEN 6380 Materials for Energy (3)
The course begins with a history of our understanding and utilization of different sources of energy and a review of thermodynamics. In all cases, the most effective materials used are discussed as well as the relevant fundamental equations used and approaches for improving the figure-of-merit. The 5 different forms of energy are introduced - mechanical, electromagnetic, thermal, chemical, and nuclear - and discussed. Materials and techniquesused for energy applications are discussed including thermoelectrics, fossil fuels, nanoparticles, different approaches for energy storage, fuel cells, nuclear energy (fission and fusion), energy biological systems - from cellular scale and ATP and catabolism/anabolism to biomass conversion, and magnetohydrodyanmics. Techniques for energy conversion, biomimetics, energy and the environment and material issues for energy transformation are discussed. The sun is also discussed as a source of energy for photosynthesis, photovoltaics, and photothermal power generation.

MPEN 6390 Synthesis of Nanomaterials (3)
This course focuses on the fundamentals of nanomaterials synthesis mechanisms and characterization. The course gives an introduction for nanomaterials classes and their importance for today's world, followed by basics of physical chemistry of solid surfaces. Then, top-down and bottom-up synthesis approaches for nanomaterials systems including gas, liquid and solid phase processes are covered. Characterization techniques of special importance for nanomaterials are taught. During the semester students will study and review scientific articles focused on nanomaterials synthesis and characterization.

Prerequisite(s): ENGP 3120.

MPEN 6560 Photonic Materials & Devices (3)
This course will cover the theory, design, fabrication, characterization, and application of photonic materials and devices. The course will start with a review of the fundamentals of photonics, including ray optics, wave optics, and nanophotonics/quantum optics. The course will then focus on light-matter interactions and photonic materials, including dielectrics, semiconductors, metals, metamaterials, and photonic crystals. Using these principles and materials, we will explore a number of device architectures, including LEDs, lasers, photodetectors, photovoltaics, etc. We will then discuss fabrication methods for making these materials and devices and common optoelectronic characterization techniques. The course will conclude with exploration of cutting edge topics in photonics research. Prerequisites: PHYS 2350 and PHYS 2360 (or equivalent) or instructor approval.

MPEN 6570 Semiconductor Devices (3)
An introduction to the physics and technology underlying semiconductor electronic and optoelectronic devices, including electrons and holes in semiconductors, energy-band diagrams, carrier transport, metal-semiconductor contacts, p-n junctions, and heterostructures. Device examples include bipolar transistors, MOSFETs, LEDs, and solar cells.

MPEN 6620 MicroFab and Nanotech (3)
Nano/micro-electromechanical devices (N/MEMS) require knowledge of a broad range of disciplines, from the fundamental physics of mechanics and electromagnetism to practical nano/microfabrication processes and techniques.

MPEN 6660 Special Topics (1-3)
Special Topics. Course may be repeated up to unlimited credit hours.

Maximum Hours: 99

MPEN 6720 Mechanic Behavior of Materials (3)
The course covers the general foundations of elasticity and plasticity theory, dislocation theory, and strengthening mechanisms. Basics of materials forming processes are studied. An overview for non-destructive testing of materials is taught. The course emphasis is on destructive mechanical testing of materials including; tension, torsion, hardness, fatigue and creep tests, in addition to fracture mechanics and failure analysis.

MPEN 6760 Thermodynamics of Materials (3)
The course covers the general foundation of both statistical thermodynamics and classical thermodynamics, including thermodynamics laws, auxiliary functions, and behavior of gases and solutions. In addition, special attention is dedicated to equilibria of reactions and phase diagrams of materials. Computer-based programs will be used to solve thermodynamics problems for complicated materials.

MPEN 6950 Engineers for Int'l Deve (1)
Engineers for International Development at Tulane University exists for students to participate in community-driven development programs worldwide through the design and implementation of sustainable engineering projects, while fostering responsible leadership. We work both internationally and locally to build and educate communities about their basic infrastructure systems such as drinking water, sanitation, and safe homes.

MPEN 7910 Research I (3)

MPEN 7920 Research II (3)

MPEN 7930 Research III (3)

MPEN 7940 Research IV (3)

MPEN 7951 Advanced Research I (3)

MPEN 7952 Advanced Research II (3)

MPEN 9000 Independent Study (0-3)
Course Limit: 99

MPEN 9980 Masters Research (3)
Research toward completion of a masters degree. Course may be repeated up to unlimited credit hours.

Maximum Hours: 99