BME354L Class Syllabus

1 Personnel & Lab / Lecture Information

Instructor: Dr. Mark Palmeri
Lectures: Wednesday& Friday, 08:30 - 09:45 (125 Hudson Hall)
Labs: Thursday, 13:25 - 16:25 (03L) & 16:40 - 19:40 (04L) (P05/P07 Teer)
Lab Head Honcho: Matt Brown
Teaching Assistants: Radu Darie (03L), Kristie Yang (03L), Trisha Lian (04L), Daria Nesterovich (04L)

2 Office Hours

Who	When	Where
Palmeri	Wed, 10:15-11:15	258 Hudson Hall Annex
Palmeri	Mon, 11:15-12:00	258 Hudson Hall Annex
Daria & Kristie	Tue, 12:00-13:00	Teer Basement
Trisha & Radu	Mon, 13:30-14:30	Teer Basement

Alternate days / times can always be scheduled with Dr. Palmeri by email.

3 Textbooks, Class Website & Communication

3.1 Required

- Blum, J. "Exploring Arduino: Tools and Techniques for Engineering Wizardry," 1st ed., Wiley, 2013.
- Starter Pack for Arduino (Adafruit) ← **THE BOOKSTORE FAILED TO STOCK THIS; PLEASE ORDER ONLINE ASAP!!**
- LCD Shield Kit w/ 16x2 Character Display (Adafruit) ← **THE BOOKSTORE FAILED TO STOCK THIS; PLEASE ORDER ONLINE ASAP!!**

3.2 Other References

- **Horowitz and Hill "The Art of Electronics," 2nd ed., Cambridge University Press, 1989.**
- Webster, J.G. "Medical Instrumentation: Applications and Design," 4th ed., NY, Wiley, 2010.
- Figliola, R.S. and Beasley D.E. "Theory and Design for Mechanical Measurements," 4th ed., NY, Wiley, 2000.

In addition to the class Sakai site, there is also a class website:

`http://mlp6.github.io/Intro-Medical-Instrumentation/`

This website contains handouts, online resources, and other references for use throughout the semester.

All class communication will be done as announcements through Sakai that will also be sent as emails to everyone.

4 Class & Lab Attendance

Lecture attendance is *strongly* recommended since a considerable amount of the material will be exclusively covered during lecture and not in a textbook. Additionally, there will be some readiness assessments given throughout the semester during the beginning lecture that cannot be made up outside of lecture.

Lab attendance is *mandatory* for all labs. Labs can only be made up with an official excuse (Short Term Illness form) filed in advance of the scheduled lab or a legitimate conflict that have you discussed with Dr. Palmeri **at least a week in advance** of your scheduled lab. Days/times to make up labs will be decided by your TA, Matt Brown and Dr. Palmeri **in advance** of missing lab, and your lab partner may be asked to attend that make up time depending on the lab exercise. All labs must be performed and complete lab reports submitted to pass this class. *Two unexcused labs will result in automatic failure of this class.*

5 Class Schedule (subject to change)

The following schedule will also be updated on the class Sakai calender.

WEEK 1	**NO LAB**
Fri, 01/10	BME354L Introduction & Overview
WEEK 2	**LAB 1: Equipment Review**
Wed, 01/15	BME253/ECE110 Review: Analog Circuit Analysis
Fri, 01/17	Transducers and Detection Circuits
WEEK 3	**LAB 2: Soldering LCD Shield**
Wed, 01/22	Introduction to Op Amps
Fri, 01/24	Input/Output Impedance, Buffers, Amplifiers & Comparitors
WEEK 4	**LAB 3: Amplifier & Filters**
Wed, 01/29	Active Filters; Differentiators & Integrators
Fri, 01/31	Diodes: Rectification & Clipping/Limiting
WEEK 5	**LAB 4: Introduction to Arduino (Time Integrator)**
Wed, 02/05	Introduction to Microcontrollers; Pulse Width Modulation (PWM)
Fri, 02/07	Power Isolation: Transistors & Relays
WEEK 6	**LAB 5a: Embedded Systems (Arduino Incubator)**
Mon, 02/12	Envelope Detection (Quadrature Demodulation) & Phase Demodulation
Fri, 02/14	Signal Processing I: Noise, SNR, Averagers
WEEK 7	**NO LAB**
Wed, 02/19	Exam I: Analog Electronics
Fri, 02/21	Signal Processing II: Convolution & Correlation
WEEK 8	**LAB 5b: Embedded Systems (Arduino Incubator)**
Wed, 02/22	Binary Numbers: Bit Resolution, Variable Types
Fri, 02/28	Analog $\rightarrow$ Digital I
WEEK 9	**NO LAB**
Wed, 03/05	Analog $\rightarrow$ Digital II
Fri, 03/07	Digital $\rightarrow$ Analog
WEEK 10	**SPRING BREAK**
WEEK 11	**LAB 6: Biopotential Amplifier & ECG Measurements)**
Wed, 03/19	Cardiac Anatomy & Physiology Review
Fri, 03/21	ECG Signals: Cardiac Dipole Moment, Einhhoven's Triangle, Wilson's Central Terminal
WEEK 12	**LAB 7: Blood Pressure Measurement (Arduino)**
Wed, 03/26	Exam II: Digital Electronics
Fri, 03/28	Electronic Noise Sources & Electronical Safety
WEEK 13	**LAB 8: Pneumotachometer / Spirometry (Arduino)**
Wed, 04/02	Pulse Plethysmography & Oximetry
Fri, 04/04	Neuroengineering
WEEK 14	**FINAL PROJECT: Pulse Plethysmography (Arduino)**
Wed, 04/09	Biomedical Device Safety
Fri, 04/11	Engineering Ethics
WEEK 15	**FINAL PROJECT**
Wed, 04/16	TBD
Fri, 04/18	TBD
WEEK 16	**FINAL PROJECT**
Wed, 04/23	LDOC (TBD)
WEEK 17	**FINALS WEEK**
Thu, 05/01	Final Project (Arduino): 19:00 - 22:00

6 Problem Sets

- Problem set due dates will be posted with each assignment.
- Late problem sets will not be accepted unless (1) Short Term Illness prevents completion, or (2) arrangements are made *in advance* with Dr. Palmeri.
- Unless otherwise stated, all assignments are due in the `BME354L (Palmeri)` grader box on the second floor of the Hudson Hall Annex at the specified time.
- Please make sure that your submitted problem sets are clearly labeled with your name, problems are clearly numbered, and the pages are secured with a staple or paper/binder clip. You can't receive credit for missing pages!
- When solving circuit analysis problems in the assignments:
  - Always draw the circuit/diagram for each problem involving a circuit/diagram.
  - Label all circuit elements with symbols. Solve problems symbolically before substituting in numerical values.
  - Please write legibly and include all relevant steps in arriving at your solution.
  - Please place a box around all final solutions.
  - Attach any computer code (e.g., Matlab code) used to solve problems. Place comments in the code where appropriate to indicate your thought process.
  - **All answers must have units.** No units = No credit!
  - All graphs must have appropriately labeled axes/legends with units.

7 Lab Policies & Reports

7.1 Policies

- Laboratory work is worth 25% of your final grade for this course. This includes your pre-lab assignments, active participation during lab, appropriate data recording / documentation in your Sakai group lab folder, and your final written report for each lab.
- Labs are due at the beginning of the next scheduled lab, as specified by the Sakai assignment. Reports will be **electronically submitted via Sakai**. Several lab reports may be combined with similar experiments on subsequent weeks; these specific reports will be clearly identified in class and lab, and are indicated on the class schedule. When in doubt, please check Sakai to determine when a lab report is due.
- Late lab reports will be penalized 50% of otherwise earned credit for being up to one day late. Lab reports greater that one day late will receive no credit, but must be completed and turned in to pass the class. **Late lab reports must be submitted through Sakai, which Dr. Palmeri will have to give you access to do after the original due date.**
- You must inform Dr. Palmeri if you have a known conflict with attending a lab *at least one week before that lab*. **Two unexcused absences from lab will result in an automatic failure of the course.**
- **You cannot attend the lab section that you are not enrolled in!**
- All laboratory exercises and reports must be completed to pass this course.

7.2 Pre-lab Assignments, Sakai Data Storage / Documentation, Lab Procedures

- All pre-laboratory questions and calculations must also be completed before lab and electronically submitted before the start of lab (one per group). Additionally, for some labs, you will be asked to complete Arduino code before lab. Lab-specific details will be provided when appropriate. These pre-laboratory assignments are with 10% of each lab's grade, and late pre-laboratory submissions will not receive any credit.
- Electronically record notes of your procedures and results throughout the lab using the PCs in the laboratory, and upload all electronic documents (text files, spreadsheets and screen captures) to your Sakai account so your TAs can review this materials if necessary. *Make sure that your notes have adequate details to complete your lab report, including all necessary data and screen captures.*
- You and your lab partner must clear your lab bench space and return all parts after you have completed your experiment.

7.3 Lab Reports

- Each lab group (i.e., you and your lab partner) must complete a lab report for each lab. Like performing the lab exercise, the writing of the report and the data analysis should be even between the lab partners.
- The lab report is not required to be a certain length, but should be long enough to adequately present results, discuss those results (including things that do not make sense, and why that may be the case), and appropriately answer any questions raised during the procedure and in the post-lab questions. Distilling your information down to the pertinent points is more important than including the "kitchen sink" in your lab reports.
- The following is a general outline for your lab reports (your lab TAs will discuss their expectations in more detail during lab):
  - Purpose: State the purpose of the experiment in one or two sentences
  - Materials & Methods: List the material and equipment used during the lab (e.g., Oscilloscope Tektronix TDS-1012). You do not need to repeat the procedure already mentioned in the lab handout; instead, please include any deviations from the protocol, reasons for those deviations, etc. After reading this section of the lab report, someone should be able to replicate what you did along with lab handout.
  - Results & Discussion: Provide all of the data acquired in the lab in a meaningful and efficient format (e.g., tables, plots, etc.). All figures, tables, plots *must* be numbered and labeled, with captions, and properly referenced in the text. All figure / plot axes must be labeled and include units!! All results must include units!! Included all analyses discussed in the lab handout, and provide equations that were used in these analyses (and any intermediate steps if they are not obvious and are significant). Answer all questions posed in the lab handout and post-lab questions (be sure to indicate the question number you are answering).
  - Conclusions: A few sentences providing an overview of your findings, interesting observations, and overall success of your experiment.
- All reports must be generated using a word processor (e.g., Word) or typesetting program (e.g., LaTeX) using a reasonable font size and single-spaced with clear section headings.
- Please include a title page with:

  - Lab title
  - Date
  - Section number
  - TA name
  - Your name and the names of your lab partners
  - Declaration of adhering to the principles of the Duke Community Standard while preparing your lab report
- Please number each page as 'Page # of #' so your TA knows how many pages should be in your lab report.
- **PDF electronic versions of your lab reports will be submitted to Sakai via the specific Lab Assignment that you and your lab partner will have access to. Only one lab report needs to be submitted for each group.**

8 Grading

There will be two midterm exams and a final project. Make-up exams will only be given for official excuses provided as early as possible in advance of the scheduled exam. Make-up exams will be oral exams with Dr. Palmeri that must be scheduled in advance of missing the exam or within 24 hours of submitting a short-term illness form.

The distribution of your grading is outlined in the table below:

Problem Sets & Readiness Assessments	25%
Labs	25%
Exam I	15%
Exam II	15%
Final Project	10%
Participation	10%

Notice that your exams are worth significantly less than your problem sets and labs…and there is a final project in place of a final exam.

9 Duke Community Standard

Engineering is inherently a collaborative field, and in this class, you are encouraged to work collaboratively on problem sets, lab reports, and group projects.

The work that you submit must be the result of your own effort and reflect your understanding of the material.

There are inherently gray areas when working in groups, but submitting individual assignments. Given that, you are strongly advised to consult with your instructor and your teaching assistants whenever you are unsure if you are crossing the line between collaboration and copying another student's work. As an internal benchmark, you should be able to explain all work being submitted with your name on it and be able to justify your choice for a solution methodology, analysis technique or the way that you arrived at a final answer.

All students are expected to adhere to all principles of the Duke Community Standard. Violations of the Duke Community Standard will be referred immediately to the Office of Student Conduct.

10 Words of Wisdom

- Check Sakai often for assignments, lab-related documents, and other important class information.
- Make the most out of attending lecture... briefly review notes from the previous lecture before class and make sure that you're understanding the "why", not just the "what". For example, instead of just memorizing that current and voltage lead/lag one another in capacitive/inductive devices, make sure that you understand the physics behind those behaviors. Remembering the lead/lag relations becomes a lot easier when you know why they exist.
- Don't wait until the last minute to do the problem sets!! They're designed to provide you with opportunities to figure out what you do and don't know; leaving them until the last minute compromises that objective. Working on problem sets in advance will also provide a catalyst to...
- Ask questions and attend office hours. BME354L is your opportunity to learn about medical device electronics. Take advantage of your instructors and TAs to help your learn this material–we're here for you!
- Feedback is a two-way street. I'll let you know how youre doing throughout the semester, and in return, you should feel free to let me know what you are or are not understanding. I'd rather cover less material that you understand well than covering lots of material that you'll forget sooner rather than later.