ENGR M12: ENGINEERING MATERIALS

Originator
srelle

College
Moorpark College

Discipline (CB01A)
ENGR - Engineering

Course Number (CB01B)
M12

Course Title (CB02)
Engineering Materials

Banner/Short Title
Engineering Materials

Credit Type
Credit

Start Term
Spring 2020

Catalog Course Description
Examines the interrelationships between processing, structure, properties, and performance of various engineering materials such as metals, polymers, ceramics, composites, and semiconductors. Investigates the effects of heat, stress, imperfections, and chemical environments upon material properties and performance. Emphasizes developing an ability to select appropriate materials to meet engineering design criteria. Requires a design project on material properties, selection, and application.

Taxonomy of Programs (TOP) Code (CB03)
0924.00 - *Engineering Technology, General (requires Trigonometry)

Course Credit Status (CB04)
D (Credit - Degree Applicable)

Course Transfer Status (CB05) (select one only)
A (Transferable to both UC and CSU)

Course Basic Skills Status (CB08)
N - The Course is Not a Basic Skills Course

SAM Priority Code (CB09)
C - Clearly Occupational

Course Cooperative Work Experience Education Status (CB10)
N - Is Not Part of a Cooperative Work Experience Education Program

Course Classification Status (CB11)
Y - Credit Course

Educational Assistance Class Instruction (Approved Special Class) (CB13)
N - The Course is Not an Approved Special Class

Course Prior to Transfer Level (CB21)
Y - Not Applicable

Course Noncredit Category (CB22)
Y - Credit Course

Funding Agency Category (CB23)
Y - Not Applicable (Funding Not Used)

Course Program Status (CB24)
1 - Program Applicable

General Education Status (CB25)
Y - Not Applicable

Support Course Status (CB26)
N - Course is not a support course

Field trips
Will not be required

Grading method
Letter Graded

Alternate grading methods
Student Option- Letter/Pass
Pass/No Pass Grading

Does this course require an instructional materials fee?
No

Repeatable for Credit
No

Is this course part of a family?
No

Units and Hours

Carnegie Unit Override
No

In-Class

Lecture
Minimum Contact/In-Class Lecture Hours
52.5
Maximum Contact/In-Class Lecture Hours
52.5

Activity

Laboratory

Total in-Class

Total in-Class
Total Minimum Contact/In-Class Hours
52.5
Total Maximum Contact/In-Class Hours
52.5

Outside-of-Class

Internship/Cooperative Work Experience

Paid

Unpaid

Total Outside-of-Class

Total Outside-of-Class
Minimum Outside-of-Class Hours
105
Maximum Outside-of-Class Hours
105

Total Student Learning

Total Student Learning
Total Minimum Student Learning Hours
157.5
Total Maximum Student Learning Hours
157.5

Minimum Units (CB07)
3
Maximum Units (CB06)
3

Prerequisites
CHEM M01A - General Chemistry I OR CHEM M01AH - Honors: General Chemistry I
AND
PHYS M20A - Mechanics of Solids and Fluids

Entrance Skills

Prerequisite Course Objectives
CHEM M01A-analyze and apply the scientific method to chemistry problems, including developing a hypothesis, hypothesis testing, evaluation, and modeling; list the basic units of measurement in the metric and English systems, perform unit conversions within and between systems, and express results appropriately with significant figures and in scientific notation; classify matter, distinguish between physical/chemical changes and properties, and comprehend the principles of chemical reactions and energy relationships.
CHEM M01A-use dimensional analysis to perform mathematical conversions and solve problems involving stoichiometry, thermochemistry, quantum mechanics, solids, liquids, gases, and solutions.
CHEM M01A-identify the symbols of common elements, the structures of molecules and polyatomic ions; name/write formulas for various elements, acids, salts, bases and inorganic compounds as well as simple organic compounds.
CHEM M01A-explain and solve thermochemistry problems by considering potential and kinetic energies, internal energy, specific heat and specific heat capacity, calorimetry, the First Law of Thermodynamics, and Hess's Law.
CHEM M01A-describe the quantum mechanical model and construct the historical development of the nuclear atom; explain the nature of atomic spectra and Bohr's model; conceptualize and utilize the Planck-Einstein equation, Rydberg equation, de Broglie equation, and the Heisenberg Uncertainty Principle; state and apply the quantum numbers to wave mechanics; apply the Aufbau principle to writing electron configurations; account for trends in chemical periodicity involving atomic and ionic radii, ionization energy, metallic character, electron affinity, and electronegativity.
CHEM M01A-identify the different types of chemical bonding; apply Lewis and VSEPR (Valence Shell Electron Pair Repulsion) theories to draw structures and shapes, label electronic geometries, molecular geometries, and bond angles, and predict polarities for molecules and ions including resonance and structural isomers; understand and incorporate the use of Valence Bond Theory to explain and identify various hybridizations; explain the fundamental basis of Molecular Orbital Theory for diatomic species to predict electron configurations, bond orders, and magnetic properties.
CHEM M01A-list and describe the distinguishing characteristics of solids, liquids, gases, and solutions.
CHEM M01A- conduct various quantitative and qualitative experiments with adherence to safety protocols, record observations and express numerical values using appropriate significant figures, analyze acquired data, apply statistical analysis and formulate proper conclusions through written expression of results.
CHEM M01A-define and describe the different types of intermolecular forces and their effects on matter; calculate the energy involved with temperature and phase changes; construct and interpret phase diagrams for different substances; identify unit cells for crystalline solids.
CHEM M01AH-analyze and apply the scientific method to chemistry problems, including developing a hypothesis, hypothesis testing, evaluation, and modeling; list the basic units of measurement in the metric and English systems, perform unit conversions within and between systems, and express results appropriately with significant figures and in scientific notation; classify matter, distinguish between physical/chemical changes and properties, and comprehend the principles of chemical reactions and energy relationships.

CHEM M01AH-use dimensional analysis to perform mathematical conversions and solve problems involving stoichiometry, thermochemistry, quantum mechanics, solids, liquids, gases, and solutions.
CHEM M01AH-identify the symbols of common elements, the structures of molecules and ions; name/write formulas for various elements,acids, salts,bases and inorganic compounds as well as simple organic compounds.
CHEM M01AH-explain and solve thermochemistry problems by considering potential and kinetic energies, internal energy, specific heat and specific heat capacity, calorimetry, the First Law of Thermodynamics, and Hess's Law.
CHEM M01AH-describe the quantum mechanical model and construct the historical development of the nuclear atom; explain the nature of atomic spectra and Bohr's model; conceptualize and utilize the Planck-Einstein equation, Rydberg equation, de Broglie equation, and the Heisenberg Uncertainty Principle; state and apply the quantum numbers to wave mechanics; apply the Aufbau principle to writing electron configurations; account for trends in chemical periodicity involving atomic and ionic radii, ionization energy, metallic character, electron affinity, and electronegativity.
CHEM M01AH-identify the different types of chemical bonding; apply Lewis and VSEPR (Valence Shell Electron Pair Repulsion) theories to draw structures and shapes, label electronic geometries, molecular geometries, and bond angles, and predict polarities for molecules and ions including resonance and structural isomers; understand and incorporate the use of Valence Bond Theory to explain and identify various hybridizations; explain the fundamental basis of Molecular Orbital Theory for diatomic species to predict electron configurations, bond orders, and magnetic properties.
CHEM M01AH-list and describe the distinguishing characteristics of solids, liquids, gases, and solutions.
CHEM M01AH-conduct various quantitative and qualitative experiments with adherence to safety protocols, record observations and express numerical values using appropriate significant figures, analyze acquired data, apply statistical analysis and formulate proper conclusions through written expression of results.
CHEM M01AH-define and describe the different types of intermolecular forces and their effects on matter; calculate the energy involved with temperature and phase changes; construct and interpret phase diagrams for different substances; identify unit cells for crystalline solids.
PHYS M20A-recognize, recall, and apply the equations that describe physical phenomena involving the mechanics of solids and fluids; analyze and solve physics problems of at least average complexity appropriate for the course.

Requisite Justification

Requisite Type
Prerequisite

Requisite
CHEM M01A

Requisite Description
Course not in a sequence

Level of Scrutiny/Justification
Required by 4 year institution

Requisite Type
Prerequisite

Requisite
PHYS M20A

Requisite Description
Course not in a sequence

Level of Scrutiny/Justification
Required by 4 year institution

Requisite Type
Prerequisite

Requisite
CHEM M01AH

Requisite Description
Course not in a sequence

Level of Scrutiny/Justification
Required by 4 year institution

Student Learning Outcomes (CSLOs)

	Upon satisfactory completion of the course, students will be able to:
1	explain the interrelationships between processing, structure, properties, and performance for various engineering materials such as metals, polymers, ceramics, composites, and semiconductors.
2	propose an appropriate material for a particular application based on design and performance criteria, material properties, economics, and societal and environmental impacts.

Course Objectives

	Upon satisfactory completion of the course, students will be able to:
1	explain the interrelationships between processing, structure, properties, and performance for various engineering materials such as metals, polymers, ceramics, composites, and semiconductors.
2	discuss the nature of chemical bonds and their effects on microscopic structure and macroscopic properties of crystalline and non-crystalline materials.
3	discuss and calculate mechanical, chemical, electrical, thermal, and magnetic properties for various engineering materials.
4	discuss imperfections in solids and examine their role in determining material properties.
5	distinguish between steady-state and non-steady state diffusion; explain what factors influence diffusion and solve for diffusion rates.
6	identify, explain, and calculate various design parameters related to material failure.
7	propose an appropriate material for a particular application based on design and performance criteria, material properties, economics, and societal and environmental impacts.

Course Content

Lecture/Course Content

- **3% - Atomic Structure and Bonding**
- **3% - Crystal Structures and Crystallography**
  - X-ray diffraction
- **4% - Imperfections in Crystals, Polycrystalline, Semi-crystalline, and Amorphous Solids**
  - Point defects
  - Linear defects
  - Planar defects
- **5% - Diffusion**
  - Steady-state and non-steady state
- **5% - Strengthening and Toughening in Metals**
- **10% - Mechanical Properties and Testing**
  - Stress-strain analysis
  - Elastic and plastic deformation in metals
- **10% - Mechanical Failure**
  - Fracture
  - Fatigue
  - Creep
- **10% - Phase Diagrams**
  - Phase transformations
  - Iron-Carbon system and heat treatment of steels
- **10% - Forming and Fabrication Techniques of Engineering Materials**
- **10% - Thermal, Electrical, Chemical, and Magnetic Properties**
  - Semiconductors
  - Corrosion - forms and prevention methods
- **25% - Structure and Properties of Engineering Materials**
  - Metals and metal alloys
  - Polymers

  - Ceramics
  - Composites
- **5% - Selection of Materials in Engineering Design**

Laboratory or Activity Content

Does not apply.

Methods of Evaluation

Which of these methods will students use to demonstrate proficiency in the subject matter of this course? (Check all that apply):

Problem solving exercises
Written expression

Methods of Evaluation may include, but are not limited to, the following typical classroom assessment techniques/required assignments (check as many as are deemed appropriate):

Classroom Discussion
Essay exams
Individual projects
Objective exams
Projects
Problem-solving exams
Quizzes
Reports/Papers/Journals
Research papers

Instructional Methodology

Specify the methods of instruction that may be employed in this course

Computer-aided presentations
Collaborative group work
Class activities
Class discussions
Demonstrations
Group discussions
Guest speakers
Instructor-guided interpretation and analysis
Instructor-guided use of technology
Lecture
Small group activities

Describe specific examples of the methods the instructor will use:

Instructor will use PowerPoint presentation, short YouTube videos, group activity, and classroom demonstration to explain course content. In addition, the instructor will model problem solving and how to interpret and analyze data presented in graphs and charts.

Representative Course Assignments

Writing Assignments

- Technical report on an engineering design project pertaining to material properties, selection, and application. A sample topic could be: Analyze the material requirements for the design of an efficient automobile engine and compare the behavior and characteristics of metal alloys and ceramics for this purpose.
- Descriptions of observations and lecture demonstrations, such as: By considering the YouTube video clip viewed during lecture regarding heat-treatment of steels, discuss the microstructural and property changes that the steel (iron-carbon alloy) experienced.
- Short-essay homework or exam questions, such as: Discuss the two possible modes of fracture for metals, ductile fracture and brittle fracture. Also, draw descriptive diagrams for each fracture mode.

Critical Thinking Assignments

- Problem solving homework and exam questions, such as: Using the data provided, compute the diffusion coefficient for magnesium in aluminum at 550^{o}C.
- Apply knowledge of physics, chemistry, mathematics, and engineering to derive formulas used in materials science and engineering, such as: Derive the flexural strength formula for a ceramic specimen with a rectangular cross-sectional area subjected to a three-point loading testing technique.
- Analyze and synthesize concepts and problems in materials science and engineering and critically evaluate the results, such as: A cylindrical rod 15.0 in. long, having a diameter of 0.40 in., is to be subjected to a tensile load. If the design criteria for the rod

indicate no plastic deformation and no elongation of more than 0.035 in. when subjected to a load of 5500 lb, which one of the following four metals or alloys is a possible candidate: aluminum alloy, brass alloy, copper metal, steel alloy? Justify your choice.

Reading Assignments

- Read peer-reviewed scientific journal articles regarding materials science and engineering provided by the instructor and answer questions about the article. An example could be: Read the article: "Study of high strength pipeline steels with different microstructures" and explain the difference in mechanical properties of the two types of steels in the article using their microstructural data.
- Research using the Library's print or on-line resources to find information relevant to the assigned materials science and engineering design project or research paper. Topics may include comparison of material properties and fabrication techniques in baseball bats.

Outside Assignments

Representative Outside Assignments

- Analyze engineering problems and/or concepts related to materials science, such as: Graphite can be both an efficient thermal conductor and an insulator. Explain why and how.
- Research special topics on the Internet or in the library to facilitate the successful completion of an assignment, beyond the textbook, related to materials science and engineering. A sample assignment would be: During the winter months, the temperature in some parts of Alaska may go as low as 65 degrees Fahrenheit. Of the following elastomers: natural isoprene, styrene-butadiene, acrylonitrile-butadiene, chloroprene, and polysiloxane; which would be suitable for automobile tires under these very cold conditions? Why?

Articulation

C-ID Descriptor Number

ENGR 140

Status

Aligned

Equivalent Courses at 4 year institutions

University	Course ID	Course Title	Units
CSUN	MSE 227 & 227L	Engineering Materials and Lab	3 & 1
UC Davis	ENGIN 45	Properties of Materials	4
San Diego State	M E 240	Introduction to Engineering Materials	3
UCLA	MAT SCI 104	Science of Engineering Materials	4
Cal Poly SLO	MATE 210	Materials Engineering	3
CSU Channel Islands	EMEC/PHYS 221	Engineering Materials	3

Comparable Courses within the VCCCD

ENGR V18 - Engineering Materials

District General Education

A. Natural Sciences

B. Social and Behavioral Sciences

C. Humanities

D. Language and Rationality

E. Health and Physical Education/Kinesiology

F. Ethnic Studies/Gender Studies

Course is CSU transferable

Yes

CSU Baccalaureate List effective term:
Fall 1995

CSU GE-Breadth

Area A: English Language Communication and Critical Thinking

Area B: Scientific Inquiry and Quantitative Reasoning

Area C: Arts and Humanities

Area D: Social Sciences

Area E: Lifelong Learning and Self-Development

CSU Graduation Requirement in U.S. History, Constitution and American Ideals:

UC TCA

UC TCA
Approved

IGETC

Area 1: English Communication

Area 2A: Mathematical Concepts & Quantitative Reasoning

Area 3: Arts and Humanities

Area 4: Social and Behavioral Sciences

Area 5: Physical and Biological Sciences

Area 6: Languages Other than English (LOTE)

Textbooks and Lab Manuals

Resource Type
Textbook

Description
Askeland, D.R., and Wright, W.J. (2018). *Essentials of materials science and eegineering,* SI edition, (4th ed.). Cengage Learning.

Resource Type
Textbook

Description
Callister, W., and Rethwisch, D. G. (2018). *Materials science and engineering: An introduction,* WileyPLUS + abridged loose-leaf, (10th ed.). Wiley.

Resource Type
Textbook

Classic Textbook
No

Description
Ashby, M. F., Shercliff, H., and Cebon, D. (2019). *Materials: Engineering, science, processing and design*, (4th ed.). Butterworth-Heinemann.

Library Resources

Assignments requiring library resources
Research projects and written assignments requiring information beyond the textbook

Sufficient Library Resources exist
Yes

Example of Assignments Requiring Library Resources
Research using the Library's print and online resources to find relevant peer-reviewed journal articles or books to successfully complete the required design project pertaining to material properties, selection, and application.

Primary Minimum Qualification
ENGINEERING

Review and Approval Dates

Department Chair
09/22/2019

Dean
09/23/2019

Technical Review
10/03/2019

Curriculum Committee
10/15/2019

DTRW-I
MM/DD/YYYY

Curriculum Committee
MM/DD/YYYY

Board
MM/DD/YYYY

CCCCO
10/18/2019

Control Number
CCC000429354

DOE/accreditation approval date
MM/DD/YYYY