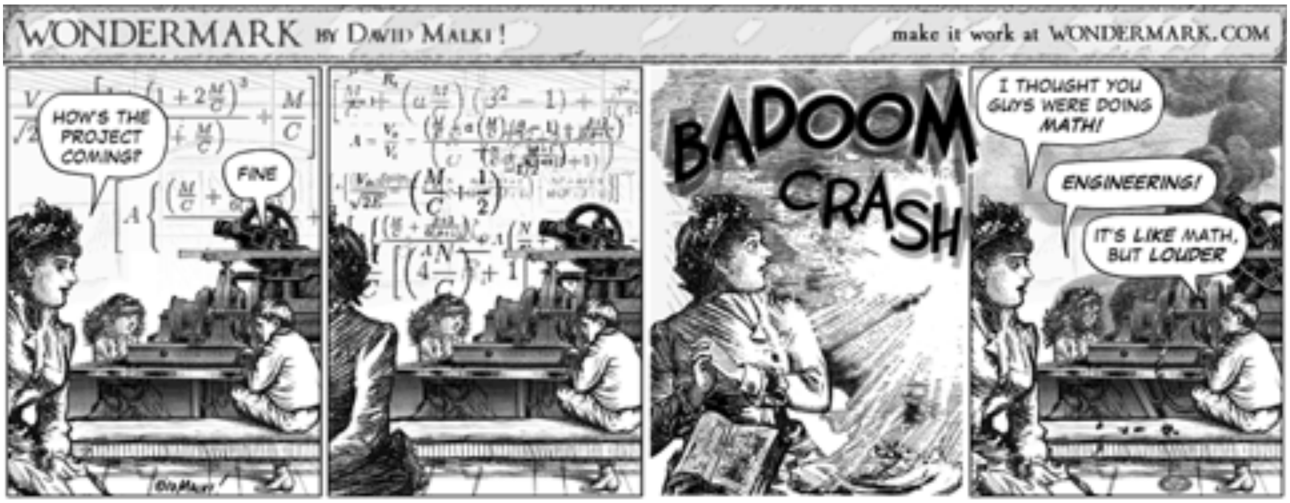
BioE 10: Introduction to Biomedicine for Engineers
Department of Bioengineering, UC Berkeley

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



Course Format: Three hours of lecture and one hour of discussion per week.

Instructor:
Terry Johnson (418 HMMB)

GSIs:
Marleigh Duncan
  Section 101: Monday 10-11AM
  Section 102: Wednesday 5-6PM
  Section 104: Thursday 4-5PM
Alyssa Zhou
  Section 105: Tuesday 2-3PM
  Section 106: Friday 12-1PM
  Section 103: Friday 2-3PM

Office Hours:
  Terry: Wednesdays 2-4PM in 418/419 HMMB
  Marleigh: Mondays 3-6PM in 419 HMMB
  Alyssa: Tuesdays 9-10:30AM and 3-4:30PM in 419 HMMB

Note: BioE 10 does *not* have a final exam. The final exam time slot is automatically given to us by the campus and will not be used.

Important dates:

Concept presentation due - weeks 3, 4, and 5 (9/12, 9/19, and 9/26) in discussion section
Individual profile due - week 6 (10/3) in discussion section
GUEST LECTURE by Brian Maiorella, ChemE faculty and former Vice President of Process Development at Chiron - Thursday 10/6
Paper summary draft due - week 8 (10/17) in discussion section
Paper summary feedback due - week 9 (10/24) in discussion section
Paper summary due - week 10 (10/31) in discussion section
Concept selection matrix presentations due - weeks 10 (10/31) and 11 (11/7)
Personal goals statements due - week 11 (11/7) in discussion section
In-class final project prelim presentations:
11/17: Teams 2-104, 1-105, 4-104, 3-101, 3-102
11/22: Teams 1-102, 1-101, 2-101, 5-106, 5-101
11/29: Teams 1-103, 2-102, 1-104, 3-104, 3-105
12/1: Teams 4-101, 2-106, 5-104, 5-102, 4-103
12/6: Teams 3-103, 4-106, 5-103, 5-105, 2-105
12/8: Teams 4-105, 3-106, 1-106, 4-102, 2-103
Final project due - Monday Dec 12 at noon (emailed to tdj@berkeley.edu in PDF format)

Course Description
This course is designed to introduce 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

42% Homeworks (1/2 credit for late homeworks turned in before solutions are posted, no credit afterwards)

16% Communications exercises (presentation, paper summary, concept selection, and goals statement)

10% Project prelim presentation feedback

32% Final project report

Please note: **we expect you to work with others in this class**. While outright copying is not allowed, collaboration on assignments is very much encouraged. Find a study group and make them a regular part of your week!

If you would like to contest a homework grade, you must turn the homework or exam back in to one of the instructors with a note briefly describing the issue. Homeworks *must* be written in ink to be considered for regrades. 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 (e.g., arriving at the correct answer using an unexpected technique). Regrade requests that argue with the rubric (e.g., “this is wrong, but you took too many points off”) will be returned without consideration.

Your homeworks should stand alone. If a homework is disorganized or ambiguous, and requires an extensive explanation to the grader, you will likely still lose points. The homeworks are not only evaluating your understanding of the material - they are also meant to evaluate your ability to communicate that understanding clearly and concisely.

Also, be aware 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, please ask!

When deliverables are missed due to unavoidable circumstances, alternate arrangements can be made at the instructor's discretion. Don’t be shy! Dealing with unavoidable circumstances is part of my job. The sooner you contact me regarding issues such as these, the better. If something is preventing you from a satisfactory engagement with this course, let me know so I can take the appropriate steps to accommodate you.

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

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

Reference: Primer for synthetic biology - part 1

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
A review of tissue-engineered skin bioconstructs available for skin reconstruction
Why Most Published Research Findings Are False
Is most published research wrong?

References:
Handbook of Biological Statistics
Primer of Biostatistics, Glantz, 6th edition (recommended, not required)
How to Lie with Statistics, Huff (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
How the refrigerator got its hum

Could Women Be Trusted With Their Own Pregnancy Tests? (a design history)

References:

Bernoulli's principle
Hagen–Poiseuille flow
Washburn's equation
Product Design and Development, Ulrich and Eppinger, 4th edition (recommended, not required - this book is a required text for BioE 192, the senior Capstone 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 (note the free download link)

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 References; not including Appendix I, II, and the project contract) paper. This paper should be in a 2-column format consistent the IEEE submissions (Times New Roman, font size 10 for main text, 14 for the title, 12 for subheadings). Please note that larger charts, diagrams, tables, etc. *should* break from the 2-column format and take the entire width of the page. All tables and figures should be numbered and have a descriptive legend. Citations should be in NLM format. A sample LaTeX file will be made available for you, though you may use another document editor (e.g., Microsoft Word) to produce your document if you wish.

If you decide to go with LaTeX, there are many free options available. I have TeXworks installed as an editor with TeXLive on my laptop, and if you'd prefer to work collaboratively online, OverLeaf is an editor that you can use directly in a browser.

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 NLM format. Your citations should consist primarily (though not necessarily exclusively) of peer reviewed journal articles. If you aren't sure if something is a peer reviewed journal - ask! Citations from the peer reviewed literature usually have a DOI number.
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