

**BMEN 343**  
**Introduction to Biomaterials**

**Fall 2012**  
**(last taught by Prof. Grunlan Fall 2012)**

**Instructor:** Professor Melissa A. Grunlan  
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**Office Hours: Wed: 2 – 3:30 pm; Thurs: 2 – 3:30 pm; or by appointment**

**Lecture: TR: 5:30 – 6:45 pm**  
ETB 1037

**Required Text:** W. D. Callister, Jr., David G. Rethwisch. Materials Science and Engineering: An Introduction, 8<sup>th</sup> Ed. (Wiley, 2010); ISBN: 978-0-470-41997-7

**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.

- *Structure:* Atomic structure and bonding; crystal structures; imperfections in solids; diffusion; structures of metals, ceramics and polymers.
- *Mechanical Properties:* The mechanical properties of metals, ceramics, and polymers (including processing and failure) and their relationship to material structure.

Special Topics in Biomaterials: Metallic, ceramic and polymeric biomaterials used for biomedical devices.

- Common biomaterials used in medical devices for hard and soft tissue fixation, repair, replacement, and regeneration.
- Biodegradable materials, elastomers and hydrogels.
- Introduction to biocompatibility and sterilization techniques.

**Course Objectives:**

1. Learn the scientific principles underlying the structure of engineering materials, including 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).

**Course Outcome:**

**Accreditation Board for Engineering and Technology (ABET) Outcome “A”:** Command of mathematical, scientific, and engineering foundations: Outcome will be met via course lectures covering atomic structure and bonding, structure of materials (e.g. metals, ceramics, and polymers) and the relationship between materials structure and properties.

**Textbook Website:** <http://bcs.wiley.com/he-bcs/Books?action=index&itemId=0470419970&bcsId=5193>

- Self-assessment exercises, concept check answers

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

- Syllabus schedule 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).
- Suggested Problems & Answers; Homeworks & Keys; Supplemental Reading Materials.

### Lectures:

Your lecture notes will be your best resource to study for exams and complete homework assignments.  
Reading the book will help solidify concepts discussed in class.

Come to lecture ready to learn.

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 classmates. Cell phone usage during class has not yet been found to improve one's ability to learn and is a distraction to others around you.

### Course Requirements:

**Homework:** Assignments (about 5) 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 text 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 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 4 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 75-80% Exam I + II info and about 20-25% 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: A 10 point extra credit question appears on the final and is added to the final exam grade point total. *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:\***

10%	100 points (scaled)	Graded Homework
5%	50 points (scaled)	Group Work
27.5%	275 points (scaled)	Exam #1
27.5%	275 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.
- 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 TA).

**Lecture Schedule and Reading Assignments:** NOTE: This syllabus **SCHEDULE** 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. Completed at the time of posting.

#	Dates	Topic	Corresponding Reading Assignment & Other Assignments
<b>Structure of Materials</b>			
1	August 28 (T)	Introduction Atomic Structure and Bonding	Chapter 1, 2
2	August 30 (R)	Atomic Structure and Bonding	Chapter 2
3	September 4 (T)	Atomic Structure and Bonding Structures of Metals	Chapter 2 Chapter 3 (Sections 3.1-3.10, 3.12, 3.13, 3.15, 3.17 (excluding pp 60-64 and 67-68 hcp)
4	September 6 (R)	Structure of Metals	Chapter 3 (see sections above) <i>Assign HW1</i>
5	September 11 (T)	Structure of Metals	Chapter 3 (see sections above) <b>GW#1</b>
6	September 13 (R)	Structure of Ceramics	Chapter 12 (Sections 12.1-12.4) <b>HW#1 Due, Assign HW2</b>
7	September 18 (T)	Structure of Ceramics, Bioactive Glasses	Chapter 12 (Sections 12.1-12.4); posted article on Bioactive Glasses
8	September 20 (R)	Structure of Polymers	<b>“Polymer List”</b> - posted Chapter 14 (Sections 14.1-14.12) <b>HW#2 Due</b>
9	September 25 (T)	Structure of Polymers	Chapter 14 (Sections 14.1-14.12)
10	September 27 (R)	Structure of Polymers	Chapter 14 (Sections 14.1-14.12)
11	October 2 (T)	Structure of Polymers	Chapter 15 (Sections 15.10-15.14) <b>GW#2</b>
12	<b>October 4 (R)</b>	<b>EXAM # 1</b>	<b>On all information covered in Lectures # 1-11</b>
<b>Imperfections, Diffusion, and Mechanical Properties of Materials</b>			
13	October 9 (T)	Review, Exam I Imperfections in Solids	Chapter 4: Sec. 4.1-4.8, 3.14, 12.5 and 14.13
14	October 11 (R)	Imperfections in Solids Diffusion	Chapter 4: Sec. 4.1-4.8, 3.14, 12.5 and 14.13 Chapter 5
15	October 16 (T)	Diffusion Mechanical Properties of Metals	Chapter 5 Chapter 6: Sec. 6.1-6.10 <i>Assign HW#3</i>
16	October 18 (R)	Mechanical Properties of Metals	Chapter 6: Sec. 6.1-6.10
17	October 23 (T)	<b>BMEN 343 WILL NOT MEET</b>	
18	October 25 (R)	Dislocation & Strengthening Mechanisms	Chapter 7: 7.1-7.3, 7.6-7.13 <b>HW #3 Due Assign HW#4</b>

19	October 30 (T)	Heat treatment of metals; mechanical properties of ceramics	Chapter 7: 7.1-7.3, 7.6-7.13; Chapter 11: 11.4
20	November 1 (R)	Mechanical Properties of Polymers	Chapter 15: 15.1-15.4, 15.6-15.9 <b>HW#4 Due</b>
21	November 6 (T)	Mechanical Properties of Polymers	Chapter 15: 15.1-15.4, 15.6-15.9
22	November 8 (R)	Mechanical Properties of Polymers	Chapter 15: 15.1-15.4, 15.6-15.9
23	November 13 (T)	Mechanical Properties of Polymers	Chapter 15: 15.1-15.4, 15.6-15.9 <b>GW#3 and #4</b>
24	<b>November 15 (R)</b>	<b>EXAM #2</b>	<b><u>On all information covered in Lectures # 13-23 – AND concepts regarding the effect of polymer structure on Tg and crystallinity from “EXAM I”</u></b>
<b>Applications of Biomaterials</b>			
25	November 20 (T)	Review Exam 2, Metallic Biomaterials <i>Metallic</i> Biomaterials for Hard Tissue Fixation/Repair	Sections 9.18-9.19* (pp 319-327); 10.5*; 11.1-11.4, 11.5 (*concepts noted in lecture); pp. 397-399 <b>Handout:</b> Metallic Biomaterials (pp. 39-50) <b>Handout:</b> Hard Tissue Replacements (pp. 9-1 – 9-10)
	November 22 (R)	No class	
26	November 27 (T)	<i>Non-degradable Polymers</i> for Joint Replacement	<b>Handout:</b> Joint Replacement (pp. 9-10 – 9-15)
27	November 29 (R)	Biodegradable polymers; Use in orthopedics and stents Biodegradable Polymers	<b>Handout:</b> Biomaterials journal article (Middleton)
28	December 4 (T) (LAST CLASS)	Ceramic biomaterials, Heart Valves, Pyrolytic carbon, silicone elastomer, IOLs Sterilization of implants Host Response to Biomaterials	<b>Handout:</b> Pyrolytic Carbon (pp. 1308-1318) <b>Handout:</b> Heart Valve Prostheses (pp. 8.2-8.10) <b>Handout:</b> Sterilization of implants (pp. 415-420) <b>Handout:</b> Host reactions (pp. 165-173)
	<b>December 12</b>	<b>FINAL EXAM (comprehensive)</b>	<b>WEDNESDAY @ 3:30 – 5:30 PM</b>

**University-Approved Absences:**

- Work missed due to absences will only be excused for University-approved activities in accordance with TEXAS A&M UNIVERSITY STUDENT RULES (see <http://student-rules.tamu.edu/rule7.htm>). Specific arrangements for make-up work in such instances will be handled on a case-by-case basis. *This will only be possible if the student lets the instructor know about this absence with at least a week in advance.* (Obviously this restriction does not apply to medical or personal emergencies).
- “*University-Approved Absences*” are for activities formally scheduled with the Department of Student Activities (see: 7. Attendance, <http://student-rules.tamu.edu>). There are two kinds of activities: Authorized Activities (associated with classes), and Sponsored Activities (generally student organization activities). Just because an activity is suggested by a faculty member, it does not necessarily mean it is a “*University-Approved Activity*.” Additional details are available at: <http://stuact.tamu.edu/activitylist/letter.html>.
- In accordance with recent changes to Rule 7, please be aware that in this class any "injury or illness that is too severe or contagious for the student to attend class" will require "a medical confirmation note from his or her medical provider" even if the absence is for less than 3 days.

**Academic Misconduct:**

- Academic misconduct (see <http://www.tamu.edu/aggiehonor/acadmischconduct.htm> for definitions) will not be tolerated.
- Academic misconduct will be dealt with according to University Regulations.

**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. Conduct contradicting to this policy will be punished according to the current rules and regulations. For details, see <http://www.tamu.edu/aggiehonor/>.

The following statement should be printed and signed on all assignments and examination cover pages:

***“On my honor, as an Aggie, I have neither given nor received unauthorized aid on this academic work”***

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Signature of student

**ADA Policy:**

The Americans with Disabilities Act (ADA) is a federal antidiscrimination 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. Any student with a disability needing academic adjustments or accommodations should approach the instructor and the Department of Student Life, Disability Services Office, in Cain Hall, Room B118, or call (979) 845 1637. All discussions will remain confidential.