DEPARTMENT OF BIOMEDICAL ENGINEERING
INSTRUCTIONAL INCUBATOR
UNIVERSITY OF MICHIGAN

BME Course Summary

Introduction

1. Course Information

Course Name	BME Integrative Design and Experimental Analysis (IDEAS) Lab
Institution	University of Virginia
Course Number	BME 3080 / 3090
# credits	4 (x2 terms)
Meeting times	1 lecture / week, 1 hr; 1 lab per week, 4 hrs
Is this a required course?	Yes
Pre-requisites	Calculus II & III, Physiology, Cell & Molec. Bio, Biomechanics
Target audience (e.g. 1st, 2nd year):	3rd year (but similar topically to BME 241 at U-M)
Textbook	N/A
Course Website (if it exists)	N/A

2. Course Description

In the space below, "paste" the description of the course. This can be the actual description listed in the syllabus from the course.

A year-long course to integrate concepts and skills from prior courses in order to formulate and solve problems in biomedical systems, including experimental design, performance, and analysis. Lab modules include testing in tissues/cells and manipulation of molecular constituents of living systems to determine their structural and functional characteristics for design of therapeutic or measurement systems. Methods include biochemical, physiological, cell biology, mechanical, electrical and computer, systems, chemical, imaging, and other approaches.

3. Course Learning Objectives

In the space below, "paste" the course learning objectives if explicitly stated.

N/A

4. Fundamental Tools and Skills

In the space below, describe the fundamental tools and skills that are addressed in the class. For example, labvview, arduino's, the design process etc.

Wet lab skills (cell culture, protein quantification, PCR, microscopy), materials characterization, MATLAB, electrical engineering fundamentals, imaging (ultrasound), drug delivery

5. Exercises or Experiential Projects of Interest

Exercise/Project	Project Overview	Learning Activities and Assessments	Required Resources for Project Completion
EXAMPLE	Students make pulse oximeters.	**Learning Activities** • Students will use resistors and a bread board to … • In a short essay assignment, students explain… **Assessment** • Students complete a laboratory report that explains …	Function generator, resistors, oscilloscope….
NOTE		Each module ends with a formal lab report complete with full documentation of experimental steps and results alongside answers to key, open-ended questions from the experiments	
1	Students learn and execute cell culture	**Learning Activities** • Students learn how to culture, split, and incubate cells • Students analyze growth, adherence, and adhesion • Students isolate nucleic acids and proteins from cells for analysis	TC hoods, cell lines, cell culture reagents (flasks, media, serological pipettes, trypsin, etc.)
2	Students learn protein quantification fundamentals	**Learning Activities** • Students use Western Blot and immunofluorescence to detect and quantify various proteins	Pipettes, gels, electrophoresis machinery, antibodies, gel imager

Exercise/Project	Project Overview	Learning Activities and Assessments	Required Resources for Project Completion
3	Students learn about nucleic acids and their analysis	**Learning Activities** • Students research RT-PCR and the reagents necessary and then execute a PCR-based experiment	PCR equipment and reagents (thermocycler, primers, enzymes, etc.), pipettes, cellular sample for analysis
4	Students use fluorescence microscopy to visualize cellular architecture	**Learning Activities** • Students use fluorescent antibodies and immunocytochemical staining procedures to stain cells and visualize them under the fluorescent microscope • Students analyze, merge, etc. images with ImageJ	Cells for analysis, fluorescent antibodies, fixation agents, permeabilization agents, fluorescent microscope
5	Students learn about materials characterization	**Learning Activities** • Students use Instron machine to analyze material properties of various biological specimens	Biological specimens (bones, tendons, etc.), tensile testing machine (here, Instron)
6	Students explore polymer chemsitry fundamentals	**Learning Activities** • Students use a goniometer to understand the effect of polymers on wettability and diffusion • Students analyze the degradation of polymer microspheres over a given period of time	Polymers, microspheres, goniometer, protein quantification kit
7	Students explore electrical engineering fundamentals through ECGs	**Learning Activities** • Students make simple ECGs using op-amp circuits • Students use MATLAB to filter and analyze signals	Oscilloscope, function generator, breadboards, EMG leads, basic circuitry tools
8	Students are exposed to imaging basics and image analysis	**Learning Activities** • Students use ultrasound to image phantoms and biological specimens • Students use MATLAB and ImageJ for image processing and analysis	Ultrasound transducers & associated equipment, biological specimens for imaging
9	Students use thermodilution to further explore EE fundamentals and fluid mechanics	**Learning Activities** • Students set up required circuitry for thermoresistor • Students make measurements of flow via thermoresistor setup from previous week	All tools from week 7 + catheters, thermometer

Exercise/Project	Project Overview	Learning Activities and Assessments	Required Resources for Project Completion
10	Students assemble liposomes and analyze their encapsulation	**Learning Activities** • Students assemble liposomes and use both digestion and fluorescence-based methods to analyze incorporation	Lipids, protein, fluorescent tracers, size-exclusion chromatography setup, detergents, protein quantification tools
11	Final Project: Students come up with a question on their own to explore	**Learning Activities** • Varied. Students determine question (usually a logical next step from a previous module) and go through an abbreviated rational design process to design appropriate experiment to test their hypothesis. After execution, they write up a report similar to previous modules.	Varies.

6. Additional thoughts

If you have any other thoughts about this course, but have not been able to reflect it elsewhere in the document, please feel free to do so here.

This course is legendary in the UVA BME curriculum for its rigor – it is by far the most time-consuming course series in the program. Much of this is due to the lab reports and questions, however, rather than the hands-on time in the lab. Additionally, it is interesting that this curriculum is similar in many ways to U-M's BME 241. According to my interviews, students often bump 241 to third year due to scheduling and are frustrated that the hands-on integrative experience is so late in the curriculum – I remember a similar emotion at UVA.