San José State University
College of Engineering/Computer Engineering Department
CMPE 242, Embedded Hardware Systems, Spring 2018

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Office Hours: Thursday. 2:00-3:00 PM.
Prerequisites: CMPE 200 or EE275 per instructor's approval

Course Catalog Description

Embedded Hardware Architecture including 32 bit RISC CPU, Memory Unit, Bus Systems, Interrupt Controller, RTC, PWM, SPI and A/D conversion, Sensors and their interface technique, firmware programming. Homework and hands-on projects required.

Program Outcomes for MS in Computer Engineering

1. Be able to tackle complex engineering problems and tasks using contemporary engineering principles, methodologies, and tools.
2. Be able to demonstrate leadership and the ability to participate in teamwork in an environment with different disciplines of engineering, science and business.
3. Be aware of ethical, economic and environmental implications of their work, as appropriate.
4. Be able to advance successfully in the engineering profession, and sustain a process of life-long learning in engineering or other professional areas.
5. Be able to communicate effectively, in both oral and written forms.

Student Learning Objectives

Upon successful completion of this course, students will be able to

- Formulate and solve engineering design problems by engaging experiments and implementation of embedded hardware systems, to be able to utilize industrial development platform for the target RISC CPU.
- Design and build interface prototype board to communicate with RISC CPU and realize firmware and device driver functions;
- Understand interrupt and interface techniques and implement analog/digital sensor interface with OpAmp preprocessing unit, UART, SPI and PWM interface protocols.

Required Texts/Readings

Textbook

- S3C44B0x RISC Processor, pp. 1 – 442, Samsung Electronics;

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- Reference design schematics;
- 16 Mbit Multipurpose FLASH data sheet, Document number SST39VF160Q/160, by Silicon Storage Technology;
- 64 Mbit SDRAM data sheet, K4S641632 CMOS SDRAM, Samsung Electronics;
- Dr. Harry Li's Lecture Notes.

Other Readings

- The reference material for ARM CPU hardware features, application notes, class handouts and CMPE 242 lab assignments and reports, please see Professor Li's lecture material at https://github.com/hualili
- The reference material for embedded Linux OS, device drivers, application notes, class handouts, and CMPE 244 lab assignments and reports, please see Professor Li's yahoo group http://tech.groups.yahoo.com/group/embeddedlinuxOS/
- The reference material for embedded wireless class, green-sheet, lab assignment, handouts, and other related materials, please see Professor Li's github https://github.com/hualili and yahoo group: http://tech.groups.yahoo.com/group/cmpe296aa/files/

Format

Lecture session once per week and lab implementations will be conducted by students outside the class. All course materials and references links will be found on the course website. Students will be required to perform individual project demo with a formal lab report. The class will use embedded development kit to allow the students gain hands-on experience.

You can access the course materials and sample schematics and programs at the course website http://tech.groups.yahoo.com/group/Cmpe242EmbeddedSystems/.

You are responsible for checking the website frequently for announcements, assignments, information on your grades, etc. You are also responsible for regularly checking with the messaging system through MySJSU for all information concerning enrollment and university issues.

The "discussion" board will be available on the class website. You are encouraged to participate in the discussion board with your fellow peers by posting or answering questions.

The lecture sessions will be conducted according to the days in the Schedule section. The duration of each lecture session is 2 hours 45 minutes. There will be 3 segments for each lecture session. At the end of each segment, you can check your understanding of the topic. The following table shows the activities and their durations of a typical lecture session:

Running Time	Duration	Activity
00:00 – 00:05	05	Q&A session and review on previous topics and homework and lab assignment
00:05 – 00:50	45	Segment 1
00:50 – 00:55	05	Break
00:55 – 01:50	55	Segment 2
01:50 – 02:00	05	Break
02:00 – 02:50	50	Segment 3

Classroom Protocol

You are required to attend each lecture sessions and conduct course work and hands-on lab and homework assignment in class and/or off line. In addition, proper testing equipment required by the class will have to be prepared by individual students following professor's guidance.

Students are required to follow all applicable classroom etiquette posted at http://www.sjsu.edu/studentconduct/docs/StudentConductCode-SCED.pdf. For example, all professors should be addressed by his or her title (e.g., Dr. or Professor), not by "Hey" or use of other informal language. Students are expected to respect the rights and opinions of others. The free and open exchange of ideas is the cornerstone of higher education, but we must always remain respectful of others, even if we disagree strongly with them. Disruptions of class activities are a violation of the Student Code of Conduct and will be reported to the Office of Judicial Affairs.

Exams

There will be one midterm exam and one final comprehensive final exam. They are all close-book, close-notes, however if you need datasheets etc., they will be provided by the professor.

Project

Four hands-on projects will be assigned during the semester, each student is required to work independently on these hands-on project. For each project, the student writes IEEE style report and submit project demo on line. The project will cover the following topics:

1. Build a prototype board to communicate with the embedded hardware system powered by 32 bit RISC CPU, to establish console debugging capability via serial link where hardware UART levelshifting to RS232 for console commuincation is designed and built. Putty or minicon are quired and the host development platform of ubuntu LINUX is employed throughout all the projects in the entire semester;
2. Memory subsystem design and implementation with SPI Flash, prototyping baord implementation with Linux device driver development are required to demonstrate

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the success of bi-directional communication between the Flash memory and the CPU.

3. Bus systems concept, ADC and FFT power specturm enabled data validattion technique for Sensor interface design. In particular, ISE (Ion Selective Electrode) sensors. This project integrates the sensor interface and signal with cicuitry consisting of P.O.T and OpAmp preprocessing, then through computation of FFT and its power spectrum to adjust the sampling frequency per validation requirement.

4. Serial interface and external interrupt techniques, with the project of close loop controller design and implementation via PWM motor drive functions. Understand and be able to utilize proper serial interfaces, such as UART, RS232, GPP, SPI etc, to perform embedded close loop control function.

Detailed project assignments, report templates, submission instructions, and grading rubrics, will be posted on the class website hosted by Canvas.

Host Development Environment

Host development environment for the RISC CPU cross compiler and open source Linux distribution are utilized. Each student is required to have an access to or have his/her own setup of Linux OS via a laptop environment or via virtual machine or multiple disk partition.

Grading

Grading components are
30%   Midterm Exam
30%   Quiz，Homework, and Hands on Projects
40%   Final Exam

The following letter grades will be assigned according to individual final scores:
A   90-100
B   80-89
C   70-79
D   60-69
F   0-59
  (+ and/or – to be adopted per university policy)
Success in this course is based on the expectation that students will spend, for each unit of credit, a minimum of 45 hours over the length of the for instruction or preparation/studying or course related. Other course structures will have equivalent workload expectations as described in the syllabus.

Library

All SJSU San Jose State students, online or on campus, have access to the extensive online resources of the Martin Luther King library. There are many electronic library

resources available and arrangements can be made to obtain physical resources at locations more convenient for the off campus students through the inter-library loan system. The College of Engineering has a designated librarian assigned to the college who is available to help the online students in addition.

The library and librarians are available to the students as the students' most important resource for an online course. The library website and online librarians are accessible 24 hours a day. For a Master's degree, the students use these resources extensively. The link to library guide for Distance Library Services is at http://libguides.sjsu.edu/distanceservices.

Student Code of Conduct

In order to ensure fairness and have a standard of representing knowledge acquired, students participating in online SJSU courses must agree to abide by the this code of conduct:
- My work will be my own in this online course.
- I will not share any questions or answers for quizzes or exams with anyone.

University Policies

Academic Integrity

Your commitment as a student to learning is evidenced by your enrollment at SJSU. The University's Academic Integrity policy, located at http://www.sjsu.edu/senate/S07-2.htm, requires you to be honest in all your academic course work. Faculty members are required to report all infractions to the office of Student Conduct and Ethical Development. The Student Conduct and Ethical Development website is available at http://www.sjsu.edu/studentconduct/. Instances of academic dishonesty will not be tolerated. Cheating on exams will result in a failing grade and sanctions by the University. For this class, all assignments are to be completed by the individual student unless otherwise specified. If you would like to include your assignment or any material you have submitted, or plan to submit for another class, please note that SJSU's Academic Policy S07-2 requires approval of instructors.

Campus Policy in Compliance with the American Disabilities Act

If you need course adaptations or accommodations because of a disability, or if you need to make special arrangements in case the building must be evacuated, please make an appointment with me as soon as possible, or see me during office hours. Presidential Directive 97-03 requires that students with disabilities requesting accommodations must register with the Disability Resource Center (DRC) at http://www.drc.sjsu.edu/ to establish a record of their disability.

Course Schedule

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Week	Date	Topics	Project
1	1st week	Organizational Meeting and Introduction to embedded hardware architecture and its development kit, Ubuntu based Linux development platform set up.	
2	2nd week	Overview of a tool chain, embedded Linux OS source code distribution and software development environment	
3	3rd week	Building prototype board, with UART/RS232 level shifting for serial based host console communication and firmware programming on GPP I/O design based on device driver programming, special purpose registers , init and config.	
4	4th week	Debugging technique based on the console to prototype communications via serial RS232 link, putty on the host and user APP and device driver on the development kit with prototype board	Project 1 Report due
5	5th week	Memory subsystem design, ROM with 8-, 16-, 32-bit data bus, and introduction to Flash memory	
6	6th week	Flash memory interface via SPI interface, SPI communication protocol, and Flash memory dependent opcode implementation	
7	7th week	Interrupt controller techniques, build a prototype board with external interrupt function triggered by an event and handled by driver program	Project 2 Report due
8	8th week	Midterm Exam	
9	9th week	ADC techniques, special purpose register setting, init and config, ADC characterization, ADC sampling rate and Nyquest theorem.	
10	10th week	ADC data validation based FFT and power spectrum computation, combination of ADC and ExINT techniques	
11	11th week	Industrial analog sensor interface design, prototype board with preprocessing circuit of OpAmps.	Project 3 Report due
12	12th week	Interface techniques and PWM techniques, special purpose registers and their init and config, frequency settings for PWM	
13	13th week	Interface technique application to control applications, form close loop system based on the development kit and prototype board (as actuator), mapping control actions to PWM signals	

Week	Date	Topics	Project
14	14th week	Interface technique application with numerical technique to map control function to PWM, integration of prototype board with full control functionality	
15	15th week	Power management with DS device to control system power, Implementation of a device driver for high speed serial interfaces to the DS device.	Project 4 Report due
		Final exam	