# BUTTE COLLEGE
## COURSE OUTLINE

I. **CATALOG DESCRIPTION**

**ENGR 45 - Materials Science** **4 Unit(s)**

**Prerequisite(s):** PHYS 41, CHEM 1
**Recommended Prep:** NONE

**Transfer Status:** CSU/UC
51 hours Lecture
51 hours Lab

This course 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 140).

II. **OBJECTIVES**

Upon successful completion of this course, the student will be able to:

A. Explain the relationship between the internal structure of materials and their macroscopic properties.
B. Explain methods (intentional or unintentional) of altering the structure of materials by mechanical, chemical, or thermal means in order to change material properties.
C. Illustrate the various systems for classifying materials, and compare differences in properties among material classes that derive from differences in structure.
D. 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.
E. Measure material properties and/or evaluate processing treatments using standard materials testing equipment and techniques. (Lab)
F. Write laboratory reports that communicate the collection, analysis, and interpretation of experimental data according to professional engineering standards. (Lab)

III. **COURSE CONTENT**

A. **Unit Titles/Suggested Time Schedule**

Lecture

| Topics | Hours |
|---|---|
| 1. Atomic structure and bonding | 2.00 |
| 2. Crystal structures and crystallography | 3.00 |
| 3. Imperfections in crystals, including polycrystalline, semi-crystalline, and amorphous solids | 2.00 |
| 4. Diffusion | 2.00 |
| 5. Elastic and plastic deformation in metals | 2.00 |
| 6. Strengthening and toughening in metals | 3.00 |
| 7. Mechanical properties and testing | 2.00 |
| 8. Stress-strain analysis | 3.00 |

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|---|---|
| 9. Mechanical failure: fracture, fatigue, creep | 3.00 |
| 10. Phase diagrams | 6.00 |
| 11. Phase transformations | 3.00 |
| 12. Iron-Carbon system, heat treatment of steels | 3.00 |
| 13. Metals and Metal Alloys | 3.00 |
| 14. Forming and Fabrication | 2.00 |
| 15. Thermal, electrical and magnetic properties, including semiconductors | 2.00 |
| 16. Chemical properties, including corrosion | 2.00 |
| 17. Structure and properties of polymers | 3.00 |
| 18. Structure and properties of ceramics | 3.00 |
| 19. Structure and properties of composites, including wood and concrete | 1.00 |
| 20. Selection of materials in engineering design | 1.00 |
| Total Hours | 51.00 |

Lab

| Topics | Hours |
|---|---|
| 1. Lab orientation and lab safety instructions | 3.00 |
| 2. Tension testing of metallic and polymer materials | 7.00 |
| 3. Hardness testing of metallic materials | 3.00 |
| 4. Impact testing of metallic materials | 7.00 |
| 5. Stress concentration, fatigue, and creep | 3.00 |
| 6. Computer modeling of stress concentration and crack propagation | 3.00 |
| 7. Strain hardening and recrystallization | 3.00 |
| 8. Specimen preparation and microscopic metallurgical examination | 7.00 |
| 9. Polyphase metal alloys, cooling curves, and microstructure examination | 3.00 |
| 10. Jominy end-quench precipitation hardening | 6.00 |
| 11. Polymers characterization | 3.00 |
| 12. Ceramics fabrication and characterization | 3.00 |
| Total Hours | 51.00 |

## IV. **METHODS OF INSTRUCTION**

A. Lecture
B. Instructor Demonstrations
C. Collaborative Group Work
D. Homework: Students are required to complete two hours of outside-of-class homework for each hour of lecture
E. Problem-Solving Sessions
F. Laboratory Experiments

## V. **METHODS OF EVALUATION**

A. Homework
B. Lab Projects
C. Mid-term and final examinations

## VI. **EXAMPLES OF ASSIGNMENTS**

A. Reading Assignments
    1. Read the safety procedures in the lab manual and be prepared to apply them in mock examples presented by the instructor.
    2. Read the section in the text defining and contrasting the unit cells of various crystal structures. Be prepared to use the course periodic table and sketch the crystal structures of randomly selected single atom solids.

B. Writing Assignments
    1. Produce a formal 5-6 page report of the harness testing experiment. The formal lab report must include a cover page, table of contents, introduction, theory, principles, and summary/conclusions.
    2. Solve selected problems regarding phase diagrams and write one page identifying the thermodynamic conditions necessary to apply the phase concept.

C. Out-of-Class Assignments
    1. Solve a series of questions on grain size determination using the ASTM methods described in class.
    2. Go the the MatWeb site and produce a reference list with a short definition of all the unique material properties on the search menu of the material properties section. Be prepared to discuss in class.

## VII. **RECOMMENDED MATERIALS OF INSTRUCTION**

Textbooks:

A. Callister W.D. Materials Science and Engineering: An Introduction. 9th Edition. Wiley, 2013.
B. Smith, W. F., Hashemi, J. Foundations of Materials Science and Engineering. 5th Edition. McGraw Hill, 2010.

Materials Other Than Textbooks:

A. Lab Manual provided by the instructor.

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