COURSE SYLLABUS CS 435

Real-Time Concepts of Embedded Systems

Fall 2020

Class hours: 2:30pm -3:45pm, MW via https://csusm.zoom.us/j/97785281414
Office Hours: 4 pm –5 pm MW or by appointment via https://csusm.zoom.us/j/879321296
Instructor: Dr. Ali Ahmadinia
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Course Description

Introduction to the high-level abstract modeling concepts and the lower-level fundamental programming aspects of real-time embedded systems development. The primary focus is in the design, development and validation of microprocessor-based real-time embedded systems. Course topics will include real-time operating system design, real-time scheduling theory, general-purpose microprocessors, common bus architectures, memory management, device driver development, interrupts, and general purpose peripherals: such as timers and counters, I/O subsystems along with some embedded system design problems and engineering issues.

Textbook:

No textbook required. Course material will be distributed in the class or posted in Cougar Course including a **free online book**:

Embedded Software in C for an ARM Cortex M, Jonathan W. Valvano and Ramesh Yerraballi, 2015.

Recommend textbooks:

W. Wolf: Computers as Components – Principles of Embedded System Design. Morgan Kaufman Publishers, 2012.
Martin. 2013. The Designer's Guide to the Cortex-M Processor Family: A Tutorial Approach (1st ed.). Newnes, Newton, MA, USA.
Yifeng Zhu. 2015. Embedded Systems with ARM Cortex-M Microcontrollers in Assembly Language and C (2nd ed.). E-Man Press LLC.

The embedded board and hardware components will be provided, which you need to return at the end of the course. If you prefer you can order them here as well:
https://www.digikey.com/short/zfqqwh

Course aim:

The course aims to produce students who are capable of designing and programming embedded systems and implementing them in low-level hardware using standard C and assembly language.

Learning outcomes:

- Knowledge and understanding of:
  - Modern processor architectures
  - Microcontrollers as modern embedded computing platforms
  - Software design basics, software engineering principles
- Intellectual
  - Ability to choose between different programing techniques for embedded system design
  - Ability to evaluate implementation results (e.g. speed, cost, power) and correlate them with the corresponding programing techniques
- Practical
  - Ability to use commercial tools to develop embedded systems
  - Ability to build an embedded system and program to satisfy given user specifications

Pre-requisites:

Basics of programming

Disabled Student Services

Students with disabilities who require reasonable accommodations must be approved for services by providing appropriate and recent documentation to the Office of Disabled Student Services (DSS). This office is located in Craven Hall 5205, and can be contacted by phone at (760) 750-4905, or TTY (760) 750-4909. Students authorized by DSS to receive reasonable accommodations should meet with me during my office hours in order to ensure confidentiality.

Academic Honesty

"Students will be expected to adhere to standards of academic honesty and integrity, as outlined in the Student Academic Honesty Policy. All written work and oral presentation assignments must be original work. All ideas/material that are borrowed from other sources must have appropriate references to the original sources. Any quoted material should give credit to the source and be punctuated with quotation marks.

Students are responsible for honest completion of their work including examinations. There will be no tolerance for infractions. If you believe there has been an infraction by someone in the class, please bring it to the instructor's attention. The instructor reserves the right to discipline any student for academic dishonesty, in accordance with the general rules and

regulations of the university. Disciplinary action may include the lowering of grades and/or the assignment of a failing grade for an exam, assignment, or the class as a whole."

Incidents of Academic Dishonesty will be reported to the Dean of Students. Sanctions at the University level may include suspension or expulsion from the University.

Course Policies

1. Students should individually work on all homework assignments and turn them in on the class website at the beginning of the class when they are due. No late assignments are accepted unless there is a family or work emergency, in which case you must provide the instructor a valid written proof before the assignment due date. If the reason seems valid, you will be granted an extension. The University writing requirements will be satisfied by written homework assignments.

2. Students are expected to be active learners. Students should read materials posted in Cougar Course before coming to lectures, and are expected to attend all classes and participate in class discussions.

4. The use of computers and mobile devices during the lecture for course unrelated purposes is not permitted. If violated, you may be logged out the computer or asked to leave the classroom.

Grades

Lab Assignments	50%
Quizzes	15%
Class Participations	10%
Group Project	25%

Your letter grade will be based on the following scale:

Total	≥ 93	90 ≤ and < 93	87 ≤ and < 90	83 ≤ and < 83	80 ≤ and < 83	75 ≤ and < 80	70 ≤ and < 75	< 70
Grade	A	A-	B+	B	B-	C+	C	D

Lab Assignments

Each student will write, debug, and demonstrate a number of short assembly and C programs for an ARM Cortex-M microcontroller using the Keil MDK-ARM integrated development environment or online mbed IDE and the STM32F4-Discovery board. These assignments provide hands-on experience and help to build student's embedded programming skills.

Group Project

Students will undertake a project (on a related topic subject to the instructor approval) to design and implement a practical application on the ARM-based ST Nucleo board. This project will

provide students the opportunity to explore fundamental issues more deeply in embedded systems. The outcome of each project will be a clear and concise technical report discussing project concepts, development, experiments, results, analyses as well as a presentation and demonstration.

Class Participation

Students are expected to be active learners. Students should read materials to-be-covered before coming to lectures, and are expected to attend all classes and participate in ***Polleverywhere*** questions and ***class activities***.

Quizzes

Quizzes are open notes and are mainly designed to help you to understand the material better and deeper and have a quick reflection on your performance.

Tentative Schedule

Week	Topics
1	Introduction to Embedded Systems
2	Introduction to mbed Platform
3-4	The ARM Cortex-M Processor Architecture
5	Introduction to Cortex-M Programming
6-7	Digital Input and Output
8-9	Interrupts and Low Power Features
10-11	Analog Input and Output
12	Timer and Pulse-Width Modulation
13	Serial Communication
14	Real-Time Operating System
15	Project Presentations and Demonstrations

Please note that this schedule is tentative, and subject to change as deemed appropriate.