EK 131 A2: Hands-on Engineering
Fall 2022

Course instructor and Coordinator: Dr. Ousama AAMAR (oaamar@bu.edu)
Office: ERB247
Office Hours: Monday and Wednesday (4:15-5:30 pm in EPIC design studio) and by appointment in my office.

Teaching Assistant:
Anant Pathak (apathak@bu.edu), Office hours in EPIC: Tuesday and Thursday 4-5 pm.
Lisa Korver (lkorver@bu.edu), Office hours in EPIC: Tuesday 5-6 pm and Friday 11:15 am - 12:15 pm.

Course Credits: 2

Course Description:
Engineering workshop for learning a set of skills, intended to give students hands-on experience on using engineering tools (software and hardware) for design and prototyping. The students will be exposed to a number of mechanical and electrical engineering tools applicable to 3D visualization, building structures, designing and wiring circuits, prototyping and instrumentation. Students will work individually and in teams to build substructures that can be integrated into a functional device (final product).

Course Goals:
Students will participate in a mechanical workshop in which they will ultiately learn to design and fabricate multiple parts that fit together. In the second half of the course they will participate in an electrical workshop in which they will learn basics of Ohm's Law, simple KVL & KCL, wire a breadboard and solder, interface to and program an Arduino to perform simple functions.

Course Topics:
- Sketching
- Engineering Drawing
- Mechanical CAD Drawing
- 3D Printing
- Circuits Wiring
- Ohm's Law, KVL, and KCL
- Power Supplies
- Microcontrollers
- Troubleshooting Strategies

Course Outcomes:

As an outcome of completing this course, students will be:
1) Able to make precision measurements and communicate through mechanical drawings

2) Able to use CAD software for design of simple mechanical components
3) Able to understand the basics of machining processes and when they are applicable (additive vs. subtractive)
4) Able to translate from concept to geometry (using CAD) and mechnical drawings to physical implementation (using hand and power tools)
5) Able to design and fabricate multiple parts that fit together
6) Able to apply Ohms law, KVL and KCL
7) Able to use a Multimeter to measure voltage, current and resistance, and troubleshoot composite system
8) Able to do basic wiring on a breadboard and solder
9) Able to interface Arduino to analog and digital I/O and PWM (using LEDs, Sensors and Actuators)
10) Able to program Arduino for an arbitrary instrumentation problem involving a timing loop and control multiple parts
11) Able to communicate technical concepts and implementation in an oral presentation/demo and technical engineering report
12) Able to work in teams

Instructional Format

The first 30 minutes of each class will be used to explain the basic concepts of the activity during the remaining time of the class and out of class. The students will be learning how to build substructures based on modular design and design simple circuits that can be integrated into a "final product". The final product is defined as a device that can provide specific functions. It has to be fully packaged with simple user interface and safe to operate.

In the first class, we will provide full description of a product that students will build over the semester.

Books and Other Course Materials

No textbook is required.

Student's kit

Each student will purchase kits to work on the assigned project in teams and individually.

Courseware

Class materials and homework will be posted on Blackboard Learn.

Assignments and Grading

You will have 10 homework assignments.

Homework: 40%
Final product: 40%
Attendance and participation: 20%

Other Notes

If you are a student with a disability or believe, you might have a disability that requires accommodations, please contact the Office for Disability Services (ODS) at (617) 353-3658 to coordinate any reasonable accommodation requests. ODS is located at 19 Deerfield Street on the second floor.

Attendance in class is mandatory. In the event of illness or other family emergency, please notify both the instructors and your team (when applicable). Failure to do so will be regarded as an unexcused absence and will be taken into account as we determine your "Participation and Attendance" grade. Note that religious events are not considered unexcused absences. See the Policy on Religious Observance for more details.

All homework and reports should be uploaded to BB Learn, unless otherwise specified.

Boston University's academic conduct code may be found at *https://www.bu.edu/academics/policies/academic-conduct-code/.* A particular concern is plagiarism while writing engineering reports. Any copying of articles, websites, or other material from the web without citation will be considered plagiarism and will be referred to the judicial system at Boston University.

Outline of Class Meetings

The overall schedule of activities and assignments is shown below.

Week	Topic	In-Class Activity	Assignments
1	Sketching	• Introduction to the course • Description of the semester project • Make precision measurements using calipers and other tools. • Free hand sketching	Free hand sketching / documenting precision measurements 4 points
2	Introduction to Machining	• Machine Shop • Threaded fasteners	Projection of 3 different views 4 points

Week	Topic	In-Class Activity	Assignments
3	Engineering drawing Mechanical CAD drawing	● Hand drawing of 3D objects using drafting tools ● Dimensions ● Learn how to use CAD (on-shape)	Lay out multiple parts/components in an enclosure using CAD. This should take into account the final product as described by the instructor. 4 Points
4	Mechanical CAD drawing	● Assembly in Onshape	Build an assembly using CAD 4 Points
5	3D printing	● Introduction to 3D printing ● Compare printer settings (materials, temperature setting, orientation of 3D print, support, thickness and density) ● Laser cutting ● Drilling	Prepare mechanical drawings for 3D printing (STL, G-Code) 4 Points
6	Introduction to circuits and wiring	● Passive circuit elements ● Read resistor value from color code ● Using breadboards ● TinkerCad	No Homework
7	Circuits wiring	● Conductors and resistivity - AWG ● Basic circuit wiring ● Soldering	Homework on the topic 4 Points
8	Ohm's law, KVL and KCL	● Demonstrate the effect of current limitation on the brightness of LEDs ● Use of Digital Multimeter	Homework on the topic 4 Points
9	Power supplies and DMM	● Understanding the difference between AC and DC. ● Understanding the battery charge capacity ● Using batteries and AC adapter to power multiple circuit components ● Power rating ● Use of Digital Multimeter	Homework on the topic 4 Points
10	Microcontroller I	● Introduction to Arduino ● Arduino coding (syntax) ● Understanding the difference between analog and digital inputs	Work on wiring and coding Arduino for final product

Week	Topic	In-Class Activity	Assignments
		● Converting analog reading into voltage value ● Understanding the concept of duty cycle (PWM) ● Connecting an Arduino to a breadboard for lighting an LED	Homework on Arduino wiring and coding to achieve one function 4 Points
11	Microcontroller II	Students may select one of the applications below for in-class activity in addition to using Arduino measure potentiometer readings. ● Using Arduino with a thermistor to measure body temperature ● Using an Arduino to control the speed of a DC motor – mechanical ● Using Arduino to control Servo and Stepper motors	Homework on Arduino wiring and coding to achieve multiple functions 4 Points
12	Troubleshooting strategies Final product	● Use of Multimeter for testing and troubleshooting ● Working on Final Product Understanding the troubleshooting process. ● Working on Final Product	Homework on using DMM 4 Points
13	Final product	● Presentation and Demonstration of Final Product	Finalizing the prototype: packaging, testing and evaluation 15 Points Final report documenting the design process is due on 12/10 by midnight. 10 points for demonstrating the product functions 15 Points for the final report