SPRING SEMESTER 2009 - BIOM 390  
BME INTEGRATIVE DESIGN AND EXPERIMENTAL ANALYSIS (IDEAS) LAB II

Instructor: Dr. Timothy Allen  
Co-Instructors: Dr. Yong Kim, Dr. Jeffrey Holmes  
TAs: Rebekah Neal, Karin Rafaeels, Sunil Unnikrishnan

Credit Hours: 4.0  
Prerequisite: BIOM 380 (or instructor permission)

Lecture: Mondays, 11:00 – 11:50 am, MR5 Room 1041  
Lab Section 1: Tuesdays, 2:10 – 6:00 pm, Stacey Hall Room 1401  
Lab Section 2: Wednesdays, 2:10 – 6:00 pm, Stacey Hall Room 1401  
Lab Section 3: Thursdays, 2:10 – 6:00 pm, Stacey Hall Room 1401

Course Overview: Second half of 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.

Reading material: Handouts from class  
Grading: Quizzes (15%), Lab reports & proficiency (40%), IDEAS Project (20%), Lab notebook (5%), Final (20%)

INSTRUCTOR (TAs)

Kim (Unnikrishnan)  
Module 7. BME Signals and Systems: Electrophysiology of the Heart  
Week 1/19 Introduction to Electric Circuits Design: Op-amps and Filters (Lecture on Tues., 1/13)  
Week 1/26 Measurement of EKG and Vector Cardiography I  
Week 2/2 Measurement of EKG and Vector Cardiography II  
Week 2/9 Lab Report Due

Allen (Unnikrishnan)  
Module 8. Biomedical Imaging: Principles of Ultrasound and Image Processing  
Week 2/6 Basics of Ultrasound Systems and Measurements  
Week 2/16 Image Processing and Analyses; Application to Ultrasound  
Week 2/23 Lab Report Due

Allen (Rafaels)  
Week 2/23 Principles of Thermodilution, Volumetric Flow Rate Measurement  
Week 3/2 OFF for Spring Recess – NO CLASSES  
Week 3/9 Pressure & Reynolds Number; Frequency Response of a System  
Week 3/16 Lab Report Due

Holmes (Rafaels)  
Module 10. Biomechanics of Soft Tissues  
Week 3/16 Characterizing the Mechanical Properties of Biological Materials (Week 1)  
Week 3/23 Characterizing the Mechanical Properties of Biological Materials (Week 2)  
Week 3/30 Lab Report Due

Allen (& multiple instructors from both semesters) (Neal)  
Module 11. The IDEAS Approach to BME: Integrating Knowledge to Find a Solution  
Week 3/30 IDEAS Project (Lecture 3/30 to assign projects – then NO lectures until review on 4/27)  
Week 4/6 IDEAS Project  
Week 4/13 IDEAS Project  
Week 4/20 IDEAS Project  
Final Report due Tuesday, April 28 at 5:00pm for ALL groups (20% of overall grade)

Review for Final Exam: Monday, April 27, 2009 (11:00am in BME Lecture Hall)

FINAL EXAM: Monday, May 4th, 9:00am-noon
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Course Expectations

The BME Integrated Design and Experimental Analysis (IDEAS) Lab is a yearlong course sequence that is a core requirement of the undergraduate major in Biomedical Engineering.

To become a new kind of engineer, a biomedical engineer for the 21st century, you must be skilled and versed in both engineering and biomedical sciences. The IDEAS Lab will expose you to fundamental, new, and exciting tools, skills, analyses, and experiences that you will use in your careers as researchers, clinicians, and engineers. The course is organized into separate 2-week experimental modules, each covering a specific theme. These modules, which span over 2 semesters, have been developed to instruct you in practical and analytical methods commonly used in cell and molecular biology & engineering, cellular microscopy, cell and tissue mechanics, physiological measurements, and signal & imaging processing/analysis. Near the end of the 2nd semester, you will be tasked with synthesizing and applying the knowledge you have gained from the previous modules, as we design and conduct experiments to test hypotheses encountered everyday by biomedical engineers.

It is important to us that every student learns from this lab experience. There will be 3 Professors and 3 TAs available to help you get the most out of the BME IDEAS Lab. Please do not hesitate to ask questions or to seek advice, either in lecture, lab, or off days. All Professors and TAs have office hours by appointment, and there are extensive opportunities to ask questions during the labs themselves.

Groups. For each lab section, there will be a maximum of 4 students in each group (with some exceptions due to over-enrolled sections). Group membership will be determined amongst the students within each lab section, and these groups will remain together for the duration of the semester. However, the Instructors reserve the right to alter group composition at any time, for any reason. Lab members must rotate responsibilities in order to get full exposure to all aspects of the lab experience. The TAs and Professors will make sure this is put into practice.

Quizzes. Because there are many details to cover in a limited amount of time, it is absolutely essential to read and understand each week’s written materials before coming to lab AND to attend the weekly lecture. To this end, quizzes will be given at the beginning of each lab session. These quizzes will test your knowledge of the concepts covered in lecture and the written materials accompanying that day’s lab. Please be prepared. Quizzes will be graded out of a total of 10 points each.

Lab Notebook. A good practice in laboratory management is the ability to document the details of daily experimental events. These include methods used to setup, run, or analyze and experiment, the raw data collected, the processed or analyzed data, and the results obtained. You should also include any comments along the way. The function of the notebook is manifold; it serves as a written legal document of the work that YOU complete, as your own, in the lab, it also allows you and others who read your notebook to go back and perform those experiments and be able to get the same results, and it is a hardcopy of all of your data. Each lab group will be responsible for maintaining one lab notebook throughout the entire semester and must ask one of the TAs to sign off on the notebook before leaving lab each day. The notebook will be handed in at the end of the semester with the Final Report (on 4/28) to be graded. Each lab group will receive a maximum of 5 points (5% of their grade) for the quality and completeness of the notebook, including work done on the final IDEAS Project.

Lab Reports. BIOM 390 consists of 4 individual lab modules and the final 4-week IDEAS Project. There are 2 weeks in each module (except for Module 7, which is 3 weeks long). A Lab Report will be due for each module (i.e. not each week), and these reports will be due the next lab session after the end of the module. Points will be deducted from reports handed in late at the rate of 10 points per day (starting at 2:10pm on the due date). One Lab Report will be handed in by each group. Only students in the same group can work together on the report. Reports must be typed, all pages stapled together, well organized, and readable. Please use 12-point font (Arial or Times), 1.5-spaced, and minimum 0.75” margins all around. After the first page, your GROUP Number should appear in the header (right side) along with the Page number. Please follow the format below. You will be deducted if you exceed the page limit. The Instructors reserve the right to alter the page limit for any of the modules as they deem necessary. If this is the case, you will be notified in advance.

**ABSTRACT** (5-points) LIMIT to 250 words
The abstract needs to provide an overview of the lab Module. It should answer the following questions: “What is the module about?” “What is the importance of this module?” “What did you do in the module?” “What were the highlights of your results?” and “What are the conclusion(s) from the results?”
**RESULTS (60pts)** LIMIT to 4-pages total text and figures

The results section includes what you observed, measured, analyzed, calculated, etc. in the module. Include brief AND concise methods used for (1) generating and (2) analyzing the data. The results must be supported with Figures and/or Tables. In some modules, the instructor will give you explicit directions on what figures/tables to include. In ALL Modules, you want to include figures/tables (data, graph, images) to properly convey your results (even if not asked for explicitly) – however, an excess of figures/tables is not acceptable. Figures/Tables can be integrated within the body of the text or all together at the end of the Results section. Convey the results in an unbiased manner – as an independent observer of the results. Be sure to explain what you did and why you perform certain experiments or calibrations. Also explain any unexpected results or errors. If any of these key explanations also happen to be included in an IBQ answer, you may refer to that particular IBQ to save space in your Results section (e.g. "Measurement error led to underestimation of ultimate tensile strength (ref. IBQ #2)."]. Use Subtitles for each distinct Results subsection, when applicable. You will be graded on the quality of your data generation/collection and your data analysis.

**INQUIRY-BASED QUESTIONS (IBQs) (35pts)** LIMIT to 2-pages

Each Module will include "Inquiry-Based Questions" that are to be answered and submitted as part of your Lab Report. These are questions we encourage you to think about more deeply and discuss amongst your group members. The first question in every module will always be the same: You will be asked to summarize your conclusions from the module by encapsulating the key findings from your results. (Given the results/data/figures/etc. that you presented in the previous section, what did you learn? Do the results support the initial hypotheses set forward at the outset of the lab module? If not, what is the most likely reason(s)?) Please number the responses corresponding to this question and the subsequent module-specific IBQs. Do not restate the question. Please make sure you document/cite any references/sources you look up and use in answering these questions. This should be listed under a section titled “References” at the end of the questions section. References will not count towards your page limit.

Our expectation is that all lab reports will be error-free, not only with respect to data presentation (e.g. properly-labeled axes, appropriate significant figures, etc.), but also with respect to written English (spelling, grammar, punctuation, etc.). This sort of attention to detail in your lab reports is the minimum that you can do to show respect for your audience (not just in this course, but to your future coworkers, supervisors, and colleagues).

ALL Lab Reports will be graded on the following merits:
- Technical execution, analysis, interpretation of data/results, and well-thought-out answers to the IBQs
- Readability – including language, correct spelling and conciseness, quality of presentation

**Final IDEAS Project and Report.** The final “module” of the IDEAS Lab course sequence is a four-week project that integrates material from other modules covered throughout the year. These projects are solicited each year from numerous faculty members within the department (typically IDEAS instructors from BIOM 380 and/or 390) and are often in a cutting-edge area of research. The IDEAS instructors and TAs act as “consultants” to the groups working on these projects, providing guidance and advice as the project proceeds.

During the lecture period at the outset of the four-week module (Monday, 3/30), each student group will receive a randomly assigned project description (approximately half a page), which includes a bulleted list of questions that you must address by the time your project is completed and the Final Report is handed in at 5:00pm on Tuesday, 4/28. (There is no lecture corresponding to the final project, given the diversity of topics covered.) You will then meet with the assigned Instructor and/or TA to discuss the details of the problem statement and the questions on the assigned project handout. Within the first week, you must develop a detailed project plan (with team member responsibilities throughout the remaining three weeks), which you are expected to discuss again with the instructor or TA (or both) by the end of the week. After that point, you are free to work on their projects when you choose and are not required to show up in lab for your regularly-assigned four-hour sessions. Each week a brief progress report will be due, and you should discuss any data with your “consultant.” Note that while four weeks is sufficient for completing these projects, fewer than four will not be. Therefore, do NOT wait until the last week to get started.

**Final Exam.** The will be no midterm exam. The final exam will be in the style of a written practicum and will test your individual knowledge of background material and concepts, techniques, and procedures you used in the labs. If (and only if) you have 3 final exams within 24 hours, you can opt to reschedule the IDEAS final.
Extended Time to Work on Labs. There will be no time to make up labs. If there are special or unexpected circumstances, please discuss your situation with Dr. Allen or one of the Instructors responsible for that week’s Module. Some labs may require groups to perform tasks on non-lab days. We know this may be an inconvenience in your schedule, but is essential to the full laboratory experience. In such cases, posted “windows of opportunity” to do these tasks will accompany each lab. No after-hours work will be allowed (that is, after 6pm) without prior permission. **If you absolutely must miss a lab due to illness or an unavoidable conflict (for which you have received prior permission from Dr. Allen), you are still expected to make a meaningful contribution to your group’s report and will have to pledge to specifically what that contribution was.**

**LAB SAFETY**

Please read and understand all instructions prior to each lab session. Some chemicals and reagents are harmful, so please protect yourself by wearing safety glasses, lab coats, and gloves when necessary, and use the chemical hood when specified. Note that most modules in BIOM 390 will not require protective clothing. If a particular lab does require gloves and/or a lab coat, you will be notified in advance by an Instructor or TA. **If you are unsure of any step, please ask for assistance from the TA or Professor.** For the biomechanics labs (and some of the IDEAS Projects), please make sure you wash your hands before and after (i.e. before leaving) the lab – even if you wear gloves.

**Lab Dress Code.** For most lab modules in BIOM 390, protective clothing (lab coat and gloves) is not necessary. However, IF you are instructed in advance to wear gloves and/or a lab coat for a specific module, you MUST also wear shoes which fully enclose your feet. Absolutely NO open-toed or backless shoes/sandals can be worn in those particular labs. If you accidentally wear the wrong shoes on those days, you will have to go back and change. You will not be allowed to perform the lab module until you are wearing the correct shoes. This is purely a safety issue. You may also be required to wear a knee-length lab coat. (We recommend coats that have elastic cuffs on the sleeves, but this is not required.) Coats can be purchased from the lab supplies section of the UVA Bookstore, and a very limited number of lab coats are available for students to borrow.

**Chemicals.** Some of the chemicals used in the laboratory are hazardous. All manufacturers of hazardous materials are required by law to supply the user with pertinent information on any hazards associated with their chemicals. This information is supplied in the form of Material Safety Data Sheets or MSDS. MSDS contains the chemical name, CAS#, health hazard data, including first aid treatment, physical data, fire and explosion hazard data, reactivity data, spill or leak procedures, and any special precautions needed when handling this chemical. MSDS information can be accessed on World Wide Web. You are strongly urged to make use of this information prior to using a new chemical and certainly in the case of any accidental exposure or spill. NOTIFY the instructor or TA immediately in the case of an accident involving any potentially hazardous reagents. The following chemicals are particularly noteworthy:

- Phenol - can cause severe burns
- Acrylamide - potential neurotoxin
- Ethidium bromide - carcinogen

These chemicals are not harmful if used properly: always wear gloves when using potentially hazardous chemicals and never mouth-pipette them. If you accidentally splash any of these chemicals on your skin, immediately rinse the area thoroughly with water and inform the instructor. Discard the waste in appropriate containers.

**Ultraviolet Light.** Exposure to ultraviolet light can cause acute eye irritation. Since the retina cannot detect UV light, you can have serious eye damage and not realize it until 30 min to 24 hours after exposure. Therefore, always wear appropriate eye protection when using UV lamps.

**Electricity.** The voltages used for electrophoresis are sufficient to cause electrocution. Cover the buffer reservoirs during electrophoresis. Always turn off the power supply and unplug the leads before removing a gel.

**General Housekeeping.** All common areas in MR5 and Stacey Hall should be kept clean and free of waste. You have only a limited amount of space to call your own, so it is to your advantage to keep your own area clean. Since you will use common equipment and facilities, please restore it to the way it was prior to you using it (that is, keep it clean and any parts stored as they were). All products produced from each module including solutions, breadboards, cell culture dishes, samples, etc, for example, should be clearly labeled by each group and dates. Please label items with your group name and Module number if applicable. Unlabeled material found in the cabinets, work benches, incubators, refrigerators, and freezers may be destroyed. Always mark the backs of the plates with your initials, the date, and relevant experimental data. Label and stow any circuits that you assemble.

BIOM 390 – BME IDEAS LAB SYLLABUS, SPRING TERM 2009