

BMEN 343
Introduction to Biomaterials

Fall 2009

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Office Hours: M: 2-3:30 pm, T: 9:30-11 am or by appointment

Lecture: **MWF 11:30 am – 12:20 pm**
CHEN 108 (Brown Building)

Required Text: W. D. Callister, Jr., Materials Science and Engineering: An Introduction, 7th Ed. (Wiley, 2007); ISBN: 0-471-73696-1

Additional References:

Ratner, B.D.; Hoffman, A.S.; Schoen, F.J.; Lemons, J.E. Biomaterials Science: An Introduction to Materials in Medicine (Academic Press; 1996; ISBN: 0-12-582460-2)

Wnek, G.E.; Bowlin, G.L.; Eds. Encyclopedia of Biomaterials and Biomedical Engineering, Vol. 1 & 2; (Marcel Dekker, 2004; ISBN: 0824755626).

**These books are not required; however, they may be useful in presenting the course information in a different and potentially useful way.*

Course Description:

Fundamental Material Science & Engineering Concepts: Introduction to the structure-property relationships of engineering materials. Atomic structure and bonding; crystal structures; imperfections in solids; diffusion; and mechanical properties including processing and failure of materials. Structure and properties of metals, ceramics, and polymers.

Special Topics in Biomaterials: Common biomaterials and their utility for implantable devices, tissue replacement, fixation, and regeneration; biodegradable polymers; hydrogels; biocompatibility; blood-compatibility and sterilization techniques.

Course Objectives:

1. Learn the scientific principles underlying the structure of engineering materials, including the atomic structure, inter-atomic bonding, crystal structure, defects, and diffusion.
2. Learn fundamental relationships between structure and mechanical properties and performance (failure).
3. Develop an understanding of the differences between the different types of engineering materials (metals, ceramics, and polymers) in terms of their structure, properties and biomedical applications.
4. Verify knowledge transferred through examinations and homework (including “group work” assignments).

Textbook Website: <http://www.wiley.com/college/callister>

- Chapters 19-23
- Self-assessment exercises, concept check answers

Course Website: <http://biomed.tamu.edu/biomaterials/> (Click on BMEN 343 link)

- Syllabus (syllabus will be updated continually although exam dates will not change).
- Occasional Power Point slides (e.g. tables, pictures) presented in lecture (Note: Lecture notes will NOT be posted. The only way to get lecture notes is by attending class or getting them from a generous classmate).
- Homeworks & Keys; Suggest Problems & Answers; Exams & Keys; Supplemental Reading Materials.

Lectures:

Lecture notes will be your best resource when it comes to studying for exams and completing homework assignments. Reading the book will help solidify concepts discussed in class.

Come to lecture ready to learn. As you enter the classroom, any homework assignments and occasional handouts will be available in piles. Take one as you enter the classroom.

Lectures will be presented mainly on the whiteboard. Power Point slides will be occasionally used to show figures, tables, etc. There will also be occasional classroom demonstrations.

Questions during the lecture are welcome. Your assistance in creating a good learning environment free of distractions is appreciated by me and your classmate.

Course Requirements:

Homework: Assignments (about 7) will be distributed in-class (and posted thereafter). Assignments will be due at the beginning of class (for full credit) typically 1 week after they are distributed (unless otherwise stated). Some problems may be selected from the book. Assignments should have your **name** and **ID#** in the **upper right corner**. Staple all pages (including original sheet) together. Problem answers should be given in order and neatly with the **final answer in a box** when appropriate. Please use **SI units**. Assignments may be turned in up to 1 day late (by noon the day after the homework is due) for up to 50% credit, after which no credit will be given.

Group Work: Occasionally (about 3 times), I will divide students into groups of four (or more) to participate in in-class demonstrations/experiments and other assignments. Each group work item will be **signed by all participating members of the group (along with ID#)** and handed in at the end of class (unless otherwise stated). *I will announce an upcoming group work assignment during the class period before. If you are absent on a "group work day", credit for that assignment cannot be made-up unless you have an excused absence.*

Exams: Two hourly exams are closed book/closed notes and will cover primarily material from the beginning of class or since the previous exam. Exams are typically a combination of true/false, short answer, concept questions, and problem solving (much like the homework format). An equation sheet will be stapled to the back of each exam. This equation sheet will also be distributed sometime before the exam so you can use it to study.

Final Exam: The final exam is comprehensive and closed book/closed notes. Approximately, it will have about 80% Exam I + II info and about 20% post-Exam II info. Except for greater length, the final exam is quite similar to an hour exam in most respects. Equations sheets will be provided.

Extra Credit: There will be 2 opportunities to earn extra credit. You can earn up to 20 points in extra credit for the entire semester. There will be no other opportunities for extra credit.

Book Problems: I will also assign "Suggested Problems" from each chapter. The suggested problems and final answers will be posted on the course webpage. *These will not be graded. However, you are expected to understand them and they may appear in some form on exams.*

Grading:*

15%	150 points (scaled)	Homework**
5%	50 points (scaled)	Group Work
25%	250 points (scaled)	Exam #1
25%	250 points (scaled)	Exam #2
<u>30%</u>	<u>300 points (scaled)</u>	Final exam
100%	1000 points	

- Scaled points total 1000 max for the semester. Your scaled point total will be added after which any extra credit points will be added for a final total.
- Requests for re-grading must be submitted within **one week** after the assignment or exam is returned. Re-grade requests should be directed to Prof. Grunlan (not the grader).

Lecture Schedule and Reading Assignments: NOTE: **Syllabus will be continually updated and posted on the course web page: HW and GW assignments will be marked and specific reading assignments updated.** *Topics and dates are tentative and subject to change. Exam dates will not change.

#	Dates	Topic	Corresponding Reading Assignment & Other Assignments
Structure of Materials			
1	August 31 (M)	Introduction	Chapter 1
2	September 2 (W)	Atomic Structure and Bonding	Chapter 2
3	September 4 (F)	Atomic Structure and Bonding	Chapter 2
4	September 7 (M)	Atomic Structure and Bonding	Chapter 2
5	September 9 (W)	Structures of Metals	Chapter 3 (Sections 3.1-3.10, 3.12, 3.17 (excluding pp 54-55 and 59-60 hcp)
6	September 11 (F)	Structure of Metals	Chapter 3 (see sections above)
7	September 14 (M)	Structure of Metals	Chapter 3 (see sections above)
8	September 16 (W)	Structures of Metals	Chapter 3 (see sections above)
9	September 18 (F)	NO 😊 CLASS	Independent Review Day
10	September 21 (M)	Structures of Ceramics and Bioactive Glasses	Chapter 12 (Sections 12.1-12.4) and supplemental information (posted article on Bioactive Glasses)
11	September 23 (W)	Structure of Polymers	Chapter 14 (Sections 14.1-14.12)
12	September 25 (F)	Structure of Polymers	Chapter 14 (Sections 14.1-14.12)
13	September 28 (M)	Structure of Polymers	Chapter 14 (Sections 14.1-14.12) Chapter 15 (Sections 15.12 and 15.13)
14	September 30 (W)	Structure of Polymers Review for Exam	Chapter 14 (Sections 14.1-14.12) Chapter 15 (Section 15.12 and 15.13)
15	October 2 (F)	EXAM #1	On all information covered in Lectures # 1-14
Imperfections, Diffusion, and Mechanical Properties of Materials			
16	October 5 (M)	Review Exam 1, Imperfections	Sections 4.1-4.8, 3.14, 12.5, and 14.13
17	October 7 (W)	Imperfections	Sections 4.1-4.8, 3.14, 12.5, and 14.13
18	October 9 (F)	Imperfections, Diffusion	Chapter 5
19	October 12 (M)	Diffusion	Chapter 5
20	October 14 (W)	Mechanical Properties of Metals	Sections 6.1-6.10
21	October 16 (F)	Mechanical Properties of Metals	Sections 6.1-6.10
22	October 19 (M)	Dislocation & Strengthening Mechanisms	Sections 7.1, 7.8-7.13, 11.4
23	October 21 (W)	Dislocation & Strengthening Mechanisms	Sections 7.1, 7.8-7.13, 11.4
24	October 23 (F)	Guest Lecture	Must attend for homework credit (no make-ups)
25	October 26 (M)	Mechanical Properties of Ceramics	Sections 12.8 – 12.11, 13.11
26	October 28 (W)	Mechanical Properties of Polymers	Sections 15.1-15.4, 15.6-15.9
27	October 30 (F)	Mechanical Properties of Polymers	Sections 15.1-15.4, 15.6-15.9

28	November 2 (M)	Mechanical Properties of Polymers	Sections 15.1-15.4, 15.6-15.9
29	November 4 (W)	Mechanical Properties of Polymers Review for Exam 2	Sections 15.1-15.4, 15.6-15.9
30	November 6 (F)	EXAM #2 🍊	<u>On all information covered in Lectures # 16-29</u>
Applications of Biomaterials			
31	November 9 (M)	Review Exam, Metallic Biomaterials	Sections 9.18-9.19 (pp 290-295); 10.5 (basic concepts only per lecture notes); pp. 364-365 Handout: Metallic Biomaterials (pp. 36-50)
32	November 11 (W)	Metallic Biomaterials	Sections 11.4, 11.5 Handout: Metallic Biomaterials (pp. 36-50)
33	November 13 (F)	Metallic Biomaterials for Hard Tissue Fixation/Repair	Handout: Hard Tissue Replacements (pp. 9-1 – 9-10)
34	November 16 (M)	Ceramic Biomaterials, Heart Valves	Handout: Joint Replacement (pp. 9-10 – 9-15)
35	November 18 (W)	Pyrolytic carbon, heart valves	Handout: Pyrolytic Carbon (pp. 1308-1318) Handout: Heart Valve Prostheses (pp. 8-2 – 8-10)
36	November 20 (F)	PEEK, silicone elastomers, IOLs, soft contact lenses, hydrogels, thermal-responsive hydrogel (PNIPAAm)	<i>Reading: lecture slides only</i>
37	November 23 (M)	Biodegradable polymers	Handout: Biomaterials journal article (Middleton)
38	November 25 (W)	Biodegradable polymers	
39	November 27 (F)	Thanksgiving Holiday- no class 🍊	
40	November 30 (M)	Biodegradable polymers Sterilization of implants	Handout: Sterilization of implants (pp. 415-420)
41	December 2 (W)	Sterilization of implants	Handout: Sterilization of implants (pp. 415-420)
42	December 4 (F)	Host reaction to implanted biomaterials	Handout: Host reactions (pp.165-173)
43	December 7 (M) (LAST CLASS)	Review for Final	We will do a short in-class “practice quiz” (will NOT be for a grade) for a review
December 16		FINAL EXAM (comprehensive)	WEDNESDAY @ 10:30 am – 12:30 pm

Americans with Disabilities Act (ADA) Policy Statement:

The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please contact Disability Services, in Cain Hall, Room B118, or call 845-1637. For additional information visit <http://disability.tamu.edu>.

Academic Integrity Statement:

Aggie Honor Code: "An Aggie does not lie, cheat, or steal, or tolerate those who do."

It is the responsibility of students and instructors to help maintain scholastic integrity at the university by refusing to participate in or tolerate scholastic dishonesty (*Student Rule 20. Scholastic Dishonesty*, <http://student-rules.tamu.edu>). New procedures and policies have been adopted effective September 1, 2004. Details are available through the Office of the Aggie Honor System (<http://www.tamu.edu/aggiehonor/>). An excerpt from the Philosophy & Rationale section states:

"Apathy or acquiescence in the presence of academic dishonesty is not a neutral act -- failure to confront and deter it will reinforce, perpetuate, and enlarge the scope of such misconduct. Academic dishonesty is the most corrosive force in the academic life of a university."