CS 1600 Syllabus

Last revised 9/2/21 8:15 pm

Subject to change (see "classroom community" section)

Milda Zizyte (she/her)

Course Information

This course introduces the concepts necessary to write software for embedded and real time systems, such as those found in Internet of Things devices, robots, and cars. The course emphasizes how embedded systems differ from traditional software systems and how these differences translate to challenges in the design, development, testing, and deployment of these systems. How do you design software that may be constrained by power and memory usage and timing? What about software that needs to interface with sensors and other devices in the "real world," and that may have safety implications if it malfunctions? How do you model and verify devices that are interacting with the physical world? This course aims to teach you specific engineering skills and considerations so that you can address these challenges.

Time: 3:00-5:30 F
Lab sections: 4:00-6:00 Tu *OR* Th

Course Objectives

- Recognize the purpose of embedded and real-time software
- Understand the resource constraints specific to embedded software systems
- Engineer complex systems that may be connected to multiple sensors and actuators working together
- Apply principles of software engineering to developing embedded systems, including specific practices for safety-critical systems
- Use models of embedded systems to verify properties of the systems
- Recognize the societal impacts of designing and writing embedded software
- Engineer an embedded system project developed in collaboration with others, by applying principles learned in the course

Book and materials:

Introduction to Embedded Systems by Lee and Seshia (available for free online)
Supplemental reading and materials will be made available
Arduino MKR IoT Bundle (available at the bookstore or online)

Schedule

Because the class sections are a single block once per week, class sessions will involve participation/group discussion along with some instruction. Homework will be due before the class session and aims to prepare you for getting the most out of class.

Assignments and labs subject to change

Day	Topics	Lab	Homework
9/10	Introduction to embedded and real-time systems	1 Introduction to Arduino	None due; in-class warmup exercise
9/17	Sensors and I/O	2 Sensors, LEDs, and PWM	1 ADC and signals
9/24	Embedded programming and memory	3 Assembly and registers	2 Memory and register layout exercise
10/1	Scheduling, concurrency, timers, and interrupts	4 Interrupts and watchdog timers	3 Scheduling exercises
10/8	Embedded design and engineering	5 Code style, peer review, and traceability	**Project proposals**
10/15	Networking and distributed systems	6 WiFi	4 Distributed computing challenges
10/22	Test and Debug	7 Testing, traceability part 2	5 Unit test writing
10/29	RTOS	**Project check-in**	**Project midpoint report**
11/5	Safety, security, and privacy	8 Runtime monitoring	6 Cautionary tales
11/12	Modeling	Project work	7 Modeling exercise
11/19	Verification	Project work	8 Verification exercise
11/26	***NO CLASS***	--	--
12/3	Wrapup/project presentations*	--	**Project report**
12/10	***Reading period***	--	**Project revisions**

Assessments

Homework - 30% (weighted evenly, 2 dropped)
Labs - 30% (weighted evenly)
Project - 40% (proposal: 5%, midpoint demo and report: 10%, final demo 10%, final report 15%)

Homework

Homework exercises are due by noon of the corresponding class day. For most homeworks, students will be asked to create a short (1-2 slide) presentation answering question prompts or exercises based on readings/videos. In class, students will be called on to present their homework and participate in group discussions. Homework is graded on “good faith” effort/completion, rather than correctness. Because homeworks are vital to the in-class participation of the corresponding class session, there are no late homeworks accepted.

Labs

Labs will primarily be done during the lab section, with a TA checking off progress . A short document is due at the completion of each lab. We will provide a rubric along with each lab that clearly defines the grading for the lab. Labs are intended to be done in pairs, but we will accommodate one-person groups for asynchronous learners or because of social distancing concerns.

Labs are due by the end of the following lab session (For example, if you attend Lab 1 on Sep 14, you would have to be checked off by Sep 21 to be considered on time). Each additional week late incurs a 10% penalty on the grade of the lab.

To be determined: to promote safer practices in the time of Covid, we may offer a synchronous lab session time via Zoom.

Project

A major component of the course is a group project that draws on principles taught in class. A project proposal and mid-point demo and report are due during the semester, and a final demo and report are due at the end of the semester.

In lieu of a final exam, the reports are the conduit by which you can provide evidence that you met the learning objectives of the course. To give you a fair chance at communicating this, the reports will ask you to answer specific questions about how your project meets these objectives. The reports will initially be graded before reading period, and you will be given the opportunity to expand on any questions raised in feedback.

Late projects are not accepted except by exceptional circumstances at the discretion of the instructor.

Classroom Community

While this course number and title has been offered at Brown before, this particular iteration presents the material in a completely new way. I (Milda) am a new instructor at Brown, so I suspect there will be a few hiccups along the way. My intention is to build trust with you so that we can communicate about these hiccups and smooth them out. As such, I will actively be asking for and **following up on** your feedback about the course (with the intent of demonstrating to you that your feedback is valuable). The policies in this document are subject to change based on our discussions, and will be communicated clearly ahead of time. One of the discussions in the first class session will be your first opportunity to offer ideas and feedback.

Remote Asynchronous Option

The course can be taken Remote Asynchronous if necessary. Because of the large participation component, class attendance is **strongly encouraged** for anyone who is in town. To receive participation credit for the homework exercises remotely, you will be asked to turn in videos of any homework presentations or responses to discussion questions, *one day prior* to class. You will also be asked to respond to your classmates' classroom discussions in writing prompts.

Assignments will be posted well before the due dates to accommodate the earlier deadlines for the remote asynchronous option.

You will be expected to make time to meet with your group members for your project regularly, and attend class (possibly remotely) in real time for the project midpoint and final demo.

The course staff is willing to discuss accommodations for these expectations, especially for students in different timezones.

Diversity, Equity, and Inclusion

Engineering, including software engineering for embedded and real-time systems, involves working with people to create artifacts that will be used by people. As we will see in this course, it is vital to be conscientious of how we work with others and how the things we build will impact others and society as a whole.

This course has a major participation and collaboration component. My goal is to foster a welcoming and inclusive environment, where your identities and experiences are honored. If you do not feel like this is the case at any point in the course, please let the course staff know.

I am always open to inspecting my own biases or changing the course content/format to better suit students' needs. If you have concerns, again, please reach out to me personally or submit anonymous feedback.

Accessibility and Accommodations

Brown University is committed to full inclusion of all students. Please inform me early in the term if you may require accommodations or modification of any of course procedures. You may speak with me after class, during office hours, or by appointment. If you need accommodations around online learning or in classroom accommodations, please be sure to reach out to Student Accessibility Services (SAS) for their assistance (seas@brown.edu, 401-863-9588). Undergraduates in need of short-term academic advice or support can contact an academic dean in the College by emailing college@brown.edu. Graduate students may contact one of the deans in the Graduate School by emailing graduate_school@brown.edu.

Class Recording

The lecture portion of the class will be recorded automatically using lecture capture. These recordings will be made available to students registered in the class.

Academic Integrity/Collaboration Policy

This class encourages collaboration and cooperation, but also expects that you submit your own work for individual projects. The distinction between individual assessments and group work will be made clear for all assignments.

From the University's Academic Code (page 5), "A student's name on any exercise (e.g., a theme, report, notebook, performance, computer program, course paper, quiz, or examination) is regarded as assurance that the exercise is the result of the student's own thoughts and study, stated in his or her own words, and produced without assistance,

except as quotation marks, references, and footnotes acknowledge the use of printed sources or other outside help."