EMAT 251
Materials Structures and Properties
Lecture: MWF 11:00–11:50 am, ELC 106

2013-2014 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 is reviewed and how this relationship is exploited in engineering described. Fundamental concepts and practical significance of phase diagrams, heat treatment of steels and cast irons are described. Attention is paid to photonic, magnetic, electrical, thermal, and mechanical properties of materials.

Credits: 3.0 Credit Hours (Lectures)

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

Prerequisites: CHEM 1066 & MATH 1530, or consent of the instructor.

Lab: There is no lab allotted to this course.

Textbook:
(Note: same text is used for EMAT 351)

Additional References:

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 the atomic bonding mechanisms in different materials,
♦ relate the material (crystal) structure to atomic bonding mechanisms,
♦ relate mechanical properties to atomic bonding,
understand the concepts of tensile strength, yield strength, 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.
Fulfill ABET outcomes a, e and l (consult the Course Catalog and Department Guidelines)

Tentative Course Plan

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<thead>
<tr>
<th></th>
<th>Tentative Course Plan</th>
<th>Forecast lectures</th>
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<tbody>
<tr>
<td>1</td>
<td>Atomic Structure and Interatomic Bonding (Chapter 2)</td>
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<td>2</td>
<td>The Structure of Crystalline Solids (Chapter 3)</td>
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<td>3</td>
<td>Imperfections in Solids (Chapter 4)</td>
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<td>4</td>
<td>Diffusion (Chapter 5)</td>
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<td>5</td>
<td>Iron-Carbon (Fe-C) Phase Diagram (Chapter 9)</td>
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<td>6</td>
<td>Heat Treatment of Steels (Chapter 10)</td>
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<td>7</td>
<td>Cast Irons – Types and applications (Chapter 11)</td>
<td>3</td>
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<td>8</td>
<td>Heat Treatment of Cast Irons – Microstructures (ASM handbook)</td>
<td>3</td>
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<td>9</td>
<td>Electrical Properties (Chapter 18)</td>
<td>3</td>
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<tr>
<td>10</td>
<td>Thermal Properties (Chapter 19)</td>
<td>3</td>
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<tr>
<td>11</td>
<td>Magnetic Properties (Chapter 20)</td>
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<td>12</td>
<td>Optical Properties (Chapter 21)</td>
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<tr>
<td>13</td>
<td>Mechanical Properties (Chapter 6)</td>
<td>5</td>
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<tr>
<td></td>
<td>Tests</td>
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<td>Total</td>
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Assessment:

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<tbody>
<tr>
<td>HW</td>
<td>20 %</td>
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<tr>
<td>Tests (2)</td>
<td>50 %</td>
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<tr>
<td>Finals (05/07/14-Wednesday, 3-5pm)</td>
<td>30 %</td>
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<td>Total</td>
<td>100 %</td>
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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 or 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, Ipods, or entertainment devices. The exception is that students are permitted to use a calculator from the following list during lectures, quizzes, and 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.

**Requirement:**
1. Attend at least 90% of the classes.
2. Attend all tests/exams and all home work assignments MUST be completed.
3. *Talking with other students during lecturing in class is prohibited and is considered disruptive behavior.*

**Contribution to Professional Component:**

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<tr>
<th>Engineering Topics-</th>
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<tr>
<td>Engineering Design-</td>
<td>Yes (Introductory)</td>
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<tr>
<td>Computer Usage-</td>
<td>Yes</td>
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<tr>
<td>Ethics-</td>
<td>No</td>
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<td>Statistics-</td>
<td>No</td>
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<td>Safety-</td>
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**ABET outcomes covered:** a, e and l

**Prepared by:** K.V. Sudhakar, Ph.D., P.E.  
**Date:** January 10, 2014