MSE 23000 Structure and Properties of Materials

Credits and Contact Hours: 3 credits. Weekly Schedule for 15 weeks: two 50 minute lectures, one 50 minute recitation.

Instructors or Course Coordinators: R. Trice, D. Johnson, and J. Mansson.

Textbook: "Materials Science and Engineering, An Introduction," 9th ed., W.D. Callister, Jr. and David G. Rethwisch (John Wiley & Sons, Inc., 2014).

Specific Course Information

a. **Catalog Description**: The relationship between the structure of materials and the resulting mechanical, thermal, electrical, and optical properties. Atomic structure, bonding, atomic arrangement; crystal structure, crystal symmetry, defects, and the use of X-ray diffraction. Phase equilibria and microstructural development. Applications to design.

b. **Prerequisites**: CHM 11500 and MA 16500.

c. **Course Status**: MSE 23000 is a required course.

Specific Goals for the Course
1. All Students
A. Recognize basic MSE nomenclature, basic microstructure, associate terms with the appropriate structure/phenomena, and be able to differentiate between related structures/phenomena. Examples:
- FCC and BCC crystal structures.
- Ionic and Covalent crystal structures.
- Elastic and Plastic deformation.
- Isomorphous and eutectic phase diagrams.
- Interstitial and vacancy diffusion mechanisms.
- Polymers exhibit a distribution of molecular weights.
- Identifying and drawing crystallographic planes and directions.

B. Perform simple calculations to quantify material properties and microstructural characteristics. Examples:
- Interplanar spacing of a family of atomic planes given a x-ray diffraction pattern.
- Equilibrium vacancy concentration at a given temperature.
- Dimensional changes associated with elastic and plastic deformation.
- Fracture strength for a given flaw size.
- Phase composition and fraction using phase diagrams.
- Apply Reuss and Voight models to determine modulus of composites.

C. Recognize the effect of composition and microstructure on material properties. Examples:
- Hall-Petch effect
- Dislocation density effect on yield strength and electrical conductivity.
- Alloying effect on yield strength and electrical conductivity.
- Inverse relationship between yield strength and fracture toughness.
- Correlation between type of atomic bonding and the mechanical and electrical properties of different classes of materials.

2. Most Students

A. Take information from a known situation and apply it to a new situation. Examples:

- Effect of temperature and applied stress on the peak positions in a XRD pattern.
- Simple calculations with multiple steps.

B. Predict property response or microstructural changes based on imposed conditions. Examples:

- Predicting microstructure using a phase diagram.
- Predicting microstructure using a TTT diagram.
- Effects of temperature and alloying on the resistivity of metals.

C. Assess the interplay of two material properties. Examples:

- Effect of atomic bond strength on Young's modulus, coefficient of thermal expansion and melting temperature.
- Determine if a material will yield or rupture at a given applied stress.

Relation of Course to Student Outcomes:

(MSE-1, ABET-1) an ability to identify, formulate, and solve complex materials engineering problems by applying principles of engineering, science, and mathematics.

Topics Covered: Atomic Bonding and Material Properties, Crystal Structure, Crystallographic Directions and Planes, Macromolecular Structure, Mechanical Behavior, Fracture, Fatigue, Diffusion, Phase Equilibria, Phase Transformations, Microstructure Control in Metals, Metal Alloys and Processing, Glass and Ceramic Processing, Polymers and Composites, Electrical Properties.