MSE 2090 – Fall 2013
INTRODUCTION TO THE SCIENCE OF ENGINEERING MATERIALS

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Course Objectives: To introduce the basic principles underlying the behavior and properties of materials. This course will provide the scientific foundations for an understanding of the relationships among material properties, structure and performance for the classes of engineering solids (metals, ceramics, polymers, semiconductors and composites). Concepts will be developed and applied which allow for correlation between performance and aspects of structure, from atomic through the macroscopic level. Ideas relating to atomic and larger size defects and their influence on material behavior are included.

Co-requisite: APMA 111.

Textbook: *Materials Science and Engineering, An Introduction; 8th edition*, William D. Callister, Jr., Wiley and Sons. Can be purchased as a regular text, a binder version or an e-book.

Homework: The homework will consist of ten problem sets. Each assignment will be due at the beginning of the class one week after assignment is posted. The assignments (and later that week the solutions) are posted on the Collab.

Homework submissions must be submitted on Collab. See "Guidelines for MSE 2090 HW.pdf" posted in *Announcements* on the Collab site for details.

Office Hours: Piyush Khullar and Crescent Islam are the teaching assistants assigned to this course and will be available for assistance each week. Prof. Groves is the other instructor this semester. We will post office hours in the very near future.

IMPORTANT DATES:

Homework:
Homework assignments for the semester are posted on Collab.
Homework is due each week on Friday **by 5:00 pm unless otherwise noted.**

Exams:
Exam 1: September 26, 2013
Exam 2: October 29, 2013
Final Exam: December 17, 2013, 9am-12 pm

Grading: 1000 point basis
Reading Quizzes and Class Participation (50 points, 5%)
Collab weekly quizzes, and engagement in the learning process.

Homework (200 pts, 20%)
10 weekly assignments, 5 problems/week. Note that the homework will be graded on a 10-pt per problem basis that will then be normalized to 20 pts per HW. *The lowest homework set grade will be dropped for each student.*

Test I (200 pts, 20%)
Multiple choice and short answer

Test II (200 pts, 20%)
Multiple choice and short answer

Final exam (350 pts, 35%)
Multiple choice and short answer, comprehensive

NOTE: homeworks and exams are identical for all 4 sections of MSE2090. Midterms are 50 min long in all sections.

Class Rules

1. Use email for easy questions and to setup special appt. times. Watch for announcements, corrections on email. Skeleton of lecture Powerpoint slides put on Collab before class.
2. Please display proper decorum during class

   Examples of poor decorum: sleeping, reading the newspaper, arriving late to class, talking to neighbor, leaving during class

3. When you have questions, ASK !!
4. When I ask questions, ANSWER !
5. Access to lecture notes at end of class only for those in attendance

Homework Assignments and Exams

1. Homeworks are due at the time and on the date indicated (see "*Assignments*" on Collab page). The consequence of lateness is the forfeiture of points according to the following schedule:

Handed in day due	Max. Score Possible = 80%
Handed in after 24 h	Max Score = 65%

Handed in after 48 h	Max Score = 50%
Handed in after 72 h	Max Score = 0%

The instructor will hold any forfeited points captive. At the end of the semester, he will decide the number of point, **if any**, to be returned to the student's grade. In the case of multiple late assignments, the chances of any points being returned are between slim and none, being much closer to the latter. In the case of a single lateness, the number of points returned is a function of the quality and quantity of the participation of the student throughout the semester.

2. Except where indicated, you may work with other members of the class in solving the homework problems at the conceptual level, but copying of calculations or solutions is not acceptable (see "Honor System," below).

3. All assignments are to be professionally done and LABELED with your NAME on the first page. Proper documentation is a critical skill in all engineering professions. It will be emphasized throughout the semester. **Points will be deducted for failure to follow the rules below.**

a. Write and draw diagrams neatly and clearly.

b. Define all variables under consideration. If different parts of your solution consider different systems, indicate this with either a new drawing or a sentence. State all assumptions.

c. Annotate all solutions to allow your thinking process to be clear.

- if your approach cannot be followed, no partial credit will be given.

d. Staple pages together.

e. Clearly delineate the start and end of each problem.

f. Include units in all final answers. Answers must be boxed.

g. Discussions must be composed of complete sentences.

h. If plots are required, use a computer-based graphing program (such as Excel^{TM}). Do **not** use simple ruled notebook paper.

4. In case of a dispute of a grade, a formal memo must be submitted along with the entire assignment. The memo must clearly explain the area of dispute and professionally make the case for a change in grade. **The memo must be submitted within 2 weeks of the return of the assignment**.

THE HONOR SYSTEM:

Every student in this course must comply with all provisions of the UVa honor system.
On tests and exams you are to pledge that you have neither received nor given unauthorized aid.

Your signature below this pledge affirms that you have not accessed notes, study outlines, old exams, answer keys, or textbooks while taking the tests and the exam and that you have not obtained answers from another student's exam.

On homework you are to pledge that the work is your own. Your signature by this pledge indicates that while you may have discussed assigned problems with fellow students at the concept level, the calculations and answers are your own.

Alleged honor violations brought to the attention of the professor will be forwarded to the Honor Committee. If, in the professor's judgement, it is beyond a reasonable doubt that a student has

committed an honor violation, that student will immediately receive a grade of zero for the affected work, irrespective of any subsequent action taken by the Honor Committee.

From your Honor Reps:
The Honor System and the School of Engineering and Applied Science
The School of Engineering and Applied Science relies upon and cherishes its community of trust. We firmly endorse, uphold, and embrace the University's Honor principle that students will not lie, cheat, or steal, nor shall they tolerate those who do. We recognize that even one honor infraction can destroy an exemplary reputation that has taken years to build. Acting in a manner consistent with the principles of honor will benefit every member of the community both while enrolled in the Engineering School and in the future.

If you have questions about your Honor System or would like to report suspicions of an Honor Offense, please contact a SEAS Honor Committee member.

Overall Educational Objectives
1. Students will be able to articulate the role of science and engineering in the development and selection of materials used in engineering artifacts.
2. Students will have an increased awareness and appreciation of the important role played by engineered materials in engineering design.
3. Students will be able to consider material characteristics and structure-property relationships during materials selection activities associated with future engineering design activities.
4. Using foundational mathematics knowledge learned in prior studies, students will strengthen their ability to complete the type of calculations employed during engineering design that employs materials.
5. Students will demonstrate an ability to write down the solutions to engineering problems in a neat, organized, and complete manner.
6. As the result of participation in class discussions (live and via discussion boards), students will better appreciate the value of active participation in a learning community.

Course Learning Outcomes
1. Describe the structure of perfect and imperfect crystalline solids.
2. Explain the role of atomic motion in material processes that include defect formation and movement, diffusion, the strengthening and softening of metals, and the formation and growth of crystallographic phases.
3. Recall and define the basic mechanical, electrical, magnetic, and optical structure and properties of metallic materials.
4. Describe the role that atomic-level kinetic energy plays in determining the structure and properties of metallic materials.
5. Explain that metallic materials represent only one class of engineering materials and that other classes of materials may have significantly different structures and properties.
6. Compute basic characteristics of engineering materials employed in engineering artifacts.

How Course Outcomes are Assessed
Participation (5%)
Reading quizzes, in-class participation

Homework (20%)

10 weekly assignments, 5 problems/week from Callister

Test I (20%)
Multiple choice and short answer

Test II (20%)
Multiple choice and short answer

Final exam (35%)
Multiple choice and short answer

Focus upon MSE Outcomes (H = high, M = moderate, L = limited, N = none)

Math, science, and engineering (H)
Assessment method: Class participation, HW, Tests, Final Exam

Basic concepts in Materials Science and Engineering (H)
Class participation, HW, Tests, Final Exam

Depth in Materials Science and Engineering (N)
Class participation, HW, Tests, Final Exam

Structure of crystalline solids (M)
Class participation, HW, Tests, Final Exam

Properties of crystalline solids (M)
Class participation, HW, Tests, Final Exam

Processing of engineered materials (M)
HW, Tests, Final Exam

Materials selection (M)
HW and Class participation (contributions to questions posed on discussion boards)

Design of physical engineering artifacts (L)
HW and Class participation (contributions to questions posed on discussion boards)

Function as part of a multi-disciplinary team (L)
Class participation (live and via discussion boards)

Preparation for life-long learning (L)
Asynchronous and synchronous on-line class participation

Ethical issues: safety, health, public welfare (N)
-

Humanities and social sciences (N)
-

Laboratory equipment and software tools (N)
-

Variety of instructional formats (M)
Asynchronous and synchronous on-line class participation

Topics Covered (Number of class hours for each)

1. Atomic Structure and Interatomic Bonding (1 hr)
2. The Structure of Crystalline Solids (2.5 hrs)
3. Imperfections in Solids (2.5 hrs)
4. Diffusion (2.5 hrs)
5. Electrical Properties (3 hrs)

6. Mechanical Properties (2.5 hrs)
7. Dislocations and Strengthening Mechanisms (2.5 hrs)
8. Failure (2.5 hrs)
9. Phase Diagrams (3 hrs)
10. Phase Transformations (2.5 hrs)
11. Polymer Structures (5 hrs)
12. Instructor's choice topic {e.g., magnetic properties, ceramics, materials selection} (3 hrs)

Computer Usage
Student computers may be used to work on and submit homeworks. Computers will be used to connect to the posted course content in UVa Collab. Computers will be used to connect to the live class sessions conducted and for archiving of lecture content through *Elluminate Live!*

Laboratory Experiences
None

Design Experiences
Selected homework problems will emphasize materials selection and design of engineering components based upon material properties.

Independent Learning Experiences
Students will be assigned readings from the textbook, and they will be expected to complete initial reading of assigned sections prior to the start of the related class sections. Numerous MSE 2090 concepts and problem solving techniques will be provided as on-line multimedia content. Students will be expected to review these materials prior to the start of the related class sections. Text and final exam questions from previous years will be made available through UVa Collab. Students are strongly encouraged to use these questions as an independent learning tool. Homework problems will be assigned, and students will be expected to work through and submit these problems for grading.

Class Schedule
Classes include interactive problem solving, small group discussions, and short commentaries on course concepts and problem solving strategies. Students are expected to do the assigned reading and review of prepared materials in advance. Students should devote 5-6 hours per week outside of the classroom; involving 1-2 hours reading and 4-5 hours on the review of prepared materials, homework, and review of materials for tests and the final exam.

Contribution to the Professional Component
Engineering Topics (Science and / or design) 3.0 credit hours