TAFTCOLLEGE

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Engineering (ENGR) 2300 Materials Science and Engineering with Lab (4 Units) CSU:UC [formerly ENGR 1530]

Prerequisites: Successful completion of PHYS 2221 General Physics (Calculus) and CHEM 2211 General Chemistry with a grade of "C" or better.

Prerequisite knowledge/skills: Before entering the course the student should be able to

1. Apply the laws and principles of classical mechanics and statics to the analysis and solution of problems of force, linear and rotational motion under the action of forces and torques, motion in a plane under gravitational force, elastic and inelastic collisions, static equilibrium, work and energy under conservative and non-conservative forces, periodic motion, fluids, wave motion and vibrating bodies,
2. Predict the future trajectory of an object moving in two dimensions with uniform acceleration, 3. Analyze a physical situation with multiple constant forces acting on a point mass using Newtonian mechanics,
4. Analyze a physical situation with multiple forces acting on a point mass or extended object using concepts of work and energy,
5. Apply the concepts and techniques of calculus learned in a concurrent or prior calculus course, or presented in the physics course, to problems requiring them,
6. Analyze complex problems, each of which requires the identification of multiple applicable physical concepts and their use in an appropriate manner and sequence,
7. Perform experiments in a reasonable manner, and prepare adequate experimental reports presenting the numerical results and analyzing the sources and significance of errors,
8. Analyze real-world experimental data, including appropriate use of error propagation, units and significant figures,
9. List and discuss objectives of any experiment, the type of measurements made, why they were made, and how they entered into the determination of the desired result,
10. Relate the results of experimental data to the physical concepts discussed in the lecture portion of the class.
11. Solve computational problems related to general chemistry,
12. Describe the nature of matter and apply the principles of atomic theory,
13. Describe and interpret the periodic trends of elements and electron configuration,
14. Apply nomenclature rules, and determine the chemical formula of a compound,
15. Qualitatively and quantitatively describe processes involved in chemical reactions and stoichiometry,
16. Describe and analyze the behavior of solutions and gases,
17. Determine the type of bonding, molecular structure and polarity of a compound, and
18. Utilize molecular geometry and bond polarity to explain or predict properties of substances

Advisory: Eligibility for English 1500 strongly recommended.

Total Hours: 48 hours lecture; 48 hours lab (96 hours total)

Catalog Description: This course and lab 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. The lab will apply concepts learned through usage of test equipment, data acquisition, analyzing experimental data and writing engineering reports. Not open to students with credit in ENGR 1530. C-ID: ENGR 140B

Type of Class/Course: Transfer Degree Credit

Text: Callister, William. *Materials Science and Engineering: An Introduction.* 9th ed. New York: Wiley P, 2013.

Course Objectives:

By the end of the course a successful student will be able to:

1. Explain the relationship between the internal structure of materials and their macroscopic properties used in engineering applications including metals, ceramics, semi-conductors and composites
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. Explain material selection criteria and impact of heat, stress, imperfections and chemical environments upon material properties and performance,
5. 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,
6. Operate various material test equipment safely and effectively, and
7. Demonstrate understanding of how to gather and analyze data, make recommendations for material use and write appropriate reports.

Course Scope and Content (Lecture):

Unit I Introduction to Materials
- A. Atomic Structure and Bonding
- B. Crystalline and noncrystalline solids
- C. Imperfections in crystals
- D. Diffusion

Unit II Material Selection in Engineering
- A. Purpose of Specifications
- B. Types of Materials
- C. Basic Properties

Unit III Mechanical properties and testing
- A. Stress and strain: modes, true/engineering
- B. Mechanical failure: fracture, fatigue, creep
- C. Strength, Stiffness, Hardness, Flexibility, Brittleness

Unit IV Metals and Metal Alloys
- A. Elastic and plastic deformation

B. Iron-Carbon system, heat treatment of steels
C. Strengthening and toughening
D. Phase diagrams
E. Phase transformations
F. Forming and Fabrication
G. Alloys
H. Aluminums
I. Applications

Unit V Polymers
A. Structure – Amorphous and Crystalline
B. Properties
C. Forming and Fabrication
D. Applications

Unit VI Ceramics
A. Structure
B. Properties
C. Fabrication Methods
D. Applications

Unit VII Composites
A. What is a composite?
B. Structural Properties
C. Concrete and Wood
D. Carbon Fiber / Resin
E. Fiberglass
F. Others

Unit VIII Semiconductors
A. Properties
B. Fabrication

Unit IX Other Properties
A. Thermal
B. Electrical
C. Magnetic properties
D. Chemical
E. Corrosion
F. Fatigue

Course Scope and Content (Lab):

Unit I Introduction to Lab Processes
A. Safety
B. Notebooks
C. Reports
D. Data Gathering
E. Statistical Sampling

Unit II Material Testing - Metals
A. Tension
B. Compression

C. Strain
D. Impact
E. Hardness
F. Thermal Expansion
G. Corrosion

Unit III Material Testing – Plastics and Composites
A. Tension
B. Compression
C. Impact
D. Conductivity
E. Resistivity
F. Thermoset vs. Thermoplastic

Unit IV Material Treatments and Change of Properties
A. Cold Working/Strain Hardening
B. Precipitation Hardening
C. Recrystallization
D. Annealing
E. Cold Rolling
F. Other

Unit V Manufacturing Methods
A. Sand Casting
B. Injection Molding
C. Drawing
D. Carbon Fiber Layup
E. Alloying

Learning Activities Required Outside of Class:

The students in this class will spend a minimum of 6 hours per week outside of the regular class time doing the following:

1. Studying assigned text, handout materials and class notes
2. Reviewing and preparing for quizzes, midterm and final exams
3. Completing individual homework assignments with clear calculations and engineering problem solving techniques.
4. Completing lab exercise and practicals

Methods of Instruction:

1. Lecture, demonstrations and discussions
2. Individual homework assignments with emphasis on application of engineering problems solving methods.
3. Case Studies
4. Laboratory work including experimentation, data collection, analysis and interpretation and report generation
5. Group Problem Solving

Methods of Evaluation:

1. Quizzes

2. Examinations
3. Participation
4. Individual assignments and group exercises
5. Team Presentations
6. Case Studies, Lab Reports Scenarios and Written Reports

Laboratory Category: Extensive Laboratory

Pre delivery criteria: All of the following criteria are met by this lab.
1. Curriculum development for each lab.
2. Published schedule of individual laboratory activities.
3. Published laboratory activity objectives.
4. Published methods of evaluation.
5. Supervision of equipment maintenance, laboratory setup, and acquisition of lab materials and supplies.

During laboratory activity of the laboratory: All of the following criteria are met by this lab.
1. Instructor is physically present in lab when students are performing lab activities.
2. Instructor is responsible for active facilitation of laboratory learning.
3. Instructor is responsible for active delivery of curriculum.
4. Instructor is required for safety and mentoring of lab activities.
5. Instructor is responsible for presentation of significant evaluation.

Post laboratory activity of the laboratory: All of the following criteria are met by this lab.

1. Instructor is responsible for personal evaluation of significant student outcomes (lab exercises, exams, practicals, notebooks, portfolios, etc.) that become a component of the student grade that cover the majority of lab exercises performed during the course.
2. Instructor is responsible for supervision of laboratory clean up of equipment and materials.

Supplemental Data:

TOP Code:	090100: Engineering, General (requires
SAM Priority Code:	E: Non-Occupational
Distance Education:	Not Applicable
Funding Agency:	Y: Not Applicable(funds not used)
Program Status:	1: Program Applicable
Noncredit Category:	Y: Not Applicable, Credit Course
Special Class Status:	N: Course is not a special class

Basic Skills Status:	N: Course is not a basic skills course
Prior to College Level:	Y: Not applicable
Cooperative Work Experience:	N: Is not part of a cooperative work experience education program
Eligible for Credit by Exam:	E: Credit By Exam
Eligible for Pass/No Pass:	NO
Taft College General Education:	NONE