# IEEE Micromouse

# Syllabus

## Course Information:

- UC Berkeley, Spring 2020
- Course Title: IEEE Micromouse
- Course Number:
    - Lower Division: EE98
    - Upper Division: EE198
- Unit Value: 1 unit
- Time / Location: Every Monday 6-8 PM in 210 Jacobs Hall (tentative)
- First class:
- Instructors:
    - Lorne Briones (lmb@berkeley.edu)
    - Keahooi Hung (keahung@berkeley.edu)

## Prerequisites:

- The course is taught with no assumptions of prior knowledge, but basic CS and EE familiarity permits you to pursue more complex topics.

## Overview:

The IEEE Micromouse DeCal is aimed at students with a strong interest in robotics, who want to pursue a hardware project but may not have the resources to do so on their own. The course will be taught in the context of IEEE's Micromouse competition, in which students form teams of 2-3 to navigate a 16x16 maze. By the end of the semester, students will be able to build an autonomous, maze-solving robot with minimal assistance, using skills that are extendable to real-world robotics problems. Special focus is given to topics including electrical and firmware engineering, brushed motors, sensing, pathfinding, and control theory.

## Instruction:

Class is two hours a week in the lab. Each lab consists of a set of parts the students will use as well as some instructional material on how to use them. Several weeks into the course, the students will assemble a full mouse that they will then bring to future labs, where we will teach techniques on how to improve them. Labs will build towards an in-class competition on the last day of instruction, for which students are expected to have fully working mice.

Work outside of class involves research and development of the robot. In the first half of the semester, students will follow the links provided at the end of labs that provide deeper context for the current activity, and important background for the next class. In the following half of the

semester, students will spend time outside of class testing code for their robots, as the time in labs will not suffice.

## Schedule:

- Week 1 : What Is Micromouse?
    - Tournament video, rules
    - Team matching/signups
    - High-level overview of schematic
    - Reading: http://sites.ieee.org/r1/files/2013/03/2013-Region-1-Micromouse-Competition-Rules.pdf
- Week 2 : Electronics Basics (Lab 1)
    - Soldering
    - Arduino programming
    - Ohm's Law, Voltages, Currents
    - Analog vs Digital Pins
- Week 3 : Basic Motor Control & Sensor Readings (Lab 2)
    - Equipment tutorial:
        - Current controlled power supply
        - Multimeter
        - Function generator
        - Oscilloscope
    - Power motor with DC, varying current
    - Power motor with PWM, varying duty cycle with signal generator
    - Reading: http://tutorial.cytron.com.my/2012/01/14/basic-pulse-width-modulation-pwm/ (Skip 4.2 How to Set the PWM using PIC microcontroller)
- Week 4 : Encoders, interrupts, and performance programming (Lab 3)
    - **Milestone 1 Deadline (Driving)**
    - Encoders
    - Record encoder ticks first naively and then with interrupts.
    - Fast digital read / fast digital write
    - Bonus: Write to port registers directly
    - Reading: http://www.w9xt.com/page_microdesign_pt5_input_basics.html
    - Reading: https://www.pjrc.com/teensy/interrupts.html
- Week 5: Localization & Odometry (Lab 4)
    - Integrating wheel velocities
    - Tracking mouse position in the maze
    - Reading: http://faculty.salina.k-state.edu/tim/robotics_sg/Control/kinematics/odometry.html
- Week 6 : PID Controls (Lab 5)

    - Proportional control
    - Integral control
    - Derivative control
    - HW: http://janismac.github.io/ControlChallenges/ (Level menu -> Vehicle Steering)
    - Reading: http://students.iitk.ac.in/roboclub/lectures/PID.pdf
- Week 7 : PID Continued (Lab 6)
    - Worksession for PID
    - Research various maze solving algorithms.
    - HW: http://janismac.github.io/ControlChallenges/ (Level menu ->Vehicle Racing)
    - Reading: https://innovativecontrols.com/blog/basics-tuning-pid-loops
- Week 8: PID Continued (Lab 6 continued)
    - **Milestone 2 Deadline (Driving under control)**
    - Worksession to finish PID
    - HW: Program Robot
    - Reading: https://www.controleng.com/single-article/to-pid-or-not-to-pid/740c0b002aca4d56a28613de4023b85c.html
- Week 9 : Turning (Lab 7)
    - How to make a scheduled 90 degree or 180 degree turn
    - Mapping the maze as you traverse it
- Week 10 : Maze Traversal Algorithms (Lab 8)
    - Follow the right wall
    - Random turning
    - Floodfill, Dijkstra's,, A*
    - HW: Program Robot
    - Reading: http://theory.stanford.edu/~amitp/GameProgramming/AStarComparison.html
- Week 11 :
    - Worksession
    - HW: Program Robot
- Week 12 :
    - Worksession
    - HW: Program Robot
- Week 13 :
    - Worksession
    - HW: Program Robot

# Grading Procedures:

Grading will be based on the following categories:

- 49%- Labs (8pts each) - must be turned in by the next section
- 31% - Milestone Completion
- 20% - Attendance and Participation

A grade of 70% or higher is considered a pass.

## Cooperation Policy:

Cooperation is highly encouraged, with full disclosure of information. Since grades are not dependent on how well you do relative to other students, there is no reason to prohibit cooperation in any way. If you find out there's an anomaly with a microcontroller you're using, share it! It only benefits everyone.