

Engineering 015 Fundamentals of Digital and Embedded Systems

Course Description

This course will introduce students to the fundamentals of digital and embedded systems. Digital topics covered will include Boolean algebra, binary arithmetic, digital representation of data, gates, and truth tables. Students will also learn basic programming skills, and apply those skills to build embedded systems. Embedded topics include the link between hardware and software, analog to digital and digital to analog systems, and an introduction to actuators (LED's, speakers, servo motors, etc.) and sensors (buttons, accelerometers, microphones, etc.). In the laboratory students will implement a variety of systems with physical inputs and outputs. The course concludes with a self-chosen project.

Learning Outcomes

By the end of this course, students should be able to:

1. Write their own programs for the Circuit Playground from scratch:
 - a. use all built-in components such as neopixels and buttons
 - b. control the flow of a program using if statements, for/while loops, timers, and interrupts
 - c. perform computations using variables and arrays
 - d. print strings/results and debug code using the Serial monitor
 - e. interface with external sensors and actuators using pulse width modulation and communication protocols such as I2C, SPI, and UART.
 - f. write custom functions and libraries for additional functionality
2. Explain how information is represented by computers:
 - a. Explain the base system and how it is used to represent decimal, binary and hexadecimal numbers.
 - b. Convert numbers between decimal, binary, and hexadecimal representations.
 - c. Define the range of variable types such as booleans, bytes, (un)signed integers, and floats, and explain their potential use cases.
 - d. Determine the value of a signed variable from its binary or hexadecimal representation.
3. Analyze and design digital circuits:
 - a. Given a schematic of a combinational circuit, determine its truth table.
 - b. Design a minimal sum-of-products circuit that implements a given truth table.

- c. Implement a design using higher level elements such as multiplexers, demultiplexers, adders...
 - d. Start with a verbal description of a sequential operation, make an appropriate state diagram and design a circuit that performs the operation.
- 4. Put embedded and digital systems in broader social context:
 - a. Identify examples of embedded/digital systems in everyday life.
 - b. Evaluate the impact of embedded/digital systems such as "Internet of Things" devices, robots, and surveillance technology on different aspects of society.
 - c. Design and build a prototype embedded system to solve a real world problem they are passionate about.

Instructor Information

Lecture:

Prof. Maggie Delano

Office: Remote

Office Hours: Mondays 3pm-5pm EDT,
and [by appointment](#) (email me if none of
those times work)

Email: mdelano1@swarthmore.edu

Lab:

Prof. Erik Cheever

Office: Remote

Office Hours: Check schedule on my
[web page](#)

Email: echeeve1@swarthmore.edu

Support Staff

Academic Support:

Ann Ruether

Office: Remote

Office Hours: [See my schedule to
make an appointment](#)

Email: aruethe1@swarthmore.edu

Wizards:

Hannah Bartoshesky

Dawson Epstein

Rekha Crawford

Wizard Sessions:

Sunday 1pm-3pm EDT

Monday 7pm-9pm EDT

Course Logistics

The course is 1 credit and is an NSEP.

Prerequisites:

None

Lecture Time / Location:

11:45 am -- 1:00 pm Tuesdays and Thursdays

The Zoom link is available on Moodle.

Lab Time / Location:

1:15 pm -- 4:00 pm Mondays or Wednesdays (you should receive an email before classes start to assign lab groups - note that labs begin the second Monday of classes). You will come to your lab section every other week.

Moodle:

All course handouts, homework, solutions, and labs will be posted on the course Moodle page.

Homework:

Homework is due by 11:40 am Tuesday morning and should be uploaded to Moodle as a legible, single PDF; JPEGs will not be accepted. We recommend cell phone apps like CamScanner for handwritten diagrams. Code can be uploaded as sketch files (.ino).

Late Homework Submission:

It is important that homework be turned in on time when possible to allow the course graders to provide students with timely feedback and for the course staff to know how students are doing. There is a grace period of one hour after the lecture ends to submit homework. After that, there will be a 10% late penalty for each day an assignment is late. If circumstances prevent you from completing an assignment on time, please request an extension *before* the assignment deadline if possible. Prof. Delano will work with you to determine a new due date based on your individual circumstances.

Collaboration Policies:

You are encouraged to discuss homework with your classmates; however, the solutions you write up must be your own work. ***Explicit copying or sharing is not allowed.*** Please list any collaborators and any references (including online resources) other than the assigned material that you accessed at the top of your homework.

Labs will be completed among assigned lab groups. You may discuss your lab report with other groups, but you may not copy anything from their reports. Each group will submit a single report (with all members of the group listed) as a pdf on moodle.

Laptops:

We will be using laptops for in class exercises. Please call into the zoom from your laptop. If you do not have a laptop readily available for in class use, please contact Prof. Delano as soon as possible.

Lecture/Pre-lecture assignments

Attendance in lecture is highly encouraged, but not required. It is the responsibility of each student to ensure that they are taking advantage of the available resources of the course (lectures, wizard sessions, office hours). Participation for the course will be assessed via pre-lecture quizzes. Each quiz will clearly state how points for that quiz will be allotted.

Lab attendance policy:

You will be expected to come to your assigned lab time. See [lab moodle page](#) to find out which group you are in; it may be different than the one you signed up for, but we will ensure that it fits your schedule. If you are in a time zone that is much different than the college time zone, you will work with Professor Cheever and those in your lab group, to find a time to meet.

Grading:

Homework: 20%

Labs: 20%

Final Project: 25%

Exams: 25%

Participation: 10%

Help Seeking

There are a variety of resources available for help throughout the course, including faculty office hours, wizard sessions, email, and scheduled appointments with relevant course staff.

Instructor Office Hours

Prof. Delano and Prof. Cheever's office hours are intended for questions related to the course material and/or assignments. We also welcome conversation about topics broadly related to the course material, such as engineering in general, career advice, etc. You may come to office hours at any time during the listed time slot.

Piazza

We have created a dedicated Piazza page for ENGR 015 students. Piazza is an online platform for getting help with concepts from lecture/lab and homework assignments. The system is highly catered to getting you help fast and efficiently from classmates and the course staff. ***Please post all your questions that come up outside of scheduled sessions to Piazza; do not email instructors or wizards.*** A link to the Piazza can be found on Moodle.

Wizards

Wizards will host weekly wizard sessions (**times TBD**). Wizard sessions are not a substitute for attending class. You should have looked at your assignment and attempted the problems before going to the help sessions. ***Do not contact wizards by email with questions; use Piazza.***

Academic Support Coordinator

Ann Ruether, Academic Support Coordinator, will attend all lectures and can help you find additional resources for supporting your learning. Ann works with the Student Disability Services office on accommodations requests and also coordinates with the Dean's office to provide tutoring resources. She will be happy to discuss any requests with you.

Scheduling Appointments

The instructors and academic support coordinator are available for one-on-one appointments on a case-by-case basis. ***Please include multiple times you are available to meet in your email.***

Course Schedule

The course schedule can be found on Moodle and is subject to change. Please check Moodle frequently for the latest version.

Accommodations

If you believe you need accommodations for a disability or a chronic medical condition, please contact Student Disability Services via email at studentdisabilityservices@swarthmore.edu to arrange an appointment to discuss your needs. As appropriate, the office will issue students with documented disabilities or medical conditions a formal Accommodations Letter. Since accommodations require early planning and are not retroactive, please contact Student Disability Services as soon as possible. For details about the accommodations process, [visit the Student Disability Services website](#). You are also welcome to contact Prof. Delano or Prof. Cheever privately to discuss your academic needs. However, all disability-related accommodations must be arranged, in advance, through Student Disability Services.