

MCEN 5024: Materials Science.

Fall Semester 2003.

Professor: Dudley S Finch.

Lecture: MWF, 10 – 11am

Office: DLC room 205.

E-Mail: Dudley.Finch@Colorado.edu

Office Hours: Tue and Thu - 10:00 am to 11:00 am

Core objective: To understand the fundamental principles of the structure of materials with a primary focus on metals, ceramics and polymers with the objective of providing the basis for understanding the properties of materials.

Course outline:

The course is primarily designed for graduate students entering without a degree in a field of materials science and aims to provide a comprehensive review of the fundamental principles of materials science and engineering. The structure in materials ranging from the subatomic to the macroscopic, including nano-, micro- and macromolecular structures will be discussed to highlight bonding mechanisms, crystallinity and defect patterns.

This course aims to form the foundation for the classical interplay among structure-processing-properties-performance in materials including polymers, metals, ceramics, glasses and composites.

Base level: the role of atomic bonding.

1. Atomic structure.

- a. Fundamental concepts
- b. Role of electrons
- c. Periodic table

2. Atomic bonding.

- a. Bonding, forces and energies
- b. Primary Interatomic bonds
- c. Secondary bonding
- d. Molecules

Next level: arrangement of atoms in the solid state

3. States of matter.

- a. Liquid – solid transformations
- b. Amorphous and crystalline states
- c. Nucleation and growth processes

4. Crystalline structures.

- a. The lattice structure
- b. Symmetry
- c. Crystal systems
- d. Space lattice and crystallographic planes

Next level: Materials in the solid state

5. Classification of engineered materials

- a. Metals
- b. Ceramics
- c. Polymers
- d. Others: composites, semi-conductors and liquid crystalline.

6. Metals

- a. Crystal structure
 - i. Face centered cubic structures
 - ii. Body centered cubic structures
 - iii. Close Packed Hexagonal structures
 - iv. Polymorphism
- b. Imperfections
 - i. Vacancies and interstitials
 - ii. Impurities
 - iii. Dislocations
 - iv. Grain boundaries

7. Ceramics

- a. Ionic crystal structures
 - i. AX crystal structures
 - ii. A_mX_p crystal structures
 - iii. $A_mB_nX_p$ crystal structures
- b. Covalent crystal structures
- c. Imperfections
 - i. Defects
 - ii. Impurities

8. Polymers

- a. Hydrocarbon molecule
- b. Polymer molecules
- c. Molecular structure
- d. Polymer crystallinity
- e. Imperfections.

Assessment.

This will consist of **four** components:

1. End of semester examination (40%) – example questions to be provided.
2. Term paper with interim reports (15%) – one topic to be chosen from list and researched. Will be presented as a literature review.
3. Class assignments / problems (25%) – weekly class assignments will be given to be handed in the following Friday.
4. Mid-term examination (20%) – example questions to be given.

Exam structure:

They will be closed book – no notes and a personal, unlinked calculator is permitted.

Time limit will be three hours.

An appendix with the general form of any required equations will be given.

Exams will be in the form of part A and part B. Part A will be short answer questions and you will be required to answer four out of six questions (10 points per question). Part B will require more depth in your answers and you will be required to answer two out of three questions (30 points per question).

Reference books.

An Introduction to Materials Science and Engineering, K. M. Ralls, T. H. Courtney, and J. Wulff (Wiley, 1976).

Principles of Materials Science and Engineering, Second Edition, W. F. Smith (McGraw-Hill, 1990).

Engineering Materials and Their Applications, 4th edition, R. A. Flinn and P. K. Trojan (Houghton Mifflin, 1994).

Introduction to Materials Science for Engineers, 5th edition, J. F. Shackelford (Macmillan, 1999).

Materials Science and Engineering: An Introduction, 4th edition, W. D. Callister, Jr., (Wiley, 1998).

The Science and Engineering of Materials, 3rd Edition, D. R. Askeland (Brooks/Cole, 1994).

Elements of Materials Science and Engineering, 6th edition, L. H. Van Vlack (Addison-Wesley, 1989).

Physical Metallurgy Principles, 3rd Edition, R. E. Reed-Hill R. E. (Thomas Learning, 1992)