ENGR 54 PRINCIPLES OF MATERIALS SCIENCE AND ENGINEERING
Spring 2005

Catalog Data: **ENGR 54 Principles of Materials Science and Engineering (Credit Units: 4).** Materials--topics range from superconductors to biodegradable polymers. Structure and properties of materials, including metal, ceramics, polymers, semiconductors, composites, traditional materials. Atomic structure, bonding, defects, phase equilibria, mechanical properties, electrical, optical, and magnetic properties. Brief introduction to materials processing and synthesis. Prerequisites: Chemistry 1A and Physics 7B. Only one course from ENGR 54 and ENGR H54 can be taken for credit. (Design unit: 0)

Textbook: *Fundamentals of Materials Science and Engineering, An Integrated Approach,* William D. Callister, Jr., 2nd Edition, John Wiley & Sons, Inc., New York, 2005

References: None

Coordinator: James Earthman and Martha Mecartney

Course Objectives: This course will serve as the common entry point for all undergraduate students in The Henry Samueli School of Engineering. It will cover the basic concepts of materials science and engineering including atomic bonding, crystallography, crystal imperfections, diffusion process, phase diagrams and phase transformations, and material behavior.

Course Outcomes: Students are able to:
Predict the chemical bonding in a material based upon the periodic table and the elements in the material.
Identify common crystal structures and calculate planes and directions in unit cells.
Familiar with types of defects in materials and understand the role these defects (especially dislocations) play in deformation.
Construct stress-strain curves from deformation data and calculate the elastic modulus, yield stress, and fracture stress from stress-strain curves.
Calculate the maximum load or maximum elongation a component can withstand prior to plastic deformation or prior to fracture using a stress-strain curve and the sample cross sectional area or length.
Familiar with ways to strengthen metal alloys.
Calculate the fracture toughness of a brittle material.
Calculate fatigue life of components using data from fatigue curves.
Use phase diagrams to calculate the phases present, the amount of each phase and the chemical composition of each phase for a given temperature and starting composition.
Use phase diagrams to calculate the maximum solubility and the melting temperature of any given composition.
Identify applications for steels and other metal alloys.
Understand the design limitations for metal alloys, ceramics, and polymers and the major differences between these classes of materials.
Apply the basic principles of composites to calculate stress and strain in composite materials.

Can predict the difference in electrical behavior for metals, insulators, and semiconductors and how defects affect electrical properties.
Can calculate thermal stresses that arise from thermal expansion stresses
Understand how material defects affect magnetic properties of materials.
Understand the physical basis for transparency and opacity in materials.
Understand basic materials design concepts along with professional and ethical responsibilities when selecting the material most suitable for a given application using data on materials properties.
Understand that materials are continually being evolved requiring continuing education to stay abreast of new developments.
Understand contemporary issues related to novel properties of new materials.

Prerequisites by Topics: General background in Chemistry or Physics.

Lecture Topics:

Atomic Bonding
Crystal Structures
Defects in Materials
Diffusion
Failure of Materials
Phase Diagrams and Alloys
Ceramics
Polymers Room Temperature
Composites
Mechanical Properties
Electrical Behavior
Thermal Behavior
Magnetic Properties
Optical Behavior Strengthening
Mechanisms for Metals
Types of Metal Alloys and Thermal Processing

Class Schedule: Each class meets 3 hours per week for 10 weeks and students are assigned a 1 hour discussion session per week.

Computer Usage: PC based software CD exercises provided with book

Laboratory Projects: None

Professional Component: Contributes toward the Materials Science and Engineering Major design experience.

Relationship to Program Outcomes:
This course relates to Program Outcomes 1 and 3 as stated at:
http://www.eng.uci.edu/dept/objective_materials_science

Design Content Description:

Approach:	N/A
Lectures:	N/A
Laboratory Portion:	N/A

Grading Criteria:

Discussion Section/Class Quizzes			10%
Midterm Exam #1	20%	Midterm Exam #2	20%
Homework	10%	Final Exam	40%

Estimated ABET Category Content:
Mathematics and Basic Science: 0 credit units or 0%
Engineering science: 4 credit units or 100%
Engineering design: 0 credit unit or 0%

Prepared by: **Mrtha Mecartney** **Date:** **April 2005**
Last modified: **Winter 2003**