STUDENT LEARNING OUTCOMES:

By the end of this course, a student should:

1. Identify and explain the relationship between the internal structure of materials and their macroscopic properties.

2. Identify, compare and contrast methods (intentional or unintentional) of altering the structure of materials by mechanical, chemical, or thermal means in order to change material properties.

3. Identify, compare, contrast, and describe the relationships between structure and properties of crystalline solids.

4. Identify the various systems for classifying materials, and compare differences in properties among material classes that derive from differences in structure.

COURSE OBJECTIVES:

By the end of this course, a student should:

1. Explain the relationship between the internal structure of materials and their macroscopic properties.

2. Explain methods (intentional or unintentional) of altering the structure of materials by mechanical, chemical, or thermal means in order to change material properties.

3. Illustrate the various systems for classifying materials, and compare differences in properties among material classes that derive from differences in structure.

4. Gather data from reference sources regarding the properties, processing, and performance characteristics of materials, and use it as a basis to recommend appropriate material(s) to meet engineering design criteria.

5. Work effectively in groups during the engineering design project which involve problem solving, report writing, and oral presentations.

CONTENT, STUDENT PERFORMANCE OBJECTIVES, OUT-OF-CLASS ASSIGNMENTS

Curriculum Approval Date:04/12/2022

1 HOUR

TOPIC 1. Introduction to Materials Engineering

a. Classification of materials

b. Materials selection and design

c. Processing, structures, properties, performance

3 HOURS

TOPIC 2. Atomic structure and bonding

a. Subatomic structure and periodic properties

b. Interatomic bonding: classes and characteristics

c. General bond force-energy diagrams

3 HOURS

TOPIC 3. Crystal structures and crystallography

a. Crystal unit cell basics

b. Metallic crystal structures

c. Density analysis

d. Crystallographic indices - points, directions, planes

e. X-ray diffraction analysis

3 HOURS

TOPIC 4. Imperfections in crystals

a. Polycrystalline, semi-crystalline, and amorphous solids

b. Point, line, interfacial, and bulk defects

c. Microscopic examination techniques/methods

3 HOURS
TOPIC 5. Solid State Diffusion
a. Diffusion mechanisms and driving force
b. Temperature dependence
c. Fick's first and second laws
d. Steady-state diffusion
e. Transient diffusion
6 HOURS
TOPIC 6. Mechanical Properties and Testing
a. Mechanical quantities - stresses, strains, moduli
b. Stress-strain analysis, tensile testing
c. Hardness testing
d. Variability of material properties
e. Elastic and plastic deformation of metals
3 HOURS
TOPIC 7. Strengthening and toughening in metals
a. Dislocations and slip
b. Resolved shear stress and slip systems
c. Grain size strengthening
d. Solid-solution strengthening
e. Strain hardening and cold work
f. Recovery, recrystallization, and grain growth
3 HOURS

3 HOURS
TOPIC 12. Thermal Properties of Materials
a. Specific heat capacity
b. Coefficient of thermal expansion
c. Thermal conductivity
d. Thermal stress and shock
3 HOURS
TOPIC 13. Structure and properties of ceramics
a. Classification of ceramics
b. Structure of crystalline ceramics
c. Composition and structure of glass and glass-ceramics
d. Thermal and mechanical behavior of ceramics
e. Applications and processing of ceramics
3 HOURS
TOPIC 14. Structure and properties of polymers
a. Classifications of polymers
b. Chemistry and molecular structure
c. Polymer chain characteristics
d. Thermal and mechanical behavior of polymers
e. Applications and processing of polymers
3 HOURS