ENGR 0140B - MATERIALS SCIENCE AND ENGINEERING

Catalog Description

Formerly known as ENGR 45
Prerequisite: Completion of PHYS 205 and 205L with grades of "C" or better; and completion of CHEM 1A with grade of "C" or better
Hours: 108 (54 lecture, 54 laboratory)
Description: Presents the internal structures and resulting behaviors of materials used in engineering applications, including metals, ceramics, polymers, composites, and semiconductors. The emphasis is upon developing the ability both to select appropriate materials to meet engineering design criteria and to understand the effects of heat, stress, imperfections, and chemical environments upon material properties and performance. Laboratories provide opportunities to directly observe the structures and behaviors discussed in the course, to operate testing equipment, to analyze experimental data, and to prepare reports. (C-ID ENGR 140B) (CSU, UC)

Course Student Learning Outcomes

- CSLO #1: Compare, and contrast the different classifications of materials used in society by engineering methods.
- CSLO #2: Analyze and formulate the atomic and/or molecular structure (including atomic bonding and crystalline nature) of the common engineering materials.
- CSLO #3: Identify the five common material properties used in engineering design.
- CSLO #4: Create laboratory reports that clearly communicate the details of experiments performed in the engineering lab.
- CSLO #5: Define and analyze the various engineering failure mechanisms (including creep, fracture, plastic deformation, fatigue, etc.) that cause mechanical assemblies to fail.

Effective Term

Fall 2023

Course Type

Credit - Degree-applicable

Contact Hours

108

Outside of Class Hours

108

Total Student Learning Hours

216

Course Objectives

Lecture Objectives:
1. Define the basic engineering materials classifications.
2. Determine and analyze atomic bonding and crystal structures for some common engineering materials.
3. Determine and evaluate the relationship of crystal structures and measured macroscopic properties and its applications to the physical material properties.
4. Identify crystal defects and imperfections related to the physical properties of engineering materials.
5. Identify the processes of solid state diffusion and then perform calculations.
6. Compare the mechanisms for elastic and plastic deformation in typical engineering materials.
7. State thermal behaviors of engineering materials.
8. Analyze and perform calculations on the mechanics of engineering material failure (static loading, dynamic loading, fatigue, creep, stress concentration, DTBTT (ductile to brittle transition temperature), hardness, etc)
9. Use binary equilibrium phase diagrams to predict the material structure and therefor the properties.
10. Analyze and predict how heat treatments are used to vary microstructure and therefore physical material properties.
11. Examine and analyze the fundamentals of physical properties of metals.
12. Examine and analyze the fundamentals of physical properties of ceramics and glass.
13. Examine and analyze the fundamentals of physical properties of polymers.
14. Defend the concepts of professional, ethical, and social responsibilities in the discipline of engineering.
Lab Objectives:
1. Demonstrate the ability to perform tests and analysis to verify the cause of failure.
2. Demonstrate the ability to perform experiments and analysis to measure multiple material properties using industry standard engineering experiments.
2A. Alloying content within steel and other metals using various testing techniques
2B. Mechanical Properties: Elastic Modulus, Yield Strength, Ultimate Strength, Ductility, Toughness, and Penetration Hardness.
2C. Identify, measure, and analyze microstructural components of alloy metals.
3. Model how to function effectively as part of a team, including how to design, prepare, and conduct an experiment.
4. Create laboratory reports including an abstract, theory, procedure, equipment/materials list, results, conclusions, and appendix which summarize all experiments conducted within the duration of this class.
5. Demonstrate effective communication skills through speaking, writing and graphics, including the appropriate use of computer software.

General Education Information

- Approved College Associate Degree GE Applicability
- CSU GE Applicability (Recommended-requires CSU approval)
- Cal-GETC Applicability (Recommended - Requires External Approval)
- IGETC Applicability (Recommended-requires CSU/UC approval)

Articulation Information

- CSU Transferable
- UC Transferable

Methods of Evaluation

- Problem Solving Examinations
  - Example: 1. Calculate the theoretical density of Aluminum given the lattice structure, atomic radii and atomic mass. 2. Calculate

atomic planar density of Titanium given the lattice structure and atomic radius.

- Reports
  - Example: 1. Prepare a lab report, including abstract, theory, equipment list, procedure, results, conclusions and appendix on an ASTM standard tensile test. This should document the five material properties of an unknown ferrous alloy. Those are Yield Strength, Ductility, Ultimate Strength, Modulus of Elasticity and toughness. 2. Prepare a lab report, including abstract, theory, equipment list, procedure, results, conclusions and appendix on alloy chemical testing to identify a specific metal alloy. This should include conclusions on which metal alloys are present within an unknown sample (for example: the metal specimen was tested and found to have Nickel as an alloy constituent, therefore it is a grade of stainless steel).

Repeatable

No

Methods of Instruction

- Laboratory
- Lecture/Discussion
- Distance Learning

Lab:

1. Instructor will assign a laboratory experiment to show the how the various metallographic alloys vary in strength when different elements are added to a carbon ferrous metal. Students are then directed to discuss their data among the team members to determine if it supports/discredits their prediction of the laboratory results. Students are required to submit their written abstract, results, conclusion, and discussion of the experiment.

Lecture:

1. Instructor will present a PowerPoint lecture discussing the theory of atomic bond energy in relation to mechanical strength of material. Students are expected to take notes, analyze the presented concepts so that they can participate in a class discussion.

Distance Learning

1. Instructor illustrates high atomic linear density directions via live/recorded video and posts an online discussion.

Typical Out of Class Assignments Reading Assignments

Required college level readings from chapters in the textbook are regularly assigned. Students are expected to solve homework problems and take examinations based upon these readings. Ex. 1. Read the textbook chapter on crystal structures. Come to class prepared to discuss (compare and contrast) the different crystal structures of engineering materials and how those crystal structures dictate material properties. Ex. 2. Read the textbook chapter on stress-strain behavior to understand the stress-strain behavior of engineering materials, specifically steel in this case. Perform the stress-strain laboratory experiment and write a report to document the theory, equipment, procedure, results, and conclusions in measuring material properties stress-strain behavior and determining the five material properties: Modulus of Elasticity, Ductility, Yield strength, Ultimate Strength and Toughness. Sample 1: From textbook chapter assignment, students will read and analyze how to identify carbon steel microstructures and thermally activated processes that can happen within them. Sample 2: From reading the laboratory assignments and research performed on the internet, each student will understand the procedure and then conduct Penetration Hardness Testing (a Rockwell Hardness Test) to measure the ultimate strength of a several metal alloys.

Writing, Problem Solving or Performance

Sample 1: Each student will prepare a metal sample for microscopic analysis. From the analysis of the microstructure of the metal grains, the student will determine the phase transformation of the metal during the heat treating cycle that it has undergone. This will be summarized in a lab report. Sample 2: Each student will be provided an unknown metal sample. By using spark, magnetic, chemical, and hardness testing methods, that student will identify the metal by its AISI or ASTM identification number using properties derived from each test aforementioned.

Other (Term projects, research papers, portfolios, etc.)

Students are required to work in a teams. Each team will design and conduct an experiment to determine which material is best for a specific engineering application.

Required Materials

- Materials Science and Engineering
  - Author: Callister and Rethwisch
  - Publisher: Wiley
  - Publication Date: 2018
  - Text Edition: 10th
  - Classic Textbook?:
  - OER Link:
  - OER:

Other materials and-or supplies required of students that contribute to the cost of the course.

USB Flash Drive Engineering Calculator