

EECE 237

Embedded Systems Development

3 Units: 3 hours of lecture (Engineering Topic)

Course Supervisor/Main Instructor: Zhaohong Wang/Kathleen Meehan, John-Mark Mamalakis, Hassan Salehi

Required Textbook and Other Course Materials:

Textbook

Jonathan W. Valvano, Embedded Systems: Introduction to ARM Cortex-M Microcontrollers, 5th Edition, CreateSpace Independent Publishing Platform, ISBN: 978-1477508992. Available: Wildcat Bookstore and online booksellers

Recommended readings

Yifeng Zhu, Embedded Systems with ARM Cortex-M Microcontrollers in Assembly Language and C (3rd Edition), E-Man Press LLC, ISBN-13: 978-0982692660

Jonathan W. Valvano. U. Texas-Austin, <http://users.ece.utexas.edu/~valvano/>

Yifeng Zhu, U. Maine, <http://web.eece.maine.edu/zhu/index.php>

Other equipment requirements

1. Laptop with at least one USB port, preferably Windows-based
2. Keil μ Vision Mrocontroller Development Kit
3. The Evaluation board, Texas Instruments TM4C123GXL Launchpad, Available from: CSU Chico IEEE Club, Texas Instruments (www.ti.com), and several electronics vendors
4. Parts Kit, Available from CSU Chico IEEE Club
5. Breadboard, Available from CSU Chico IEEE Club and from several electronics vendors, not needed if you have the EECE 144/211 or other breadboard

Course Description:

This course presents the concepts and techniques associated with developing low level Embedded Systems Applications, using both Assembly Language and C. Topics include microprocessor architecture concepts, instruction set architectures, Assembly Language programming, data representations, interrupt handling and execution modes, low level C programming, and the use of on-chip and external peripherals.

Prerequisites: CSCI 111

Learning Objectives:

Students shall be able to:

- design, write and test embedded applications in C and assembly
- develop embedded applications that interface to low level devices
- design and develop interrupt-driven embedded applications

Course Topics (subject to change based on class needs and progress)

1. Overview of Computing Systems
 - a. History and concept of RISC
 - b. Number systems and representations of numbers and characters

- c. Applications involving embedded systems
- 2. Software Development Process
 - a. Product life cycle
 - b. Flowcharts and structured programming
 - c. Debug programs
- 3. Input/Output
 - a. Texas Instruments Microcontrollers I/O pins
 - b. Basic concepts of input and output ports
 - c. Concepts of memory-mapped peripherals
 - i. Brief introduction to CMSIS
 - ii. Switches and LEDs
 - d. SysTick Timer
- 4. Cortex-M4 Architecture
 - a. Data types
 - b. Processor modes
 - c. Registers
 - d. Memory
- 5. Assembler Rules and Directives
 - a. Concepts of CISC and RISC
 - b. Simplified machine language execution
 - c. ARM, Thumb, and Thumb-2 instructions overview
 - d. Structure of Assembly Language Modules
 - e. Frequently used directives
- 6. Addressing, Loads, Stores
 - a. Memory accessing instructions
 - b. Operand addressing modes
 - c. Loading constants into registers
 - d. Loading addresses into registers
 - e. Endianess
 - f. Bit-banded memory
- 7. Logical and Arithmetic Operations
 - a. Flags and their use
 - b. Comparison operations
 - c. Arithmetic operations
 - d. Bit manipulation operations
- 8. Functions and Control Flow
 - a. Branching
 - b. Looping
 - c. Conditional execution
 - d. Subroutines and stacks
 - i. Function calls: pass by value and pass by reference
- 9. Interrupt Handling
 - a. Interrupt concepts
 - b. SysTick periodic interrupts
- 10. Relation between C and Assembly
 - a. Pointers and Data Structures
 - i. Indexed addressing and pointers
 - ii. Arrays
 - iii. Structures (struct in C)
 - b. Making decisions: conditionals, loops