ECE336 (CSE 336) Embedded Systems

Dr. Y. Rosa Zheng, Fall 2019

Instructor's Contact Information:
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Course Information:
HW platform: ARM Cortex-M
Software language: C/C++
Class Time: MW, 15:00 – 16:15
Location: 331 Packard Lab

Course Description

Course Catalog Description: Use of small computers embedded as part of other machines. Limited-resource microcontrollers and state machines from high level description language. Embedded hardware: RAM, ROM, flash, timers, UARTs, PWM, A/D, multiplexing, debouncing. Development and debugging tools running on host computers. Real-Time Operating System (RTOS) semaphores, mailboxes, queues. Task priorities and rate monotonic scheduling. Software architectures for embedded systems.

A student-friendly description: An embedded system is a system that performs a specific task and has a computer embedded inside. A system is comprised of components and interfaces connected together for a common purpose. We interact with embedded systems every day in our houses, our cars, our toys, and our work. These systems perform some specific tasks: some can be as simple as a smart door lock, a wash machine, or a microwave oven, and some can be as complicated as a cell phone. In this course, we will learn the hardware architecture, development tools, and software programming of a small embedded micro-controller from Texas Instrument (TI) Inc., and have fun learning it with an entrepreneurship mindset.

Course Learning Objectives

By the end of this course, students will be able to understand the basic components of a micro-controller (micro-computer), write C language programs that perform hardware and software functions, such as using data structures, manipulating numbers in multiple formats, storing permanent and/or temporary information, and controlling input and output (I/O), etc. Students will also be able to use an Integrated Development Environment (IDE) tool for programming, debugging and optimization.

Prerequisites

Course: CSE 017 Programming and Data Structures: Algorithmic design and implementation in a high level, object oriented language, such as Java, Python, or Matlab. Classes, subclasses, recursion, searching, sorting, linked lists, trees, stacks, queues.

Skills: basic math and discrete-time linear systems, programming and debugging in Matlab, Python, or C/C++.

Required Texts or Tools

*Required hardware platforms:
Every team of two students is also required to have a microcontroller development board. You may purchase from one of the three development boards:

- EK-TM4C123GXL Tiva™ C Series TM4C123G LaunchPad Evaluation Kit (http://www.ti.com/tool/EK-TM4C123GXL), $12.99 at ti.com or
- Sensor Hub BoosterPack (http://www.ti.com/tool/BOOSTXL-SENSHUB) $49.99 at ti.com, has LaunchPad & sensor hub included, or
- EK-TM4C1294XL Connected LaunchPad™ Evaluation Kit ($19.99 at ti.com).

*Two textbooks are recommended:

1. Jonathan W. Valvano, "Embedded Systems: Introduction to ARM Cortex-M Microcontrollers," Book 1, Kindle Edition, $9.99 on Amazon.
2. Jonathan W. Valvano, "Embedded Systems: Real-Time Operating Systems for ARM Cortex-M Microcontrollers," Book 2, Kindle Edition, $9.99 on Amazon.

*Other reference books and websites:

- J. W. Valvano and R. Yerraballi, "Embedded Software in C for an ARM Cortex M," 2015, [online] available at http://users.ece.utexas.edu/%7Evalvano/embed/toc1.htm
- Design News, https://www.designnews.com/
- Texas Instruments, http://www.ti.com/. Create an account at myTi.com for purchase and software download.

Policies

Expectation: When in class, please turn off all notifications on cell phones, laptop computers, and other devices that flash, ring, buzz, or otherwise might disrupt the class. You are expected not to be distracted by social media or unrelated browsing.
Group work: Lab projects and their corresponding reports are to be done in groups. Each group consists of two students and shall submit only one copy of programs and report for each project. To receive credit for a lab exercise, both members of the group must attend the classes allocated to the lab exercise. Peer-rating forms and instructor observation will also be used to account for individual effort.
Grading Scale: Lab projects: 50%, exams: 45%, attendance: 5%

Final grades are assigned as

94-100 = A	90-93 = A-	
87-89 = B+	84-86 = B	80-83 = B-
77-79 = C+	74-76 = C	70-73 = C-
67-69 = D+	64-66 = D	60-63 = D-
<60 = F		

Attendance: You are expected to attend every lecture and lab session. You are solely responsible for anything you miss, including announcements, handouts, assignments, quizzes, programming exercises, exams, and course topics discussed in the class.

Late Papers or Missed Exams

- Late submission of project report is accepted but will be given 20% penalty per day.
- Exams are to be done by each individual student. Makeup exams will not be given unless you have a very unusual excuse with the instructor's permission in advance, or a documented medical/family emergency.

Logistics and Important Dates:

Each team will develop one set of programs and write one report for each project. Submit the report and the programs at Course Site by one team member. Each student is also required to submit a peer rating form for each project at Course Site.

For pacing break, holidays, and religious observations, etc, check the website:
http://www.lehigh.edu/registrar/cal_sched/academic_cal.html

Student Senate Statement on Academic Integrity

> We, the Lehigh University Student Senate, as the standing representative body of all undergraduates, reaffirm the duty and obligation of students to meet and uphold the highest principles and values of personal, moral and ethical conduct. As partners in our educational community, both students and faculty share the responsibility for promoting and helping to ensure an environment of academic integrity. As such, each student is expected to complete all academic course work in accordance to the standards set forth by the faculty and in compliance with the University's Code of Conduct.

The work you do in this course must be your own. This means that you must be aware when you are building on someone else's ideas—including the ideas of your classmates, your professor, programs on the internet, and the authors you read—and explicitly acknowledge that you are doing so. Feel free to build on, react to, criticize, and analyze the ideas of others but, when you do, make it known whose ideas you are working with. If you ever have questions about drawing the line between others' work and your own, ask me and I will give you clear guidance or you may visit Lehigh Library's 'Proper Use of Information' page at
http://libraryguides.lehigh.edu/plagiarism

If you find that your paper has unoriginal text that is not properly cited, you should either cite the source or remove the text. If you remove or reword the unoriginal text, but retain the *idea* expressed by the source, you still must give a citation that names the source (paraphrasing without citation is not sufficient). If you do leave the uncited work in your paper, you are likely committing plagiarism. Remember, your work should build on the class discussions, reading, lectures, remarks, etc., but the paper you write *must* be your own work.

Other examples of cheating are

- Submitting a report for which the experiment or the write-up is not done by you.
- Sharing results or notes during exams.
- Stealing other student's results during exams.
- Bring notes, in hard copy or electronic form, to an exam where they are not allowed.
- Continuing work on your exam after we have called for papers.
- Requesting a re-grade on an exam or an assignment that has been altered after grading.
- Copying programs from the internet without crediting the original authors.

It is my hope and expectation that you all abide by the standards of academic integrity and that these procedures will help remind us all of the need for such standards.

The Principles of Our Equitable Community:

The Principles of Our Equitable Community: Lehigh University endorses The Principles of Our Equitable Community (www.lehigh.edu/diversity). We expect each member of this class to acknowledge and practice these Principles. Respect for each other and for differing viewpoints is a vital component of the learning environment inside and outside the classroom.

Accommodations for Students with Disabilities:

Accommodations for Students with Disabilities: If you have a disability for which you are or may be requesting accommodations, please contact both your instructor and the Office of Academic Support Services, University Center C212 (610-758-4152) as early as possible in the semester. You must have documentation from the Academic Support Services office before accommodations can be granted.

Lehigh University Policy on Harassment and Non-Discrimination

Lehigh University upholds The Principles of Our Equitable Community and is committed to providing an educational, working, co-curricular, social, and living environment for all students, staff, faculty, trustees, contract workers, and visitors that is free from harassment and discrimination on the basis of age, color, disability, gender identity or expression, genetic information, marital or familial status, national or ethnic origin, race, religion, sex, sexual orientation, or veteran status. Such harassment or discrimination is unacceptable behavior and will not be tolerated. The University strongly encourages (and, depending upon the circumstances, may require) students, faculty, staff or visitors who experience or witness harassment or discrimination, or have information about harassment or discrimination in University programs or activities, to immediately report such conduct.

> **If you have questions** about Lehigh's Policy on Harassment and Non-Discrimination or need to report harassment or discrimination, contact the Equal Opportunity Compliance Coordinator (Alumni Memorial Building / 610.758.3535 / eocc@lehigh.edu)