Introduction to Biomedicine for Engineers

Jump to Today

"The human foot is a masterpiece of engineering and a work of art." - Leonardo da Vinci

Instructor: Terry Johnson, 418 HMMB

GSIs: Michael Asensio (M 4-5PM, Th 5-6PM sections), Jasmine Hughes (W 3-4PM, F 2-3PM sections)

Note: BioE 10 does *not* have a final exam. The Tuesday 5 12/16/14 8-11A is automatically given to us by the campus and will not be used.

Office hours:

- Monday noon-1:30 in 419 HMMB (Michael)
- Tuesday 4-5:30PM in 419 HMMB (Jasmine)
- Wednesday 1-3PM in 419 HMMB (Terry)

Important dates:

- Concept presentation due - weeks 3, 4, and 5 (9/15, 9/22, and 9/29) in discussion section
- Paper summary draft due - week 7 (10/13) in discussion section
- Paper summary written comments due - week 8 (10/20) in discussion section
- Paper summary final due - week 9 (10/27) in discussion section
- Protocol due - week 9 (10/27) in discussion section
- Concept selection matrix presentations and personal goals statements due - week 10 (11/3) in discussion section
- Guest lecture - 9/23 - Brian Maiorella, adjunct professor, former vice president of biopharmaceuticals at Chiron
- Guest lecture - 10/9 - Diana Lin, Patent Agent at Schox Patent Group
- In-class final project prelim presentations - 11/20, 11/25, 12/2, 12/4, and 12/9 in lecture
  - 11/18: Team 26
  - 11/20: Teams 17, 20, 21, 22, 23
  - 11/25: Teams 3, 4, 5, 6, 7
  - 12/2: Teams 1, 2, 8, 10, 11
  - 12/4: Teams 15, 9, 12, 13, 14
  - 12/9: Teams 16, 18, 19, 24, 25
- Final project due - Friday 12/12 at noon (emailed to tdj@berkeley.edu in PDF format)

Course Description

This course is designed to introduce lower division undergraduates to the types of problems that bioengineers solve and the concepts they apply to solve them. Various types of devices - from genetically engineered bacteria to biosensors - will be discussed, and we will explore the physics and biology necessary to understand and design each of these devices. In addition, students will learn how to work effectively in groups and to communicate their results in a professional manner.

While this syllabus is meant to be accurate description of the course and its content, it may be modified at the instructor's discretion.

Objectives

To introduce students to the field of bioengineering and, in general, to thinking about problems and solutions as a bioengineer would.

Grading Policy

40% Homeworks (1/2 credit for late homeworks turned in before solutions are posted, no credit afterwards)

20% Communications exercises (concept presentation, paper summary, protocol, concept selection, and goals statement)

10% Project prelim presentation feedback

30% Final Project

If you would like to contest a homework or exam grade, you must turn the homework or exam back in to one of the instructors with a note briefly describing the issue. Regrade requests should be based on an error on our part (e.g., adding up the points incorrectly) or what you suspect is a misunderstanding of your work. Regrade requests that argue with the rubric (e.g., "this is wrong, but you took too many points off") will be returned without consideration. Homeworks must be written in ink to be considered for regrades.

When deliverables are missed under extraordinary circumstances, alternate arrangements can be made at the instructor's discretion. The sooner you contact me regarding issues such as these, the better.

Please take note of UC Berkeley's Code of Student Conduct. Plagiarism or cheating will not be tolerated. Plagiarism includes appropriation of whole passages with or without credit, appropriation of words and phrases without credit, appropriation of both main and supporting ideas without credit, and paraphrasing without credit. Plagiarism also includes submitting a paper written by someone else. If you are unsure of how to properly cite sources, ask.

While it is expected that students will consult with each other on difficult homework assignments, outright copying is not allowed. Collaboration on group projects, on the other hand, is encouraged.

Course Content

Introduction

- Structure of the course
- What is bioengineering?
- Professional ethics and standards
- Working in groups
- Effective communication

References:

- Advice for graduate and undergraduate students in science and engineering (Links to an external site.)

Device 1 - Genetically engineered yeast

Theory: Molecular biology; genetic engineering

- Central dogma
- Transcriptional regulation
- Genetic modification

Practice: Intellectual Property

- Copyright
- Patents
- Trade secrets

Reading: Production of the antimalarial drug precursor artemisinic acid in engineered yeast (Links to an external site.)
Reference: Primer for synthetic biology - part 1 (Links to an external site.)

Device 2 - DermaGraft

Theory: Physiology; biomaterials

- Organ structure and function
- Biocompatibility
- Compartmental modeling
- Mass transfer

Practice: Regulatory concerns; hypothesis testing

- FDA regulation for drugs, medical devices, biologics, and combination products
- Clinical trials
- Experimental design
- Statistics and hypothesis testing

Readings:

- The Efficacy and Safety of Dermagraft in Improving the Healing of Chronic Diabetic Foot Ulcers (Links to an external site.)
- Why Most Published Research Findings Are False (Links to an external site.)

References:

- Handbook of Biological Statistics (Links to an external site.)
- Primer of Biostatistics, Glantz, 6th edition (recommended, not required)

Device 3 - Home pregnancy test

Theory: Immunochemistry, Fluid dynamics

- Immunoassays
- Causes of flow
- Laminar vs. turbulent flow (Reynolds number)
- Bernoulli's principle
- Hagen–Poiseuille flow
- Washburn's equation
- Dimensional analysis

Practice: Identifying needs and solutions

- Needs finding
- Target specifications
- Concept generation
- Concept selection

Reading:

- Lateral flow (immuno)assay: its strengths, weaknesses, opportunities and threats (Links to an external site.)

- How the refrigerator got its hum (Links to an external site.)

References:

- Bernoulli's principle (Links to an external site.)
- Hagen–Poiseuille flow (Links to an external site.)
- Washburn's equation (Links to an external site.)
- Product Design and Development, Ulrich and Eppinger, 4th edition (recommended, not required - this book is a required text for the BioE Capstone senior design course)

Device 4 - Electrocardiograph

Theory: Signals

- Continuous functions vs. discrete data
- Sampling
- Aliasing
- Noise
- Analog to digital conversion
- Dynamic Range

Practice: Street-fighting mathematics

- Dimensions (Chapter 1)
- Estimating integrals and derivatives (Ch 3)
- Pictorial proofs (Chapter 2)
- Buckingham pi (Chapters 2 and 4)

Readings:

- Street-fighting mathematics

Final Project

Each group of five students will be jointly responsible for the final product as a whole, and though you may split the work up amongst yourselves, all of you will be expected to comprehend and be able to explain any part of the final product.

If any member of the group is unable to do their share of the work due to unforeseen and extraordinary circumstances, it is that student's responsibility to inform the instructor as soon as possible so that alternate arrangements can be made. The instructor reserves the right to assign different grades to various members of the group if the workload is not distributed and carried out evenly.

The final project consists of a six page maximum (including bibliography; not including Appendix I, II, and the project contract) paper. This paper should be in a 2-column format consistent with the style of a PNAS

paper (Links to an external site.) - please note that larger charts, diagrams, tables, etc. should break from the 2-column format and take the entire width of the page.

- Introduction - A description of the device, its function, and its operating principles. A brief history of the device's development. Finally, a description of the problem that the device solves. Some devices may be applied to more than one problem; if so, choose one and focus on it.
- Alternatives - A list of alternate solutions, including a weighted selection matrix. It is perfectly acceptable to conclude that your device is not the best device!
- Key Challenges - This should include a focus on at least one other practical concern (efficacy testing, the regulatory process, etc.) discussed in the course.
- Ethical Issues - Consider at least one ethical issue associated with your device. This issue could be associated, for example, with the construction, application, or economics of your device.
- Conclusions
- Works Cited - please use a number[1] system to indicate citations in the body of the text. Citations should be in MLA format.
- Appendix I - minutes from weekly group meetings. These should include: the date and time of each meeting, a list of participants, the agenda, minutes (brief notes of what was discussed), and the action items generated.
- Appendix II - a copy of the personal goals statement for each team member detailing what that student wants to get out of the project experience along with a brief (250 words or fewer) statement from each team member discussing what steps that member took during the project to meet those goals.
- A signed project contract (Links to an external site.)