GAVILAN COLLEGE
5055 Santa Teresa Blvd
Gilroy, CA 95023

Course Outline

COURSE: ENGR 4 DIVISION: 10 ALSO LISTED AS:

TERM EFFECTIVE: Spring 2022 CURRICULUM APPROVAL DATE:04/12/2022

SHORT TITLE: PROPERTIES OF MATERIALS

LONG TITLE: Properties Of Materials

Units	Number of Weeks	Type	Contact Hours/Week	Total Contact Hours
3	18	Lecture:	3	54
		Lab:	0	0
		Other:	0	0
		Total:	3	54

COURSE DESCRIPTION:

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. (C-ID: ENGR 140) PREREQUISITES: CHEM 1A and PHYS 4A with a grade of 'C' or better.

PREREQUISITES:

Completion of CHEM 1A, as UG, with a grade of C or better.
AND Completion of PHYS 4A, as UG, with a grade of C or better.

COREQUISITES:

CREDIT STATUS: D - Credit - Degree Applicable

GRADING MODES

L - Standard Letter Grade

REPEATABILITY: N - Course may not be repeated

SCHEDULE TYPES:

02 - Lecture and/or discussion
05 - Hybrid
71 - Dist. Ed Internet Simultaneous
72 - Dist. Ed Internet Delayed

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
TOPIC 8. Mechanical failure: fracture, fatigue, creep
a. Fracture mechanics
b. Impact testing and ductile-brittle transition
c. Fatigue
d. Stress relaxation and creep
3 HOURS
TOPIC 9. Phase Diagrams
a. Overview of binary phase diagrams
b. Analysis of isomorphous systems
c. Analysis of eutectic systems
d. Analysis of eutectoid Fe-C system
3 HOURS
TOPIC 10. Phase Transformations
a. Phase transformation kinetics: nucleation and growth
b. TTT and CCT diagrams
c. Microstructure formation and properties in the Fe-C system
3 HOURS
TOPIC 11. Applications and Processing of Metals and Metal Alloys
a. Ferrous alloys
b. Heat treatment of steels
c. Non-ferrous alloys
d. Forming and Fabrication

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
TOPIC 15. Electrical Properties of Materials
a. Conductivity and resistivity
b. Classification - conductors, semiconductors, insulators
c. Energy band structures
d. T and impurity effects for conductors
e. T and impurity effects for semiconductors (doping)
f. Semiconductor devices - diodes and transistors
g. Dielectric behavior and capacitance
3 HOURS
TOPIC 16. Magnetic Properties of Materials
a. Solenoid Physics
b. flux density, magnetization, permeability, susceptibility
c. diamagnetism and paramagnetism
d. ferromagnetism
e. curie temperature
f. domains and hysteresis
g. soft and hard magnetic materials
3 HOURS
TOPIC 17. Chemical properties of metals and alloys
a. Corrosion rates and forms of corrosion
b. Environmental Effects
2 HOURS
Final exam

METHODS OF INSTRUCTION:

Instruction is by lecture, discussion, demonstrations and/or illustration. Homework will be assigned in order to assure mastery of the concepts covered in class. Students are also required to complete a final project.

OUT OF CLASS ASSIGNMENTS:

Required Outside Hours 54

Assignment Description

Regularly assigned homework that requires students to analyze and study pertinent text material, solved examples and lecture notes.

Required Outside Hours 54

Assignment Description

Regularly assigned homework that requires students to apply the principles and skills covered in class by solving related problems.

METHODS OF EVALUATION:

Writing assignments

Evaluation Percent 10

Evaluation Description

Course primarily involves skill demonstration or problem solving, but students will work on a final project where one of the deliverables is a written report.

Problem-solving assignments

Evaluation Percent 50

Evaluation Description

Homework Problems;

Objective examinations

Evaluation Percent 40

Evaluation Description

In class exams.

REPRESENTATIVE TEXTBOOKS:

Materials Science and Engineering: An Introduction, William D. Callister, Wiley,, 2018.

ISBN: 978-1-119-40549-8

Reading level of text, Grade: 12 Grade Verified by: Verified by: David Argudo using MS Word

ARTICULATION and CERTIFICATE INFORMATION

Associate Degree:
CSU GE:
IGETC:
CSU TRANSFER:
Transferable CSU, effective 199370
UC TRANSFER:
Transferable UC, effective 199370

SUPPLEMENTAL DATA:

Basic Skills: N
Classification: Y
Noncredit Category: Y
Cooperative Education:
Program Status: 1 Program Applicable
Special Class Status: N
CAN: ENGR4
CAN Sequence: XXXXXXXX
CSU Crosswalk Course Department: ENGR
CSU Crosswalk Course Number: 140
Prior to College Level: Y
Non Credit Enhanced Funding: N
Funding Agency Code: Y
In-Service: N
Occupational Course: E
Maximum Hours:
Minimum Hours:
Course Control Number: CCC000628912
Sports/Physical Education Course: N
Taxonomy of Program: 090100