BMEN 482/682 **Fall 2014**
Polymeric Biomaterials
(3 credits)

Instructor: Prof. Melissa A. Grunlan, Ph.D.
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Office Hours: Mondays 10:30 – 11:30 am; Thursdays 2:00 – 4:00 pm; by appointment

Lecture: Tues & Thurs 12:45 pm – 2:00 pm (ETB 1034)

Required Text: Stevens, M.P. Polymer Chemistry: An Introduction, 3rd Edition (Oxford University Press, 1999; ISBN: 0-19-512444-8).

Prerequisites: Graduate standing or BMEN 343

Additional References:

Arshady, R., Ed. Introduction to Polymeric Biomaterials; Citus Books, 2003; ISSN: 1479-1285.
Billmeyer, F.W. Textbook of Polymer Science; 3rd Edition (John Wiley & Sons, 1984; ISBM 0-471-03196-8)
Carraher, C.E., Jr. Seymour/Carraher's Polymer Chemistry; 6th Ed.; (Marcel Dekker, Inc., 2003; ISBN: 0-8247-0806-7).
Odian, G. Principles of Polymerization; 3rd Ed.; John Wiley & Sons, 1991; ISBN: ISBN: 0-471-61020-8.
Rudin and Choi; The Elements of Polymer Science and Engineering (3rd Edition) (Elsevier, 2013; ISBN: 978-0-12-382178-2).
Sperling, L.H., Ed. Introduction to Physical Polymer Science, 4th Ed.; Wiley, 2006; ISBN: 0-471-70606-X.
Wnek, G.E.; Bowlin, G.L.; Eds. Encyclopedia of Biomaterials and Biomedical Engineering, Vol. 1 & 2; Marcel Dekker, 2004; ISBM: 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:

1. Preparation and properties of polymeric biomaterials, including: polymerization; structure-property relationships; molecular weight and measurement; morphology; thermal transitions; mechanical behavior; networks; hydrogels; biodegradation and polymer surface modification.
2. We will explore common polymeric biomaterials and their applications in medicine, including: polymers for orthopedics, cardiovascular, wound care, ophthalmics, drug delivery and tissue engineering applications. These include thermosetts and thermoplastics; biostable and biodegradable polymers; shape memory polymers (SMPs); (stimuli-responsive) hydrogels; tissue engineering scaffolds; elastomers and anti-fouling/blood-compatible polymers. Design of polymer systems.

Course Objectives:

1. Develop a fundamental understanding of polymeric biomaterial synthesis/fabrication and structure-property relationships.
2. Gain familiarity with polymeric biomaterials used in biomedical applications.
3. Verify knowledge transferred through examinations and homework assignments.

eCampus:

Using eCampus, I will post the following categories of items:

- **"Original Syllabus"** – (As passed out on the first day of class.)
- **"Schedule"** – The syllabus schedule will be updated (although exam dates will not change except by consensus) and posted. Items such as topics, assigned reading, homework due dates and "in-class type homework assignments" dates will be continually added and updated throughout the semester. Check regularly. It is your responsibility to know when things are due.
- "**Lecture Slides (Student)**" – Lecture is done with whiteboard and Power Point slides. The "student version" of Power Point slides (i.e. those distributed in class in hard copy format; often contain "blanks" to complete during lecture) will be posted, typically the day of lecture. *Lecture notes will NOT be posted! The only way to get lecture notes is by attending class or getting them from a generous classmate.*
- "**Handouts"** – Handouts will be distributed as hard copies in class. These will also be posted.
- **"Reading Materials"** - To further supplement the required textbook, occasional reading materials will be posted.
- **"Chapter Problems"** - Assigned "chapter problems" from textbook and keys will be posted.
- "**Graded Homework**" - Graded homework assignments will be posted. Keys will be posted later.

Lectures:

Your lecture notes will be one of your primary tools to study for exams. Your presence and involvement in class will help you to do well and *learn*.

- Lecture is done with whiteboard and Power Point slides. The "student version" of Power Point slides (i.e. those distributed in class in hard copy format; often contain "blanks" to complete during lecture) will be posted, typically the day of lecture.
- *Lecture notes will NOT be posted! The only way to get lecture notes is by attending class or getting them from a generous classmate.*

Reading the assigned sections of the textbook (see "schedule") as well as "handouts" (which will be provided *in class and also posted on eCampus)* will be very helpful. In addition, "reading assignments" (posted on eCampus) may be used to clarify concepts discussed in class.

Questions during the lecture are welcome!

Class Participation Policy:

Your assistance in creating a good learning environment free of distractions (e.g. cell phone use of any kind and chatting) is appreciated by me and your classmates.

Please put away cell phones and other distracting electronic devices during class.

Re-grading Policy:

* Requests for re-grading must be submitted within one week after the work is returned. Material returned for re-grading is subject to re-grading of entire exam/homework. Assignments may be turned in up to 1 day late (by 4 pm the day after the homework is due) for up to 50% credit, after which no credit will be given.

Excused Absences:

Refer to http://student-rules.tamu.edu/rule07 for **ALL** policies regarding excused absences. Please note important details and course-specific requirements:

Please note: "*The student is responsible for providing satisfactory evidence to the instructor to substantiate the reason for absence."* In the case of injury or illness of 3 or more days, "The medical confirmation note must contain the **date** and **time** of the illness and medical professional's **confirmation of needed absence**." Also, in the case of injury or illness of less than 3 days, it is the policy of this course that the student likewise provides a medical confirmation note containing the **date** and **time** of the illness and **medial professional's confirmation of needed absence**. The Texas A&M University Explanatory Statement for Absence form **WILL NOT** be accepted as evidence of an excused absence for this course.

In-Class Homework Assignments:

There will be 4-6 (approximately) "in-class design problems" and 1-2 (approximately) "in-class guest lecture" homework assignments. **These will be updated on the syllabus schedule**. I will announce an upcoming in-class HW assignment during the class period before (or before). If you are absent on a day of an in-class homework assignment, credit for that assignment cannot be made-up unless you have a "university excused absence". In addition, failure to actively participate/contribute in in-class design problems will result in loss of points from your assignment grade.

Grading and Point Distribution:

A = 100-90% B = 89-80% C = 79-70% D = 69-60% F = 59-0%

Assigned homework (30 points - scaled)
Other homework including "in class design problems" and guest lectures (50 points - scaled)
Exam 1 (100 points)
Exam 2 (100 points)
Final Exam (200 points)
TOTAL: 480

Course Requirements:

Homework:

(a) "Assigned": Assignments 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.

Only selected problems will be graded; these will be bolded. The remaining question will be checked to verify that they have been completed; if *ANY* of these questions are not completed (or are only marginally completed), a 20% deduction from the total possible HW points will be made.

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**. When applicable (e.g. for calculations), you must show your work.

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.

(b) "In-class guest lecture": Students will complete an in-class summary of the guest lecture pertaining to a specific research project &/or general field. Assignments are due at the end of class for credit.

(c) "In-class design problems": Assignments will be completed in small groups. These are typically design questions. Notes &/or book may be used. Due to the time limit (~15 min), you should review the information prior to that class period. Assignments are handed in at the end of class for credit. (Any individual may complete his/her own answer to hand in separate from the "group answer.)

Homework due dates will be periodically added to the syllabus schedule. Some dates are already designated but some additional dates may be added and some may be removed.

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/critical analysis/design and problem solving (number crunching). An equation sheet will be stapled to the back of each exam. This equation sheet will also be posted sometime before the exam so you can use it to study.

Final Exam: The final exam is comprehensive and closed book/closed notes. Except for greater length, the final exam is quite similar to an hour exam in most respects. Equations sheets will be posted in advance.

Extra Credit: There will be a total of "9 points" of bonus questions: 3 pts (exam 1), 3 pts (exam 2) and 3 points (final exam). Points earned will be added to the point total for that exam. *There will be no other opportunities for extra credit.*

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 (disability.tamu.edu) in Room B118 of Cain Hall or call 845-1637.

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."*

On all course work, assignments, and examinations at Texas A&M University, the following Honor Pledge shall be preprinted and signed by the student: *"On my honor, as an Aggie, I have neither given nor received unauthorized aid on this academic work."*

Syllabus Dates. **NOTE: This will be <u>continually updated</u> and posted on eCampus:** HW will be marked and specific reading assignments updated. Exam dates will not change. CHECK FOR UPDATES FREQUENTLY. Completed at time of posting (green font). Items not completed are subject to change.

#	*Dates*	*Topic*	*Corresponding Reading Assignment & Other*
1	Sept 2 (T)	Introduction Repeat Unit Structures Polymer Classification	**Chapter 1** **Handouts:** "Polymer List", Polymer T_g's, Source Names, Linkage Names, Functional Groups, Nomenclature, Periodic Table
2	Sept 4 (R)	Addition vs. Condensation Polymers Step Growth vs. Chain Growth Polymerization	**Chapter 1** **Chapter 6:** pp. 167-171; 176-177 **Handouts:** Addition and Condensation Polymers; Polymerization Mechanisms; ROP
3	Sept 9 (T)	Step Growth vs. Chain Growth (cont.) Molecular weight	**Handouts**: see above, MW
4	Sept 11 (R)	Molecular Weight Molecular weight determination	**Chapter 2** **Handouts:** see above
5	Sept 16 (T)	Polymer Solutions Molecular weight determination	**Handouts**: PP notes, Solubility, Table 3.4, Ex. Vol.; etc.
6	Sept 18 (R)	Molecular weight determination	**Chapter 3**: pp. 61-64, 70-91 **Handouts**: PP notes, viscometry, fractionation, GPC
7	Sept 23 (T)	MW determination (GPC) Chemical structure, intermolecular bonding,	**Handouts**: GPC (above), PP notes, images from PP notes, "microstruc. crys. polym"
8	Sept 25 (R)	Morphology, thermal transitions, amorphous state,	**Handouts:** above items, "amorphous state", "det. of crystallinity & thermal transitions",
9	Sept 30 (T)	DSC, T_g, T_m and % crystallinity	**Chapter 5:** 149-152 (DSC) **Handouts:** above items, DSC (Stevens)
10	Oct 2 (R)	T_g, T_m and % crystallinity - trends	**See above (Odian)**
11	Oct 7 (T)	Mechanical properties	Posted "Chapter 4" Mechanical Props.; **Handouts:** PP notes
12	Oct 9 (R)	**In-class HW: guess lecturer**	**HW due at end of class**
13	Oct 14 (T)	Mechanical properties	Posted "Chapter 4" Mechanical Props.; **Handouts:** PP notes
14	Oct 16 (R)	**Exam I**	Equation sheet (posted) <u>will be provided</u>; bring calculators. All information from lectures **1 – 13** will be covered. Must know info on "Polymer List"
15	Oct 21 (T)	DMA, DMTA, Smart polymers: SMPs, networks	**Reading:** Posted "DMA" and "SMPs"
16	Oct 23 (R)	SMPs, hydrogels	**Handouts, Reading:** Posted "Hydrogels";
17	Oct 28 (T)	thermoresponsive hydrogels	**Handouts, Reading:** "Stimuli-Responsive Hydrogels I AND II"

18	Oct 30 (R)	Thermoresponsive hydrogels (cont.) pH-responsive hydrogels glucose-response hydrogels Super-absorbant hydrogels	**HWX: In-Class Assignment** **Handouts**
19	Nov 4 (T)	Chemical XLing: thiol-based chemistries, etc Nanocomposite hydrogels	**HWX: In-Class Assignment** **Handouts**
20	Nov 6 (R)	Cardiovascular Opthalmic Orthopedic	**HWX: In-Class Assignment** **Handouts**
21	Nov 11 (T)	Orthopedic (cont)	**HWX: In-Class Assignment** **Handouts**
22	Nov 13 (R)	Biodegradable polymers	**HWX: In-Class Assignment** **Handouts**
23	Nov 18 (T)	Biodegradable elastomers	**HWX: In-Class Assignment** **Handouts**
24	Nov 20(R)	Drug delivery	**HWX: In-Class Assignment** **Handouts**
25	Nov 25 (T)	Advanced biomaterials and surfaces	
26	Nov 27 (R)	***** Thanksgiving Holiday *****	**Class does not meet**
27	Dec 2 (T)	Advanced biomaterials and surfaces	
28	Dec 4 (R)	**Exam II**	Equation sheet will be provided; bring calculators. All information from lectures 14-27 will be covered. Some concepts from exam I may also appear.
29	Dec 9 (T)	Review Exam II Advanced biomaterials and surfaces	
33	**Dec 17 (WED)**	**FINAL EXAM (comprehensive)**	**8 – 10 AM**