Class Syllabus

Personnel

Instructor: Dr. Mark Palmeri (mark.palmeri@duke.edu)

Lab Master: Matt Brown (matt.brown@duke.edu)

Teaching Assistants

- TBD: tbd@duke.edu

Course Times & Locations

Lecture: Tues & Thurs from 12:00-13:15 in Hudson Hall 115A

Lab: 5704 Chesterfield (Design Suite)[1]

- Each student will be issues a building access card for 24/7 access to the BME Design Suite.
- Please review Matt's Chesterfield Design Suite Guidelines (posted on Sakai).

Course Objectives

This course will give students experience with the design, function and deployment of medical electrical equipment. Students will have hands on experience with electronic hardware and software development, along with gaining experience with biosignal transduction into circuits.

Upon completion of this course, students should be able to:

- Use version control software (git) to manage software and hardware project repositories, including continuous integration / deployment and semantic versioning.
- Perform electronics schematic capture, including:
  - Functional circuit decomposition using heirarchechal sheets
  - Component references and footprints assignment using datasheets
  - Proper [heirarchcal and global] net labeling
- Layout single- and double-sided printed circuit boards.
- Electronic biosignal transduction
- Know what cabling and connectors to use for power and signals.
- Make design choices between AC and battery sources.
- Manage heat and electromagnetic interference (EMI).
- Use different data encoding and communication protocols, including SPI, I2C, Bluetooth, WiFi and Zigbee.

[1] A campus shuttle runs to/from the E-quad; details can be found here: `https://parking.duke.edu/buses/downtown-shuttle`. Visitor parking (2 hour) is available behind the building.

- Know when and how to use microcontrollers (versus discrete electronics or microprocessors) and write device firmware.
- Use client/server communications, including:
  - RESTful APIs
  - HIPAA / data privacy / encryption / cybersecurity
  - UI/UX wireframing
  - Data models & databases
  - AI-assisted processes
- Verify and validate software and hardware (FDA waterfall).
- Outline procedures to adhere to relevant industry and safety standards (e.g., UL, IEC60601, IEC62304).

Prerequisites

- Introductory Circuit Analysis (ECE110 or equivalent)
- Undergraduates: Medical Device Design I (BME473L)
- Recommended: Medical Software Design (BME547 or equivalent)

Textbooks & Resources

All of these books contain valuable content and will be referenced throughout the semester. If you are looking to pursue a career in medical device design, then it may be worth having one of these as a reference.

- Practical Electronics for Inventors (Scherz & Monk) [Fourth Edition]
- The Art of Electronics (Horowitz & Hill) [Third Edition]
- Design of Biomedical Devices and Systems (King, Fries, Johnson)
- Engineering Design: A project-based introduction (Dym, Little, Orwin)
- Product Design and Development (Ulrich, Eppinger)

A variety of online resources will be provided on Sakai throughout the semester.

Attendance & Participation

Class participation, including lecture attendance, team meetings, scheduled lab time and project effort (as evaluated through progress reports), contributes to your class grade. Not being able to participate in class activities due to illness should be reported using the Short Term Illness Form (STIF) **before** the missed class activity.

If you have a non-illness-related reason for not being able participate in a class activity or meet an assignment submission deadline, please reach out to Dr. Palmeri as soon as possible to discuss the situation. This can include the amplified stress or anxiety.

Students are responsible for obtaining missed lecture content from other students in the class.

Class Schedule

All class assignments and associated due dates will be listed on Gradescope.

All in-person lab time is to be used at your discretion to complete your prototype development and testing.

The following table is an overview of activities this semester (always use Sakai/Gradescope for the latest information, due dates, etc.):

TUESDAY	THURSDAY
Aug 30th **1** Syllabus Review	Sep 1st **2** Tympanometer Project Overview & Team Assignments
6th **3** Version Control Software (git) & Project Management Repositories	8th **4** Electronics Review
13th **5** Block Diagrams	15th **6** Microcontrollers
20th **7** Microcontrollers	22nd **8** **EDA Project** Pseudo-Code / Flowcharts
27th **9** try/except	29th **10** AC Power & Safety
Oct 4th **11** Battery Power	6th **12** **Power Project** Cabling & Connectors
11th Fall Break (No Class)	13th **13** Data Communication Protocols
18th **14** Data Communication Protocols	20th **15** Microcontrollers
25th **16** **Microcontroller Project** Microcontrollers	27th **17** Frontend Clients (UI/UX)
Nov 1st **18** Backend Servers (RESTful APIs)	3rd **19** Data Models, Validation & Databases
8th **20** Data Security (HIPAA, encryption)	10th **21** Heat & EMI Management
15th **22** **Final Projects** Industry Standards (UL, IEC60601, IEC62304)	17th **23** Project Time

TUESDAY		THURSDAY	
22nd Project Time	**24**	24th Thanksgiving Break (No Class)	
29th Project Time	**25**	Dec 1st **Final Project Presentations**	**26**

Office Hours

You can sign up for office hours using Dr. Palmeri's online calendar:

`http://officehours.palmeri.io`

If you or your team cannot meet during the times available on the calendar, please directly contact Dr. Palmeri.

The teaching assistant(s) and Matt will also be available, as needed, to help with all aspects of your projects throughout the semester (check Teams and Sakai).

Electronic Project Management & Software Tools

CAD/EDA

We will be using the following [E]CAD packages:

- KiCad (`https://kicad.org/`) (EDA)[2]
- OnShape (`https://duke.onshape.com`) (CAD)[3]

These packages are available as cloud tools or are cross-platform for installation on your personal computers.

Project Management

- Teams (https://teams.microsoft.com) - "Slack-like" tool for live chat, team discussion, asking questions and resource sharing
- MeisterTask (`https://meistertask.com`) (Kanban boards)
- draw.io (`https://draw.io`) (software / hardware flowcharts, functional decomposition)
- Mindmeister (`https://mindmeister.com`) (brainstorming, mindmaps)

[2]Please download and install the stable version (currently `v6.0.7`).
[3]You will be invited to join and do not need to signup.

Grading

The following grading scheme will be used for this course:

Participation / Midterm Deliverables	15%
Midterm Projects	60%
Final Project	25%

Gradescope

All graded assignments, associated due dates, and final grades will be posted on Gradescope.

- **You must associate the pages of your submission with the grading rubric criteria during the submission process.** Failure to do so will result in lost assignment credit.
- Please make sure that assignments associated with a team submission have **each team member associated with the submission**.
- Gradescope will also be used to provide feedback and grading rubrics.

Late Policy

Unexcused late assignments will lose 50% of their potential point value for each 24 hour period beyond the due date (i.e., 100% → 50% → 25% ...). Permission to submit an assignment late should be sought from Dr. Palmeri as far in advance as reasonably possible, but no less than 48 hours in advance, except in cases of illness.

All assignments must be satisfactorily completed by each student to pass the class, even if no credit will be awarded based on the late policy.

Final Course Grades

This course is not "curved" (i.e., a distribution of grades will not be enforced), and a traditional grading scheme will be used (e.g., 90-93 = A-, 94-97 = A, 97-100 = A+). All grades will be posted to Gradescope throughout the semester to track your performance.

Regrades

Any regrading requests need to be made within one week of grades for a given assignment being returned using Gradescope. You must provide a description of why you feel a regrade is appropriate. Requesting a regrade could lead to additional loss of credit when a problem is re-evaluated.

There will be a combination of individual and team-graded assignments. Some assignments will have an opportunity to be resubmitted based on grading feedback at Dr. Palmeri's discretion.

Duke Community Standard & Academic Honor

Engineering is inherently a collaborative field, and in this class, you are encouraged to work collaboratively on your projects. The work that you submit must be the product of your and your group's effort and

understanding. All resources developed by another person or company, and used in your project, must be properly acknowledged.

All students are expected to adhere to all principles of the Duke Community Standard (`https://trinity.duke.edu/undergraduate/academic-policies/community-standard-student-conduct`). Violations of the Duke Community Standard will be referred immediately to the Office of Student Conduct. Please do not hesitate to talk with Dr. Palmeri about any situations involving academic honor, especially if it is ambiguous what should be done.