SAMPLE SYLLABUS. Enrolled students will receive the finalized syllabus prior to the start of the institute.

ENGR 1A Introduction to Engineering Design: Microcontrollers
Sample Topics

Monday-Friday 9:00 am - 4:00 pm
Location: 2808 Boelter Hall

Instructor of Record: Prof. Jacob Schmidt, Ph.D., schmidt@seas.ucla.edu

Day	Topic	Goals
Week 1		
1	**Intro to Class and to Engineering** - Syllabus review - Complete Pre-Class Survey - Ohms Law - Breadboards and circuit prototyping - Voltage dividers - Thermistors	1. Get to know the class and instructors 2. Complete Lab Safety Training 3. Makerspace and SEASnet Lab Tour 4. Understand basic resistor circuits 5. Use circuits to measure temperature
2	**Microcontroller basics** - Intro to Arduino and Arduino IDE - Digital Output - PWM - Digital Input - Pullup and pulldown resistors	1. Understand program flow in Arduino IDE 2. Understand for loops, variables, and conditional statements 3. Understand and control LEDs 4. Understand and use switches
3	**Measurements with Microcontrollers** - Analog Input - Serial communication	1. Learn how to pass messages between the computer and the microcontroller 2. Measure voltage divider output with microcontroller 3. Use Steinhart-Hart equation to derive temperature from resistance measurement
4	**Computer Interface** - Programming using Processing - Plotting and drawing on the screen - Communication with microcontroller over Serial	1. Create computer programs capable of drawing graphics to the screen 2. Create programs that can receive and send data to the microcontroller over Serial 3. Create programs that plot data sent from the microcontroller
5	**CAD** - Introduction to CAD - Make sketches and extrusions - Design simple objects for 3D printing and laser cutting	1. Design a game controller containing a joystick and buttons 2. 3D print and laser cut this design 3. Interface joystick and buttons to Arduino and communicate data to

	- Combine these objects with electronics and microcontroller	computer 4. Make a simple video game in Processing using this hardware
Week 2		
6	**Motors** - Servos - Use of Transistors to control high power devices - DC motors - H bridges - Stepper motors and stepper drivers	1. Use Servo library to control servo 2. Use PWM to control DC motor speed 3. Connect DC motor to H bridge and demonstrate reversible motor movement 4. Move Stepper motors with H bridge and stepper drivers
7	**Motors part 2** - Motion control platform	1. Use stepper drivers to control 3D plotter platform 2. Interface with Processing to make computer drawing application
8	**I2C** - Binary numbers - Arithmetic and manipulation of binary numbers - Introduction to the I2C communication protocol -	- Convert Binary to Decimal and back - Bit reading, bit writing, and bit shifting - Establish communication with an external IC over I2C - Understand concepts of memory registers
9	**I2C part 2** - Use I2C to communicate with an external temperature-measuring integrated circuit - Configure external IC over I2C - Retrieve data and manipulate it to obtain temperature	1. Retrieve requested data from external IC using I2C 2. Manipulate received data to obtain useful information
10	**SPI** - Introduction to the SPI communication protocol - Use SPI to communicate with an external acceleration-measuring integrated circuit Configure external IC over SPI	1. Establish communication with an external IC over SPI 2. Retrieve requested data from external IC using SPI 3. Transmit acceleration data to computer for graphical display
Week 3		
11	**RP2040** - Introduction to the RP2040 microcontroller - Differences from Arduino UNO -	- Analog Input - Achieve I2C and SPI communication using the RP2040

12	**I2S** - Introduction to digital audio and the I2S protocol - Use I2S to obtain sound data from I2S microphone using RP2040 - Strategies for streaming higher data rate to computer Processing - Introduction to frequency analysis	1. Obtain and plot audio data 2. Write program in Processing capable of receiving/analyzing/plotting data in real time 3. Spectrum analysis of sound data
13	**I2S part 2** - Use I2S with RP2040 to digitally output input sound to speaker - Manipulate sound data before outputting to speaker	1. Make echoing speaker 2. Make tone shifting program 3. Store audio and playback upon trigger
14	**Overflow day** - Continue above material	1. CAD and 3D print speaker case
15	**Fun- Bluetooth speaker** - Use ESP32 microcontroller to create Bluetooth speaker	

- Course attendance is *extremely important*.