University of California, Berkeley
Department of Mechanical Engineering

ME 100 – Electronics for the Internet of Things (4 units)

Undergraduate Required

Syllabus

CATALOG DESCRIPTION

Electronics and Electrical Engineering has become pervasive in our lives as a powerful technology with applications in a wide range of fields including healthcare, environmental monitoring, robotics, or entertainment. This course offers a broad survey of Electrical Engineering ideas to non-majors. In the laboratory students will learn in-depth how to design and build systems that exchange information with or are controlled from the cloud. Examples include solar harvesters, robots, and smart home devices. In the course project, the students will integrate what they have learned and build an Internet-of-Things application of their choice. The course has a mandatory lab fee.

COURSE PREREQUISITES

E7 or CS10 or CS61A or DS8 equivalent background in computer programming

Math 1a or equivalent background in Calculus

Physics 7A or equivalent background in Physics

TEXTBOOK(S) AND/OR OTHER REQUIRED MATERIAL

None. Lecture notes and other reading material will be provided.

COURSE OBJECTIVES

Electronics has become a powerful and ubiquitous technology supporting solutions to a wide range of applications in fields ranging from science, engineering, healthcare, environmental monitoring, transportation, to entertainment. This course teaches students majoring in these and related subjects how to use electronic devices to solve problems in their areas of expertise. Through the lecture and laboratory, students gain insight into the possibilities and limitations of the technology and how to use electronics to help solve problems. Students learn to use electronics to interact with the environment through sound, light, temperature, motion using sensors and actuators, and how to use electronic computation to orchestrate the interactions and exchange information wirelessly over the internet. The course has two objectives: (a) to teach students how to build electronic circuits that interact with the environment through sensors and actuators and how to communicate wirelessly with the internet to cooperate with other devices and with humans, and (b) to offer a broad survey of modern Electrical Engineering including analog electronics: analysis of RLC circuits, filtering, diodes and rectifiers, op-amps, A2D and D2A converters; digital electronics: combinatorial and sequential logic, flip-flops, counters, memory; applications: communication systems, signal processing, computer architecture; basics of manufacturing of integrated circuits.

DESIRED COURSE OUTCOMES

- Use and program low-cost and low-power microcontrollers for sensing, actuation, and information processing, and find and use program libraries supporting these tasks; representation of information using digital and analog signals;

- Deploy electronic sensors and interface them to microcontrollers through digital and analog channels as well as common protocols (I2C, SPI);
- Interface DC motors, steppers and servos to microcontrollers; Interact with the internet and cloud services using protocols such as http, MQTT, Blynk,
- Understand concepts from modern communication systems work: coding, security, modulation, etc
- Understand concepts from signal processing: filtering, analog computation, sampling, D2A and A2D conversion
- Understand concepts from digital electronics: gates, combinatorial logic, flip-flops, sequential logic etc
- Learn about computer architecture: memory, registers, CPUs
- Understand the basics of how semiconductor devices are manufactured: lithography, patterning, packaging.

TOPICS COVERED

- RLC circuits, analysis, diodes, opamps, measurement of voltage, current, power, DC and sinusoidal analysis, phasors, impedance
- low-cost and low-power microcontrollers for sensing, actuation, and information processing, programming these devices, communication interfaces (I2C) , protocols (MQTT)
- modern communication systems work: coding, security, modulation, etc
- signal processing: filtering, analog computation, sampling, D2A and A2D conversion
- digital electronics: gates, combinatorial logic, flip-flops, sequential logic etc
- computer architecture: memory, registers, CPUs
- semiconductor manufacturing: lithography, patterning, packaging.

CLASS/LABORATORY SCHEDULE

3 hours of lecture/week; 3 hours of lab/week; 2 hours discussion/week

CONTRIBUTION OF THE COURSE TO MEETING THE PROFESSIONAL COMPONENT

Internet of things is a fast growing industry valued at 120B$ in 2016. This course teaches students to design and build IoT electronic systems for diverse consumer and industrial applications.
This course also prepares our students to take multidisciplinary jobs in the Bay Area Semiconductor Manufacturing Industry allowing them to apply and combine electrical engineering with their broader mechanical engineering skill sets.
Finally, many of our students work in start-ups, where understanding of basic electrical engineering concepts is essential.

RELATIONSHIP OF THE COURSE TO ABET PROGRAM OUTCOMES

(c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability

(e) an ability to identify, formulate, and solve engineering problems

(g) an ability to communicate effectively

(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

ASSESSMENT OF STUDENT PROGRESS TOWARD COURSE OBJECTIVES

Homework 15%
Two Midterm 40%
Final Project 25%
Laboratory 20%
No Final Exam because of Project

SAMPLE OF WEEKLY AGENDA

Week	Topic	Lab
1	What is IoT Programming environments Voltage, current, power, energy	No lab
2	Resistive circuits, Nodal analysis, Thevenin equivalent circuits	uC programming environment, connect to internet (wifi, http), MQTT
4	Diodes, rectifiers, Op-Amps; analog computation	Solar cell characterization, maximum power transfer, competition to get max power out?
5	RLC circuits, filtering, impedance	Sensor interfaces:I2C, SPI, UART
6	Communication systems: bandwidth, multiplexing, coding	Sensors: Temperature, humidity, light, inertial, sound, Magnetic proximity sensor
7	Digital signals Digital I/O, pull-ups,	IMU, inclinometer for 2-wheeled robot; Motor control, position and speed feedback
8	Signal processing: filtering, coding, D2A	Control by smartphone Ex: LOFI control, Blynk, blockly
9	Combinatorial logic; gates, A2D	Sound I/O; Strain gauges
10	Sequential logic: flip flops, counters	Analog I/O; ADC, DAC, PWM
11	Actuators; DC motors, encoders; Servos, stepper motors	Project
12	Human interface Smartphone, LOFI control or Blynk	Project
13	Semiconductor Manufacturing	Project
14	Computer architecture, memory, RISC	Project
15	RRR	Project demos

PERSON(S) WHO PREPARED THIS DESCRIPTION
Kameshwar Poolla, September 11, 2018

ABBREVIATED TRANSCRIPT TITLE (19 SPACES MAXIMUM): Electronics for IOC
TIE CODE: LECS
GRADING: Letter
SEMESTER OFFERED: Fall and Spring
COURSES THAT WILL RESTRICT CREDIT: EE 49
INSTRUCTORS: Poolla
DURATION OF COURSE: 15 Weeks
EST. TOTAL NUMBER OF REQUIRED HRS OF STUDENT WORK PER WEEK: 12
IS COURSE REPEATABLE FOR CREDIT? No
CROSSLIST: None