

Syllabus for EE 109L – Spring 2022

General Information

Lectures:	9:30-10:50 TTh (31019)	Redekopp	VHE 205
	11:00-12:20 TTh (31395)	Redekopp	GFS 101
	12:30-1:50 TTh (31291)	Qian	THH 210
	2:00-3:20 TTh (30999)	Puvvada	VHE 205
Labs:	12:30-1:50 W (30799)	11:00-12:20 F (31018)	
	2:00-3:20 W (31396)	12:30-1:50 F (30794)	
	3:30-4:50 W (31292)	All labs meet in VHE 205	
Quiz:	7:00-8:50 P.M. W (30530) - only used for quiz and midterm		

Instructors	Email	Phone
Prof. Gandhi Puvvada	gandhi@usc.edu	310-733-8025
Prof. Mark Redekopp	redekopp@usc.edu	213-740-6006
Prof. Feifei Qian	feifeiqi@usc.edu	213-740-4455

See class web site for faculty office hours and locations.

Class web site: <https://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

Students will be provided with a project box of tools and electronic components that will be used throughout the semester for lab exercises. Students are expected to bring their project box to all the lab sessions. The project boxes and all tools and components must be returned at the end of the semester.

There is no required text but we recommend the following:

- **Digital Design with RTL Design, VHDL and Verilog, Second Edition** by Frank Vahid (Wiley, 2011, ISBN 978-0470531082).
- **Make: AVR Programming** by Elliot Williams (Maker Media Inc., 2014, ISBN 978-1449355784)

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.

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. While most engineering labs are 2 hours, your registered lab is only 80 minutes. To maximize the value of in-person time and to make up the difference, we will ask you to watch a 15-25 minute introductory lab video each week **BEFORE** you come to your lab section.

The teaching assistants will be available to help you during your assigned lab session and also hold office hours in VHE 205 throughout the week to help you with the assignment. A schedule of TA hours is posted on the class web site and in the lab classroom.

Lab assignments are to be completed individually. 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. **Labs are compared to current and previous student submissions. Any violation will result in submission to SJACS with a recommended sanction of F in the course.** See the Statement on Academic Conduct (Page 5.)

Labs are assigned during the Wednesday and Friday lab sessions and are **due one week later**. By the due date you must demonstrate its functionality to one of the instructors or teaching assistants. 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. Labs demonstrated on the due date but **after** the registered lab time, or the following day, are subject to a 3 point deduction. Labs demonstrated on the second day after the due date will have 6 points deducted. Labs demonstrated after that will receive no points.

Material that must be turned in (write-ups and/or program source code) must be submitted online by 11:59 P.M. Friday of the week the assignment is due. Labs submitted late are subject to a 10% deduction for each day up to a maximum of 2 days late. Labs submitted after 11:59 P.M. Sunday night will not be accepted.

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. All homeworks will be submitted on Blackboard or Gradescope (see website for each assignment.) Most will use a combination of multiple choice or fill in the blank, while one or two will require scanning hand-drawn diagrams. All diagrams must be drawn neatly! Show how you solved the problem on all non-trivial problems.

Homeworks may be turned in late for up to 2 days losing 20% of the max score per day (even if only a second late). After 2 days we will not accept late submissions. 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 a quiz, a midterm and final exam. The date of the quiz and midterm is shown on the attached schedule but may be moved to a different date. The quiz and midterm will be held during the Quiz section (Wednesday, 7:00 to 8:50 P.M.). The final exam will be held on the date and time specified by the University for our class (**Saturday, May 7th, 2:00-4:00 P.M.**). 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 how 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 the end of your lab session during the last week of the semester. **All source code must be submitted by 11:59 P.M., Saturday, April 30th.**

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	7%
Labs	25%
Project	10%
Quiz	10%
Midterm	20%
Final	28%
Total	<u>100%</u>

Weekly Schedule

Week	Tuesday Lecture	Wednesday/Friday Lab	Thursday Lecture
1 1/10 - 1/14	Orientation, embedded systems, computer organization	Lab 0: Linux tutorial, software installation	Basic circuit analysis (voltage, current, Ohm's law)
2 1/17 - 1/21	Transistors, digital logic, combinational and sequential circuits	Lab 1: Exploration of KVL, KCL, Ohm's laws	Number systems, binary, hexadecimal, character codes
3 1/24 - 1/28	Single variable Boolean algebra, microcontroller 1 (bitwise operations)	Lab 2: Oscilloscopes, combinational gate network, delays	Microcontroller 2 (digital I/O)
4 1/31 - 2/4	Microcontroller 3 (advanced bit fiddling), state machines	Lab 3: Digital I/O lab with Arduinos	LCDs and parallel interfaces
5 2/7 - 2/11	Combinational logic design 1 (minterms/maxterms, Boolean algebra)	Lab 4: LCDs	Combinational logic design 2 (more Boolean algebra, Karnaugh maps)
6 2/14 - 2/18	Combinational logic design 3 (more Karnaugh maps)	Lab 5: State machines 2/16: Quiz	Combinational logic design 4 (components: decoders and muxes)
7 2/21 - 2/25	Interrupts	Lab 6: ADCs	More interrupts, signed number systems
8 2/28 - 3/4	Signed arithmetic and adders	Lab 7: Interrupts	Adder exercises
9 3/7 - 3/11	Sequential logic 1 (latches, FFs and registers)	3/9: Midterm	
3/14 - 3/18	Spring Break	Spring Break	Spring Break
10 3/21 - 3/25	Sequential logic 2 (latches, FFs and registers)	Lab 8: Timers	Hardware state machines 1
11 3/28 - 4/1	Hardware state machines 2	Lab 9: Serial communications	Hardware components (ALUs, registers, instruction cycle)
12 4/4 - 4/8	Processor organization (design of CPU)	Project	Performance (caching, pipelining)
13 4/11 - 4/15	Memory, FPGAs	Project	Interfacing (voltage and current capabilities)
14 4/18 - 4/22	Hardware accelerators	Project	
15 4/25 - 4/29	Embedded failures	Project evaluations	Review

Policies

Withdrawals

Last day to withdraw from the course **without** a mark of W is January 28, 2022. Last day to withdraw from the course **with** a mark of W is April 8, 2022. 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.

Statement on Academic Conduct and Support Systems

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 Part B, Section 11, “Behavior Violating University Standards” (<https://policy.usc.edu/files/2020/07/SCampus-Part-B-2.pdf>). 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>).

Support Systems

Counseling and Mental Health - (213) 740-9355 – 24/7 on call

<https://studenthealth.usc.edu/counseling>

Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention.

National Suicide Prevention Lifeline - 1 (800) 273-8255 – 24/7 on call

<http://suicidepreventionlifeline.org>

Free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week.

Relationship and Sexual Violence Prevention Services (RSVP) - (213) 740-9355(WELL), press “0” after hours – 24/7 on call

<https://studenthealth.usc.edu/sexual-assault>

Free and confidential therapy services, workshops, and training for situations related to gender-based harm.

Office of Equity and Diversity (OED) - (213) 740-5086 | **Title IX** – (213) 821-8298

<https://equity.usc.edu>, <http://titleix.usc.edu>

Information about how to get help or help someone affected by harassment or discrimination, rights of protected classes, reporting options, and additional resources for students, faculty, staff, visitors, and applicants.

Reporting Incidents of Bias or Harassment - (213) 740-5086 or (213) 821-8298

https://usc-advocate.symlicity.com/care_report

Avenue to report incidents of bias, hate crimes, and microaggressions to the Office of Equity and Diversity | Title IX for appropriate investigation, supportive measures, and response.

Office of Student Accessibility Services (OSAS) - (213) 740-0776

(previously called Disability Services and Programs (DSP))

<http://osas.usc.edu>

Support and accommodations for students with disabilities. Services include assistance in providing readers/notetakers/interpreters, special accommodations for test taking needs, assistance with architectural barriers, assistive technology, and support for individual needs.

USC Campus Support and Intervention - (213) 821-4710

<https://campussupport.usc.edu>

Assists students and families in resolving complex personal, financial, and academic issues adversely affecting their success as a student.

Diversity at USC - (213) 740-2101

<https://diversity.usc.edu>

Information on events, programs and training, the Provost's Diversity and Inclusion Council, Diversity Liaisons for each academic school, chronology, participation, and various resources for students.

USC Emergency - UPC: (213) 740-4321, HSC: (323) 442-1000 – 24/7 on call

<http://dps.usc.edu>, <http://emergency.usc.edu>

Emergency assistance and avenue to report a crime. Latest updates regarding safety, including ways in which instruction will be continued if an officially declared emergency makes travel to campus infeasible.

USC Department of Public Safety - UPC: (213) 740-6000, HSC: (323) 442-120 – 24/7 on call

<http://dps.usc.edu>

Non-emergency assistance or information.

Office of the Ombuds - (213) 821-9556 (UPC) / (323-442-0382 (HSC)

<https://ombuds.usc.edu>

A safe and confidential place to share your USC-related issues with a University Ombuds who will work with you to explore options or paths to manage your concern.