BE 526/726: Fundamentals of Biomaterials
Course Syllabus Fall 2017
M & W 4:30 – 6:15 PM, CAS 211

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Office hours: T 1-2 & W 12-2 pm & by appointment

Lab Section (***726 ONLY***): W & Th 1:00 – 4:00, ERB 509
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COURSE DESCRIPTION:

The primary objective of this course series (Biomaterials 526/726 and 527/727) is to teach the chemistry and engineering skills needed to solve challenges in the biomaterials and tissue engineering area. This two-semester course is divided into four sections – macromolecular chemistry & material science, physical characterization & properties, materials & biology, and focused biomaterial sections.

Biomaterials 526/726 will concentrate on fundamental principles in biomedical engineering, material science, and chemistry. This course uses a combination of lectures, guest lectures, student presentations, and self-directed learning to examine the structure and properties of hard materials (ceramics, metals) and soft materials (polymers, hydrogels). Specifically, the class will be divided into three parts: (I) Biomaterial Science and Engineering, (II) Polymers, and (III) Surfaces and Colloid Science. For each section, I will provide a theoretical description of the relevant phenomena, give examples of experimental measurements, highlight specific applications, and discuss the physiological requirements/relevance. **Only for BE 726,** there will be a weekly laboratory section that will cover principles of biointerface science and technology.

LEARNING OBJECTIVES

After successfully completing this course, students will be able to:

1. Understand the fundamental principals in biomedical engineering, material science and chemistry, and how they contribute to biomaterial development and performance.
2. Apply the math, science, and engineering knowledge gained in the course to biomaterial selection and design.
3. Critically review papers from the scientific literature and identify areas of research opportunities

REQUIRED READINGS

- Biomaterials Science - Ratner, Hoffman, Schoen, Lemons (Elsevier; ISBN 0-12-582461)

- Biomaterials - Temenoff and Mikos (Pearson Prentice Hall; ISBN 0-13-009710-1)
- Materials Science and Engineering: An Introduction - Callister (John Wiley and Sons; ISBN 0-471-13576-3)
- Science and Engineering of Materials - Askland and Phule (Thomson; ISBN 0-534-55396-6)
- Any Organic Chemistry Text book

You will be responsible for reading in the textbook to keep up with the class lectures and homework assignments. No reading assignments will be made. Further readings will be required to review pertinent literature in the bioengineering field for a variety of topics as part of the final group presentation.

GRADING

Students will be assessed based on their grades on midterms, homework assignments, and a final group project. There will be a total of 3 midterm non-cumulative examinations. Undergraduate and graduate students will be required to complete 4 homework assignments as well as a group project. Graduate students will also be required to attend a weekly lab section and submit regular lab reports.

Undergraduate:

- Three midterms: 26.7% each, or 80% total
- HW assignments: 8%
- Group Design Project on a Medical Device: 12%

***Graduate*:**

- Three midterms: 18.3% each, or 55% total
- Lab reports: 25%
- HW assignments: 8%
- Group Design Project on a Medical Device: 12%

Examinations: The midterms are closed-book tests for which you are only required to bring a calculator and a pen. The tests will use a combination of multiple choice and true/false questions along with short essays to evaluate your performance. There are no make-up exams. There is no final for the course.

Homework: HW consists of problems and exercises that test your understanding of the material and help you prepare for the exams. All assignments should be submitted to the instructors by the specified due date. If unable to meet the prescribed deadline, it is your responsibility to negotiate an alternative date. Failure to submit work by the due date (or negotiated deadline) will result in a zero for that assignment.

Final Course Grade: The course grade is computed based on the individual assessment grades using the indicated percentages. The letter grade is assigned upon a scale.

GROUP PROJECT ON A MEDICAL DEVICE

Details will be given later

ACADEMIC POLICY

Students may discuss homework problems and assignments with fellow classmates but are expected to work independently on the completion of all written assignments. Copying and plagiarism from another student or other sources is cheating and will not be tolerated. Students are expected to adhere to the Academic Code of Conduct of the College of Engineering: *http://www.bu.edu/eng/handbook/chapter09*.

COURSE PLAN

Weeks 1-5	**PART I: BIOMATERIALS SCIENCE & ENGINEERING**	

Lecture	Introduction to Materials in Medicine / Logistics General Biomaterials; Polymers; HW #1 distributed	Wed 9/6
Lecture	Cell Biology, Physiology, and Bonding; Mechanical Properties of Biomaterials; HW #2 distributed	Mon 9/11
Lecture	Mechanical Properties of Biomaterials; Metals	Wed 9/13
Lab 1	Alginate Part I (Material Preparation)	
Lecture	Phase Diagrams and Ceramics; HW #1 due	Mon 9/18
Lecture	Polymers & Composites	Wed 9/20
Lab 2	Alginate Part II (Material Characterization)	
Lecture	Surfaces (thin films and coatings); HW # 2 due	Mon 9/25
Lecture	Nanostructures and Nanotechnology; Exam #1 review	Wed 9/27
Lab 3	Alginate Part III (Material Characterization)	
	EXAM 1	Mon 10/2
Weeks 5-8	**PART II: POLYMERS**	
	Polymer Introduction; Natural Polymers	Wed 10/4
	No Class – Columbus Day	Mon 10/9
Lecture	Organic Chemistry and Polymers; HW #3 distributed	TUESDAY 10/10
Lecture	Condensation & Free Radical Polymerizations	Wed 10/11
Lecture	Polycarbonates and Polyanhydrides	Mon 10/16
Lab 4	PHEMA Part I (Material Preparation)	
Lecture	Degradation; HW # 3 due	Wed 10/18
Lecture	Responsive Polymers & Scaffolds (Biomaterial Design Project information)	Mon 10/23
Lab 5	PHEMA Part II (Material Characterization)	
	EXAM 2	Wed 10/25
Weeks 8-11	**PART III: SURFACES AND COLLOID SCIENCE**	
Lab 6	PHEMA Part III (Material Characterization)	
Lecture	Surface Introduction, Surface Tension, Law of LaPlace	Mon 10/30
Lecture	Surfaces, SAMs, HW #4 distributed	Wed 11/1
Lecture	Surface Characterization Techniques	Mon 11/6
Lecture	Colloids and DLVO Theory	Wed 11/8
Lecture	Colloids, Foams, Emulsions, Packing Parameters; HW#4 due; Design Project Instructions (Identify Design Team Members)	Mon 11/13
Lab 7	PDMS Part I (Material Preparation)	
Lecture	Business, Patents, Regulatory, Commercialization of a Device (Assign Presentation Days)	Wed 11/15
Lecture	Ethics/Policy/ etc	Mon 11/20
Lab 8	PDMS Part II (Material Characterization)	
	Thanksgiving - No class and laboratory	
	EXAM 3	Mon 11/27
Lecture	10 Min Presentations on Device Design Project	Mon 11/29
Lab 9	PDMS Part III (Material Characterization)	
Lecture	10 Min Presentations on Device Design Project	Wed 12/4
Lecture	10 Min Presentations on Device Design Project	Mon 12/6
Lecture	10 Min Presentations on Device Design Project	Wed 12/11