DEPARTMENT OF CHEMICAL ENGINEERING

Syllabus

CHE 31000: Introduction to Material Science

Designation: Required course for Chemical Engineering Juniors

Catalogue Description*:* Basic concepts in the behavior of solid materials. Atomic bonding; crystal structure; crystal defects; alloys; insulators; metals. Mechanisms of corrosion; selection of materials of construction.

Prerequisites: CHE 22800
Co-requisites: Chem 34100

Text: Callister, W.D., Jr., *Materials Science and Engineering: An Introduction*, 6^{th} edition, John Wiley & Sons, New York, 2003.

Course Objectives:
This course is designed to acquaint chemical engineering students with the fundamental properties of materials, particularly the relationship between 1) interatomic bonding, 2) structure, and 3) material properties. The students should also be able to apply this understanding to a variety of material types, including metals, ceramics and polymers.

In addition, students will work in small teams to examine a particular material, material phenomenon or material processing method. The project facilitates the notion that materials engineering is a diverse field, while challenging the student to develop practical teamwork and presentation skills.

Topics Covered:

1. Atomic bonding forces and energies. Interatomic bonds: ionic bond, covalent bond, metallic bond, Van der Waals interaction.
2. Crystal Structure: Bravais lattices, index system for crystal planes and directions, crystal structure density.
3. Defects: vacant lattice sites, the equilibrium number of point defects, dislocations, planar defects, diffusion in solids.
4. Phase behavior: phase diagrams, Gibbs' phase rule, solubility, lever rule, eutectics, phase transformations
5. Mechanical properties of solids: stress and strain, elastic and plastic deformation, fracture, fatigue.
6. Material properties:
   - Electrical properties: Ohm's law, conductivity, conduction, electron mobility, resistivity, semiconductors.
   - Thermal properties: heat capacity, thermal expansion, thermal conductivity.
   - Magnetic properties: diamagnetism, paramagnetism, ferromagnetism, temperature effects, superconductors.
   - Optical properties: EM radiation, absorption, refraction/reflection, transmission.

7. Materials: polymers (molecular weight, structure, copolymers, processing), Metals, ceramics, composites, bio-materials.
8. Materials selection and design.

Course Schedule: This class meets twice a week for a total of three academic hours over a fourteen-week semester. Out-of-class assignments stress problem solving capability. Two in-class exams that include essay questions to test overall comprehension of the material. Grading: Homework assignments – 20%, in-class exams – 30%, final exam – 30%, group presentation – 20%.

Contribution of course to meeting the professional component:
The primary purpose of the course is to provide students with an understanding of the basics of materials science, the principles behind current material applications, and the relationship between the structure and the properties.

Relationship of course to program outcomes:

This course contributes to the following program outcomes:

a. An ability to apply knowledge of mathematics, science and engineering
e. An ability to identify, formulate and solve chemical engineering problems
g. An ability to communicate effectively;
j. A knowledge of contemporary issues
k. An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

Instructor (person who prepared this description) and date of preparation.
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