ENGR 45 Course Outline as of Fall 2001

CATALOG INFORMATION

Dept and Nbr: ENGR 45 Title: PROP OF MATERIALS
Full Title: Properties of Materials
Last Reviewed: 1/25/2021

Units		Course Hours per Week		Nbr of Weeks	Course Hours Total	
Maximum	4.00	Lecture Scheduled	3.00	17.5	Lecture Scheduled	52.50
Minimum	4.00	Lab Scheduled	3.00	17.5	Lab Scheduled	52.50
		Contact DHR	0		Contact DHR	0
		Contact Total	6.00		Contact Total	105.00
		Non-contact DHR	0		Non-contact DHR	0

Total Out of Class Hours: 105.00 Total Student Learning Hours: 210.00

Title 5 Category: AA Degree Applicable
Grading: Grade Only
Repeatability: 00 - Two Repeats if Grade was D, F, NC, or NP
Also Listed As:
Formerly:

Catalog Description:
Structure, properties, selection, utilization, and deterioration of engineering materials. (CAN ENGR 4)

Prerequisites/Corequisites:
CHEM 1A or CHEM 4A and PHYS 4A.

Recommended Preparation:

Limits on Enrollment:

Schedule of Classes Information:
Description: Preq: Chem 1A or 4A & Physics 4A. Structure, properties, selection, utilization, deterioration of engineering materials. (Grade only) (Grade Only)
Prerequisites/Corequisites: CHEM 1A or CHEM 4A and PHYS 4A.
Recommended:
Limits on Enrollment:
Transfer Credit: CSU;UC. (CAN ENGR4)
Repeatability: Two Repeats if Grade was D, F, NC, or NP

ARTICULATION, MAJOR, and CERTIFICATION INFORMATION:

AS Degree:	**Area**			Effective:	Inactive:
CSU GE:	**Transfer Area**			Effective:	Inactive:
IGETC:	**Transfer Area**			Effective:	Inactive:
CSU Transfer:	Transferable	Effective:	Spring 1982	Inactive:	
UC Transfer:	Transferable	Effective:	Spring 1982	Inactive:	

CID:
CID Descriptor: ENGR 140B Materials Science and Engineering
SRJC Equivalent Course(s): ENGR45

Certificate/Major Applicable:
Not Certificate/Major Applicable

COURSE CONTENT

Outcomes and Objectives:
Upon completion of this course, the student should be able to:
1. List the five basic types of engineering materials, explain the fundamental differences between them, and explain the unique engineering potentials of each.
2. Explain the structure of atoms, quantum numbers, and the build up of the periodic table.
3. Explain how the periodic table can be used to correlate and predict many of the bulk properties of elemental materials.
4. Distinguish quantitatively a metallic material from a non-metallic material, and explain the differences between them qualitatively.
5. List the seven crystal systems and the 14 Bravais lattices.
6. Understand how to work with unit cells--determination of the atomic radius from x-ray measurements of the lattice parameter and the cell type, how to count atoms per cell, how to determine the coordination number of atoms within a cell, and how to determine the theoretical density of a solid from a knowledge of its unit cell.
7. Determine & specify positions, directions, & planes within a unit cell
8. Work with Miller indices of planes and directions in cubic structures.
9. Understand the nature of allotropic transformations.
10. Identify interstitial & substitutional sites within unit cells.
11. Understand the relationship between the orientation of close-packed planes, the direction of the applied force, & slip in crystals.
12. Identify the CsCl, NaCl, Zinc Blende, Fluorite, Wurtzite, & diamond cubic structures in non-metallic materials.
13. Identify an edge dislocation and a screw dislocation.
14. Explain how dislocation can affect the mechanical properties of various materials.
15. Understand the nature of the 6 different types of point defects in crystal lattices, & their effects on mechanical, electrical, and

optical properties.
16. Explain the effects of grain size & grain boundaries on the mechanical properties of materials.
17. Calculate the ASTM grain size number from a photomicrograph.
18. Explain the nature of strain hardening, solid solution strengthening, grain size strengthening, and dispersion strengthening.
19. Use Fick's first & second laws in the solution of diffusion problems.
20. Explain the nature of such diffusion problems as grain growth, diffusion bonding, and sintering.
21. Interpret a stress-strain diagram for a given material & tell what material properties & design parammeters can be obtained from it.
22. Explain the factors which determine whether a material will behave in a ductile or a brittle manner.
23. Explain the procedure for carrying out (a) a tensile test, (b) a impact test, (c) a fatigue test, (d) a creep test, & (e) a hardness test, & what basic information & design parameters can be obtained from each.
24. Explain the effect of cold work on the microstructure of various materials.
25. Explain the importance of annealing on material processing.
26. Explain the difference between hot work & cold work, & the pros & cons of each on the processing of various materials.
27. Explain the nature of nucleation & grain growth in various materials under various conditions.
28. Explain the nature of various solidification & casting defects & what steps can be taken to control them.
29. Interpret binary phase diagrams & make phase diagram calculations.
30. Explain the nature of segregation & other non-equilibrium processes.
31. Use Gibbs' phase rule in phase diagram analysis.
32. Identify monotectic, eutectic, & peritectic reactions in binary systems.
33. Do simple binary phase diagram calculations.
34. Use time-temperature-transformation diagrams.
35. Explain what can be done to produce certain desired changes in a particular TTT diagram.
36. Determine the type & carbon content of a common steel by its AISI-SAE designation.
37. Explain what can be done to produce certain desired changes in a particular TTT diagram.
38. Explain the martensite reaction in steel.
39. Explain the 4 most important processes for the heat treatment of steel
40. Explain the concept of hardenability, the Jominy hardenability test, & the use of hardenability curves.
41. Carry out the diffusion calculations required for carburizing & nitriding surface treatments.
42. Distinguish between ferritic, austenitic, & martensitic stainless steels.
43. Explain how the 5 most important types of cast iron differ from one another, & be able to sketch the microstructure of each.
44. Explain the most important heat treatment processes for aluminum alloys.
45. Demonstrate a familiarity with the structures & nomenclature of the

most important non-ferrous metals & alloys.
46. Demonstrate a familiarity with the structures & properties of several crystalline & glassy ceramic materials of current engineering interest
47. Explain Griffith crack theory & various methods of toughening glasses & ceramics.
48. Explain the phenomenon of the glass transition temperature.
49. Understand how to read both binary & ternary ceramic diagrams.
50. Explain the techniques used to form, fabricate, & heat treat glasses & crystalline ceramic products.
51. Explain the composition, fabrication, & applications of (1) clay products, (2) refractories, (3) electrical & magnetic ceramics, (4) glasses, (5) glass-ceramics, & (6) glazes.
52. Discuss electrical properties of metals & electrical properties of semiconductors
53. Discuss energy band theory.
54. Discuss temperature properties of semiconductors.
55. Explain ferroelectricy and piezoelectricity
56. Explain magnetic properties & discuss various magnetic phenomenon
57. Explain soft and hard magnetic materials & hysteresis

Topics and Scope:

Topics covered include:
1. Classification of engineering materials.
2. Atomic structure and the periodic table.
3. Bonding between atoms and molecules.
4. Space lattices and atomic arrangements.
5. Vacancies, impurities, and dislocations in the atomic arrangement.
6. Diffusion in materials.
7. Mechanical properties of materials.
8. Deformation, work hardening, and annealing of materials.
9. Nucleation and grain growth, and grain size strengthening.
10. Phase diagrams.
11. Solid solution strengthening and dispersion strengthening.
12. Heat treatment of materials.
13. Ferrous alloys.
14. Nonferrous alloys.
15. Electrical propertieis of metals and semiconductors.
16. Magnetism in materials & space
17. Composite materials.
18. Preservation, deterioration, and failure of materials.

Lab work includes:
1. Mechanical testing of materials.
2. Crystal model building.
3. Use of an electrical strain gage to measure modulus of elasticity.
4. Determination of lattice constant of macroscopic pseudocrystal by microwave spectrometry.
5. Determination of lattice constant by electron diffraction.
6. Phase diagram
7. Precipitation hardening.
8. Hardening, tempering, and annealing of steel.
9. Jominy hardenability test.

10. Cold working and annealing of brass
11. Introduction to finite element analysis.

Assignment:

1. No less than 14 sets of homework problems.
2. Twelve laboratory experiments of varying lengths, including both short reports and formal writeups.
3. No less than three (3) mid-term
4. Final exam.

Methods of Evaluation/Basis of Grade:

Writing: Assessment tools that demonstrate writing skills and/or require students to select, organize and explain ideas in writing.

None, This is a degree applicable course but assessment tools based on writing are not included because problem solving assessments are more appropriate for this course.	Writing 0 - 0%

Problem Solving: Assessment tools, other than exams, that demonstrate competence in computational or non-computational problem solving skills.

Homework problems, Lab reports, Exams	Problem solving 10 - 16%

Skill Demonstrations: All skill-based and physical demonstrations used for assessment purposes including skill performance exams.

None	Skill Demonstrations 0 - 0%

Exams: All forms of formal testing, other than skill performance exams.

Multiple choice, True/false, Matching items, Completion, ENGINEERING PROBLEMS TO SOLVE	Exams 60 - 75%

Other: Includes any assessment tools that do not logically fit into the above categories.

LAB REPORTS	Other Category 16 - 24%

Representative Textbooks and Materials:
Materials Science and Engineering, An Introduction by Callister, 5th ed.
Wiley, 2000