EMAT 251 **Instructor: Sudhakar Vadiraja, Ph.D., P.E.**
Materials Structures and Properties Office: ELC 218, ×4267

Catalogue Description:
The structure and bonding within metals, ceramics, and polymers are reviewed and their impact on various physical and mechanical properties is explored. The types of defects at the atomic to micron-length scales are described. Their impact on material properties and performance and their correlations in real-world engineering applications are described. Fundamental concepts and practical significance of phase diagrams, heat treatment of steels and cast irons are outlined. Optical, magnetic, electrical, thermal, and mechanical properties of materials are also described.

Credits: 3.0 Credit Hours (Lectures)

Designation: Required course (Metallurgical & Materials Engineering, General Engineering – Welding Option)

Prerequisites: CHMY141, M171, *or* consent of the instructor

Lab: There is no lab allotted to this course

Textbook:
Required: William D. Callister, Jr., and David G. Rethwisch: *Materials Science and Engineering: An Introduction*, **10th** Edition, John Wiley & Sons (**2018**). ISBN-13: 9781119321590
(Note: ***same text*** *is used for EMAT 351 lecture course*)

Additional References:
- James F. Shackelford, *Introduction to Materials Science for Engineers Plus Mastering Engineering*, 8/E, Prentice Hall, ISBN-10: 0133789713, ISBN-13: 9780133789713, 2015
- D.R. Askeland & P.P Phule, *The Science and Engineering of Materials*, 4th/5th Edition, Thompson Cole, 2005

Relationship of Course to Metallurgical and Materials Engineering Program Outcomes:
This course introduces the fundamental themes in the structure and property relationship which are built upon in the junior and senior years.

Objectives: The objective of this course is to provide the student with:
- A sound understanding of the structure and fundamental properties of materials,
- A qualitative and quantitative understanding of the relationship between them, and
- Knowledge of the limits of these factors in materials science and engineering.

The topics of structure and properties of materials are two of four topics that are usually expressed as a tetrahedron forming the basis of all materials science and engineering inquiry. This tetrahedron establishes the foundation, or context, for further learning as a student and as an engineer.

Outcomes: Graduates of the course will:
- Understand atomic bonding mechanisms in different materials,
- Relate material (crystal) structure to atomic bonding mechanisms,
- Relate mechanical properties to atomic bonding,
- Understand the concepts of tensile strength, yield strength, stress and strain,
- Relate diffusion of atoms to vacancies and temperature,
- Relate electrical and thermal properties to mechanisms on an atomic level,
- Relate electrical and thermal properties to each other,
- Relate magnetic properties to mechanisms on an atomic level,
- Define and understand performance measures in materials testing,

- Recognize that materials design involves compromise/trade-off.
- Fulfill **ABET outcomes 1 & 9** (*please see below for descriptions*)

	Tentative Course Plan	**Forecast lectures**
1	Atomic Structure and Interatomic Bonding (*Chapter 2*)	2
2	Structure of Crystalline Solids (*Chapter 3*)	4
3	Imperfections in Solids (*Chapter 4*) ……...Test 1	3
4	Diffusion (*Chapter 5*)	3
5	Iron-Carbon (Fe-C) Phase Diagram (*Chapter 9*)	4
6	Heat Treatment of Steels (*Chapter 10*)	4
7	Cast Irons – Types and applications (*Chapter 11*)	3
8	Heat Treatment of Cast Irons (*Chapter 11*) ……Test 2	2
9	Electrical Properties (*Chapter 18*)	3
10	Thermal Properties (*Chapter 19*)	3
11	Magnetic Properties (*Chapter 20*)	2
12	Optical Properties (*Chapter 21*)	2
13	Mechanical Properties (*Chapter 6*) …Finals	5
	Tests & Reviews	5
	Total	**45**

Assessment:

HW	10 %
Tests (2)	50 %
Term Paper *(Oral presentation only, NO report reqd.)*	10 %
Finals	30 %
Total	100 %

Grading:
A = (92-100), A− = (90-91.9), B+ = (88-89.9), B = (82-87.9), B− = (80-81.9), C+ = (78-79.9), C = (72-77.9), C− = (70-71.9), D+ = (68-69.9), D = (62-67.9), D− = (60-61.9), F = (0-59.9)

Academic Integrity:
Students enrolled in the Metallurgical and Materials Engineering courses are expected to maintain an integrity standard that is consistent with the applicable fundamental canons of the NSPE Code of Ethics for Engineers. Specifically, students are expected to conduct themselves honorably, responsibly, ethically, and lawfully so as to enhance the honor, reputation, and usefulness of the profession.

Academic dishonesty/cheating will not be tolerated. Acts of academic dishonesty include (but are not limited to):
- Plagiarism
- Copying from another student's paper while taking a quiz or examination
- Using unlawful aids (books, notes, cell phones or other electronic devices, etc.) to pass an examination (*unless the instructor has clearly stated that it is an open notes or open book exam*)
- Assisting another student in an act of academic dishonesty

If it is determined that a student has deliberately cheated on a quiz, examination, or assignment, he or she will be dropped from the course with an "F" grade. In compliance with Montana Tech policy, cases of academic dishonesty will be reported to the Office of the Vice Chancellor for Academic Affairs.

With one exception, the Department policy is that electronic devices are not to be activated or evident during lectures and examinations. This restriction includes but is not limited to programmable calculators, cell phones, IPod, or entertainment devices. The exception is that students are permitted to use a calculator from the following list during lectures and tests/exams:

Casio – any model fx-115 calculator
Hewlett-Packard – the HP33s and 35s models
Texas Instruments – all TI-30X or TI-36X models

Students that possess unapproved calculators or other electronic devices during a quiz or exam are subject to dismissal from the classroom. Penalties for disregarding the policy during lecture will be enforced at the instructor's discretion.

Attendance:
Students are expected to attend at least 90% of the lectures. *Role may be taken randomly. Students who arrive after role is taken or depart prior to dismissal are considered absent.* Students must arrange to submit assignments, if any, in advance of field trips, athletics, or other school-sanctioned events that force them to miss class. *Students are responsible for notifying the instructor, submitting assignments, if any, and sitting for quiz/examinations prior to the absence.* Following an absence, students must arrange to obtain class notes from another student. The instructor's lecture notes are not available to students.

Requirements:
1. Attend all tests/exams/term paper seminars
2. **Talking with other students or sleeping in class or having ear phones during lecturing is prohibited and is considered disruptive behavior.**

Contribution to Professional Component:
Engineering Topics - Yes
Engineering Design - Yes (Introductory)
Computer Usage - Yes (Limited use)
Ethics - No
Statistics - No
Safety - No

ABET outcomes covered: 1 & 9
1) Identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
9) Integrate the understanding of the scientific and engineering principles underlying the four major elements of the field: structure, properties, processing, and performance related to metallurgical and material systems appropriate to the field

Prepared by: Sudhakar Vadiraja, Ph.D., P.E.