Master Course Syllabus for EE 201 (ABET sheet)

Title: Making, Breaking, and Hacking Stuff (ECE hardware skills)

Credits: 2

UW Course Catalog Description

A lab-based class focused on a wide range of basic hands-on skills for electrical and computer engineers to give an overview of topic areas and career paths in electrical and computer engineering. Topics include introduction to physical circuit building, microcontroller programming in Arduino, PCB design, soldering, circuit simulation, 3D design and printing, PID control, and sensors. Prerequisite: CSE 122, CSE 123, CSE 142, or CSE 143, any of which may be taken concurrently. Offered: Autumn/Winter/Spring

Coordinator: Tai Chen, Teaching Professor, Electrical and Computer Engineering

(Team) Faculty who have or are willing to teach this core course):
Tai Chen, Serena Eley, Sam Burden

Goals: To give early ECE students a toolkit of basic skills and techniques that will help them in later classes, and in their engineering career. Offers an introductory exploration of various techniques, alongside potential ECE pathways that can shape their decisions regarding future courses and careers. Serves as a Launchpad for students to investigate further into topics of interest.

Learning Objectives: At the end of this course, students will be able to:

1. Create basic printed circuit boards, including schematic, layout, and soldering assembly with components.
2. Write simple microcontroller programs within a standard tool flow.
3. Create simple 3D printed objects, including CAD design and 3D printer-based fabrication.
4. Measure steady-state and time-varying voltages and currents.
5. Design digital circuit diagrams using software such as MultiSim.
6. Differentiate different pathways in electrical and computer engineering.

For the Hands-on Course Laboratories:

1. Demonstrate the ability to solder through hole components safely on both a perfboard and a PCB.
2. Create physical circuits from given and student designed digital circuit diagrams.
3. Demonstrate the ability to use oscilloscopes, function generators, and digital multimeters for usage in digital and analog circuits.
4. Decode IR signals and identify their meanings.
5. Synthesize knowledge from all labs and lectures to generate a unique design for the final project.
6. Quantitatively and qualitatively test a final project under both criteria given in the specification and milestones decided upon by the individual.
7. Modify PID control code to improve functionality for a specific use case.

8. Calibrate and verify validity of sensors.

Textbook (required): None

Prerequisite courses: CSE 122, CSE 123, or CSE 142, CSE 143

Prerequisites by Topic: Basic familiarity with computer programming

Lecture Topics:
The sequential order of the labs does not matter as long as the topics used in each lab are discussed before the lab is assigned. The order of labs and lectures may be changed to accommodate the professor teaching the class.

1. Introduction to Soldering and Soldering safety, skills, and usage. (1 week)
2. Introduction to embedded systems and writing C-code for Arduino with a focus on core programming concepts such as print statements, for-loops, variables, and sequential execution. (2 weeks)
3. Introduction to circuit simulation, design, and construction. (1 week)
4. Introduction to Robotics and final project (1 week)
5. PCB schematic design. Focus on circuit design, part selection and importing footprints, and PCB layout. (1 week)
6. 3D modeling. Focus on basic skills such as sketches, revolutions, extrusions, constraints, and dimensioning. (1 week)
7. Introduction to filters and electronics including lab equipment such as digital multimeter, oscilloscope, and function generator. (1 week)
8. Introduction to ECE pathways (2 weeks)

Laboratory Topics:
- *Lab 0 (1 week):* soldering safety, skills, and solder a circuit on perfboard.
- *Lab 1 (1 week)*: Introduction to Arduino and physical circuits. Install Arduino, create a blinking light using an LED, integrate button control as a digital signal to a blinking LED, print to a serial monitor, read an analog signal from a photoresistor.
- *Lab 2 (1 week):* Wireless communication with Arduino. Communicate with an IR remote using an IR receiver, embedded control of an RGB LED with IR remote, and obstacle detection with IR sensor.
- *Lab 3 (1 week)*: analyze and measure characteristics of filter circuits built with opamps, plot gain vs. frequency to understand circuit operations.
- *Lab 4 (1 weeks):* digital circuit simulation of audio signals using MultiSim. Install MultiSim, create and simulate an inverting amplifier, low-pass filter, high-pass filter, band-pass filter, and audio amplifier.

Final Project (6 weeks, overlaps lab 4 in a 10-week quarter): Embedded systems design, creation, and control of a line following robot. Implement sensors such as potentiometers and photoresistors, design a physical cart assembly, solder a motorshield and wire connections, creative hardware design (left open to the students' choices), PID control, and sensor calibration.

Course Structure:
The course structure includes both lecture and lab components, with a strong emphasis on the hands-on lab sessions. Each week, there will be a single 50-minute lecture and one three-hour lab section (or equivalent).

The lecture content will cover problems, applications, and pathways in electrical and computer engineering. The lectures will also cover lab topics in the form of tutorials with short, accompanying assignments.

In the Lab sections, students' progress through a series of individual labs guiding them through major techniques. Students then pursue a creative project that harnesses some of the topics learned in previous labs.

Computer Resources: Students will need general knowledge of a word processing program such as Microsoft Word to complete and submit graded work. Class will use PC workstations preloaded with the course software, found in either the department computer (361) and/or hardware (137, 347) labs.

Laboratory Resources: Students will use test and soldering stations within the department hardware labs (137). In addition, students will have access to 3D printers via UW's MakerSpaces.

The course will have two lab kits - a lab kit for each 2-person partner group and a lab kit for each 4-person final project group. These lab and final project kits can be brought home by students.

Laboratory Safety: this course requires the use of hands-on, take-home laboratory kits. The following lab safety issues are of particular concern to this course and should be conveyed to students by all instructors on a regular basis:

- Soldering: soldering will be conducted during scheduled laboratory sections and be supervised by a laboratory manager or TAs only.
- Capacitors: polarized and electrolytic capacitors should be avoided in lab kits. If they become necessary, however, students should be supervised during the placement and use of these capacitors to avoid placement in improper orientation (and potential harm to the eyes and body).
- Resistors: some low-valued resistors in this course (particularly those rated at a higher wattage and evident by a larger component body) may become hot due to high current flow and subsequent power dissipation. Students should be cautioned to leave these resistors connected for as little time as possible and also to allow the resistors to cool down before handling them (because they may be hot to the touch).

Grading:
Homework: 30%
In-class labs and participation: 30%
Final project and report: 40%

Students will complete the homework assignments individually as they are expected to be completed outside of dedicated lecture and lab time. TAs will provide basic feedback, but the majority of the learning will be done in attempting the assignments rather than the feedback.

Students will complete in-class labs in groups of two. Both students will receive the same grade for their participation and demonstrations. The in-class demonstrations during the labs will ensure each member is contributing and meeting the learning objectives.

The final project will be completed in groups of four. The groups will be created by joining two lab groups. Do not allow groups smaller than four as the amount of effort required for the final project is significant. TA checkoffs will be done throughout the final project to ensure all members of the group are contributing. Students may take specialized roles during the project, but all students should contribute.

ABET Student Outcome Coverage: This course addresses the following outcomes:

H = high relevance, M = medium relevance, L = low relevance to course.

Outcome (5): *an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives (M)*

the students work as members of 2-4 person teams to execute each of the labs and the final project.

Prepared By: Tai Chen
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Additional information and resources regarding teaching ECE courses (e.g., links to course repositories for materials from previous course offerings; guidelines for using AI tools in courses; syllabus language for course accommodations, etc.) can be found on the UW ECE Intranet:
https://peden.ece.uw.edu/academic-ops/