

Syllabus for EE 109L – Spring 2018

General Information

Lectures:	Section 31395 (Redekopp):	VHE 205, 11:00-12:20 TTh
	Section 31291 (Weber):	VHE 205, 12:30-1:50 TTh
	Section 31019 (Annavaram):	VHE 205, 2:00-3:20 TTh
Labs:	Section 30799:	VHE 205, 12:30-1:50 W
	Section 31396:	VHE 205, 2:00-3:20 W
	Section 31292:	VHE 205, 12:30-1:50 F
Quiz:	Section 30530:	7:00-8:50 PM W

Instructors:	Prof. Murali Annavaram	Prof. Mark Redekopp	Dr. Allan Weber
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Office Hours:	TBD	M,W: 11-12, M: 1-2:30 Th: 1-1:40, F: 1-3	M: 10-12, W: 11-12 Th: 3:30-4:30

Class web site: <http://bytes.usc.edu/ee109>

Overview and Objectives

This course introduces students to the fundamental concepts of computer systems and computer engineering **using embedded systems as a vehicle**. Concepts include information representations, embedded C language constructs, state machines, and fundamental circuit analysis. Specific embedded topics will include digital I/O, serial I/O protocols, analog-to-digital conversion and interrupt mechanisms. A lecture/lab course format will be employed to provide hands-on experience and active learning techniques. Upon completion of this course students will be able to:

1. Understand how digital systems represent information
2. Understand the execution model of a modern computer system
3. Design and implement combinational logic circuits
4. Design and implement sequential logic circuits and FSMs
5. Utilize a microcontroller to sense and activate digital signals
6. Utilize a microcontroller to perform analog-to-digital and digital-to-analog conversion
7. Use state machines as a system design tool
8. Write interrupt-driven and timer-driven programs
9. Design a non-trivial embedded project

Prerequisites and Corequisites

All students must either have taken or be concurrently taking a C/C++ programming course like EE 155, CSCI 103 or ITP 165, or be proficient in one of these programming languages before taking EE 109.

Course Material

The required textbook for the course is **Digital Design with RTL Design, VHDL and Verilog, Second Edition** by Frank Vahid (Wiley, 2011, ISBN 978-0470531082).

Recommended books are **Make: AVR Programming** by Elliot Williams (Maker Media Inc., 2014, ISBN 978-1449355784) and **Computer Organization and Design, Fifth Edition: The Hardware/Software Interface** by Patterson and Hennessy (Morgan Kaufmann, 2013, ISBN 978-0124077263).

Each student will be required to have an Arduino Uno (Rev. 3) microcontroller development board for use in doing the lab assignments. These will be available for purchase for \$25 during one of the lab sessions or can be obtained from other sources. Students will be provided with a project box of tools and electronic components that will be used throughout the semester for lab exercises. The project boxes and all tools and components that have been borrowed must be returned at the end of the semester.

Format of Class

We will use a lecture/lab format to create a classroom environment where the instructor facilitates active student participation in their own learning process. Students are expected to set their own learning goals (i.e., be curious) and then actively pursue those goals both in and out of the classroom through personal study, programming, and in-class activities. Simply showing up to class is not enough; come to class ready to think, ask questions, and work with your fellow students. Small in-class and out-of-class activities (both individual and group-based) will be provided to help facilitate achievement of learning goals. Students are expected to bring their laptop and their project boxes to each lecture and lab so we can do hands-on experiments at any time.

Collaboration Web Site

The class will be using the Piazza collaboration web site to facilitate communication between students and between students and the instructors. All students will receive an email shortly after the start of semester with a link for enrolling in the class Piazza page. Students are encouraged to use Piazza for class-related communication with the instructors. Posting to the Piazza site is preferred over email for discussion topics since you have the option of allowing other members of the class to join in the conversation.

Lab Assignments

There will be approximately ten lab assignments. Lab assignments are larger, more comprehensive, assignments that should challenge you to integrate hardware and software concepts. Some may involve designing and building circuits, other may be software exercises using a simulator. Labs are assigned during the Wednesday and Friday lab sessions and are **due one week later** on the following Wednesday or Friday. By the due date you must demonstrate its functionality to one of the instructors or teaching assistants. The teaching assistants hold office hours in the VHE 205 classroom and are available to help you with the assignment whenever they are there. A schedule of TA hours is posted on the class web site and in the classroom. If you wait to demonstrate your assignment until your scheduled lab section on the due date, you can only demonstrate the lab assignment. **Assistance with the assignment will not be given in the lab section on the due date.** Material that must be turned in (write-ups and/or program source code) must be submitted online by midnight Friday of the week the assignment is due.

Lab assignments are to be completed individually unless otherwise noted (a few group assignments may be scattered throughout the semester.) Students are expected to write their own software for all

assignments. Copying (and then modification) of any portion of code from Internet sources or fellow students is prohibited unless cleared with the instructor. See the Statement on Academic Conduct (Page ??.)

Homeworks

There will be a few written homeworks throughout the semester. Assignments will be made available on the course web site and are due one week after it is made available unless indicated otherwise by the instructor. The instructor will decide if the homeworks are to be submitted via Blackboard or hard-copy.

Show how you solved the problem on all non-trivial problems. Homework should be done in a neat and orderly fashion that is easy for the grader to understand. The grader is not obligated to spend time trying to decipher your handwriting or search for your answers. Solutions to the homework problems will be available on the class web site within a couple of days after the due date.

Exams

There will be two midterm exams. Both exams will be held during the Quiz sections (Wednesdays, 7:00 to 8:50 PM). The dates of the midterms are shown on the attached schedule but may be moved to a different date. The exams may also be moved to a different classroom. Always check with the instructor as the listed exam date approaches to confirm the date and time. The exam dates will be announced in class and on the web site. You are responsible for finding out when and where the exams will be held. Makeup exams will be given if you have a valid excuse (e.g. serious illness or accident, urgent trip, but proof will be required).

Project

During the last three or four weeks of the semester students will work on a project selected by the instructor. The project will incorporate several of the hardware and software concepts covered in the preceding weeks. The deadline for having the project evaluated by the instructors is **Friday, April 27th**. All source code must be submitted by **11:59 PM, Wednesday, May 9th**.

Projects will be evaluated not just on whether or not it works, but to a large extent on the quality of the hardware and software incorporated in it. A project that appears to have been designed and built by a professional engineer will get higher marks than one that looks like it was thrown together over a weekend with little concern for professional standards.

Grades

The following point structure will be used in determining the grade for the course. Final grade will be based upon the total points received, the highest total in the class, and the average of the class.

Homeworks	10%
Labs	30%
Project	10%
Quiz	5%
Midterm 1	20%
Midterm 2	25%
Total	<u>100%</u>

Weekly Schedule

Week	Tuesday	Lab	Thursday
1 1/8 - 1/12	Orientation, embedded systems, computer organization	Linux tutorial, software installation	Basic circuit analysis (voltage, current, Ohm's law)
2 1/15 - 1/19	Circuits (LED, switches), digital circuits, transistors	Exploration of KVL/KCL/Ohm's laws	Digital logic, combinational and sequential circuits
3 1/22 - 1/26	Number systems, binary, hexadecimal, character codes	Oscilloscopes, combinational gate network, delays	Single variable Boolean algebra, microcontroller 1 (bitwise operations)
4 1/29 - 2/2	Microcontroller 2 (digital I/O)	Digital I/O lab with Arduinos	Microcontroller 3 (advanced bit fiddling), state machines
5 2/5 - 2/9	LCDs and parallel interfaces	LCDs	Combinational logic design 1 (decoders and muxes)
6 2/12 - 2/16	Combinational logic design 2 (minterms, canonical sums)	State machines	Quiz Combinational logic design 3 (2 & 3 variable Boolean algebra)
7 2/19 - 2/23	Combinational logic design 4 (Karnaugh maps)	ADCs	Combinational logic design 5 (K-maps and memories)
8 2/26 - 3/2	Binary systems (signed), arithmetic	Midterm 1	Combinational logic design 6 (adders)
9 3/5 - 3/9	Interrupts	Interrupts	Sequential logic 1 (latches, FFs and registers)
3/12 - 3/16	Spring Break		Spring Break
10 3/19 - 3/23	Sequential logic 2 (presets/clears, counters)	Timers	Interfacing (voltage and current capabilities)
11 3/26 - 3/30	Hardware state machines 1	Serial communications	Hardware state machines 2
12 4/2 - 4/6	Computer organization 1 (ALUs, registers, instruction cycle)	Parallelization	Computer organization 2 (instruction sets, assembly language)
13 4/9 - 4/13	Performance (caching, pipelining)	Project	Processor organization
14 4/16 - 4/20	Hardware accelerators	Project	Parallelism
15 4/23 - 4/27	Midterm review, project work	Midterm 2 Project	Project work

Policies

Withdrawals

Last day to withdraw from the course **without** a mark of W is February 23, 2018. Last day to withdraw from the course **with** a mark of W is April 6, 2018. An incomplete grade can only be assigned if there is a verifiable cause after the 12th week of the semester that prevented you from completing either the final exam or the class project and is acceptable to the instructor, the department and the University.

Academic Conduct

Plagiarism - presenting someone else's ideas as your own, either verbatim or recast in your own words - is a serious academic offense with serious consequences. Please familiarize yourself with the discussion of plagiarism in SCampus in Section 11, Behavior Violating University Standards (<https://policy.usc.edu/student/scampus/>). Other forms of academic dishonesty are equally unacceptable. See additional information in SCampus and university policies on scientific misconduct (<http://policy.usc.edu/scientific-misconduct/>).

Discrimination, sexual assault, and harassment are not tolerated by the university. You are encouraged to report any incidents to the Office of Equity and Diversity (<http://equity.usc.edu>) or to the Department of Public Safety (<http://dps.usc.edu>). This is important for the safety whole USC community. Another member of the university community - such as a friend, classmate, advisor, or faculty member - can help initiate the report, or can initiate the report on behalf of another person. Relationship and Sexual Violence Prevention and Services (<https://engemannshc.usc.edu/rsvp/>) provides 24/7 confidential support, and the sexual assault resource center webpage (sarc@usc.edu) describes reporting options and other resources.

Support Systems

A number of USC's schools provide support for students who need help with scholarly writing. Check with your advisor or program staff to find out more. Students whose primary language is not English should check with the American Language Institute (<http://ali.usc.edu/>), which sponsors courses and workshops specifically for international graduate students. The Office of Disability Services and Programs (<http://dsp.usc.edu/>) provides certification for students with disabilities and helps arrange the relevant accommodations. If an officially declared emergency makes travel to campus infeasible, USC Emergency Information (<http://emergency.usc.edu/>) will provide safety and other updates, including ways in which instruction will be continued by means of blackboard, teleconferencing, and other technology.