

San Francisco State University
School of Engineering
ENGR 478: Design with Microprocessor

Bulletin Description:

ENGR 478: Design with Microprocessor (Classwork, 3 units; Laboratory, 1 unit)

- Basic microprocessor/microcontroller architecture
- Assembly and C language programming.
- System bus and interfacing with memory and I/O devices.
- Serial and parallel communications.
- Timer and counter functions
- Polling and interrupt
- A-D, D-A conversion

Prerequisites:

ENGR 356 and either ENGR 213 or CSC 210, all with grades of C- or better

Course Objective*:

1. To learn the internal organization of some popular microprocessors/ microcontrollers. [B.2]
2. To learn hardware and software interaction and integration. [B.1, B.2]
3. To learn microprocessor interfacing. [B.2, B.3]
4. To learn the design of microprocessors/microcontrollers-based systems. [A.2, B.1, B.2, B.3]

* Numbers in brackets refer to the objectives and outcomes of the School of Engineering.

Prerequisites by Topic:

1. Binary number systems and arithmetic operations.
2. Logic devices and their operational characteristics.
3. Logic functional units – decoders, encoders, multiplexers, registers, counters, etc.
4. General combinational and sequential circuits.
5. Simple main memory structure.
6. Computer programming.

Specific Learning Outcomes:

Students completing the course successfully will demonstrate

- an in-depth knowledge of a microprocessor/microcontroller.
- an ability to program in assembly and C language
- knowledge of the interactions between software and hardware.
- an ability to integrate software and hardware for microprocessor-based systems.
- an ability to interface microprocessor with other devices through serial and parallel I/O.
- an ability to deal with analog signals in digital systems.
- an ability to use timer and counter functions.
- an ability to design an expanded system by adding external circuits as required.
- an ability to use development tools.
- a skill in troubleshooting a microprocessor-based system.

Lecture Instructor:

ENGR 478-01/03: Xiaorong Zhang, Ph.D.
 Office: SCI 213D
 Office Hours: Monday 11am-12pm, Thursday 3-5pm, or by appointment
 E-mail: xrzhang@sfsu.edu
 Course Website: <https://ilearn.sfsu.edu>
 (All lecture slides, supplementary materials, and assignments will be posted on iLearn.)

Lab Instructor:

ENGR 478-02/04: George Anwar, Ph.D.
 Office: TBD
 Office Hours: TBD
 E-mail: TBD

Class Schedule

Lecture	ENGR 478-01/03:	Tu, Th 12:35-1:50pm
	Location:	HSS 213
Lab	ENGR 478-02:	Th 6:10-8:55pm
	ENGR 478-04:	Tu 6:10-8:55pm
	Location	SCI 141

Required Course Material

Each student needs to buy a
 Tiva C Series TM4C123G LaunchPad Evaluation Kit (EK-TM4C123GXL) (\$12.99)
<http://www.ti.com/ww/en/launchpad/launchpads-connected-ek-tm4c123gx1.html#tabs>

The launchpads can be purchased from:
 TI eStore, element14, Digi-Key, Mouser, Newark, Arrow

Reference Materials:

Purchase is not required.

1. Tiva TM4C123GH6PM Microcontroller Data Sheet. (ilearn-> Reference Materials -> tm4c123gh6pm.pdf)
2. Getting Started with the Tiva TM4C123G LaunchPad Workshop Student Guide and Lab Manual (Chapter 4) (iLearn -> Reference Materials -> TM4C123G_LaunchPad_Workshop_Workbook.pdf)
3. TivaWare Peripheral Driver Library User's Guide (iLearn-> Reference Materials -> SW-TM4C-DRL-UG-2.1.0.12573.pdf)
4. Tiva C Series TM4C123G LaunchPad Evaluation Board User's Guide. (ilearn -> Reference Materials -> TM4C123_LaunchPadUsersManual.pdf)
5. Cortex-M4 Technical Reference Manual. (ilearn-> Reference Materials -> CortexM4_TRM_r0p1.pdf)
6. Cortex-M4 Devices Generic User Guide. (ilearn-> Reference Materials -> DUI0553A_cortex_m4_dgug.pdf)

7. Cortex-M3/M4F Instruction Set Technical User's Manual. (ilearn -> Reference Materials -> CortexM_InstructionSet.pdf)
8. Jonathan W. Valvano, "Introduction to ARM Cortex-M Microcontrollers (fifth edition)," 2014. ISBN: 978-1477508992. <http://users.ece.utexas.edu/~valvano/arm/outline1.htm>
9. Free online course by Professor J. Valvano from UT-Austin, "Embedded Systems – Shape The World". <https://www.edx.org/course/embedded-systems-shape-world-utaustinx-ut-6-02x#.VMXPP54o7I>

(Other readings will be posted on the course website)

Tentative Weekly Schedule

Week	Date	Lecture Topic	Lab activity
1	1/28, 2/2	Introduction to the course; review of digital logic; Introduction to TM4C123, Thumb-2	Introduction to the lab and development tools; Form groups
2	2/4, 9	ARM architecture and execution; Simple addressing modes; Registers	software installation; first sample program
3	2/11, 16	Assembly syntax; Functions; Logic operations; Parallel I/O;	Lab 1 uVision simulator; asm and C program simulation
4	2/18, 23	Switch and LED interfacing; IO synchronization	Lab 2 create new projects; parallel ports on the TM4C123; PinMux tool
5	2/25, 3/1	Timers; Interrupt concept	Lab 3a Switches and LED interfaces; busy-wait synchronization
6	3/3, 8	Periodic interrupt	Lab 3b Switches and LED interfaces; busy-wait synchronization
7	3/10, 15	Edge-triggered interrupt	Lab 4 Periodic interrupt
8	3/17	D/A conversion – Digital to analog conversion (DAC);	Lab 5 Edge-triggered interrupt
9	3/ 29	Midterm review	
10	4/5	Midterm exam	Lab 6 Multiple interrupts
11	4/7, 12	A/D conversion – Analog to digital conversion (ADC);	Lab 7a LCD display image
12	4/14, 19	Serial I/O – Universal asynchronous receiver transmitter (UART);	Lab 7b LCD button
13	4/21, 26	Serial I/O – SSI vs. UART vs. USB vs. I2C	Project
14	4/28, 5/3	Power management;	Project
15	5/5, 10	Advanced Embedded System Design.	Project
16	5/12, 17	Review for Final Exam.	Final project

			presentation and demo
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Note: This schedule is to be completed and subject to change based on the "reality" of the class performance. Information given in class supersedes this schedule.

Important Dates

Last day to add/drop: Feb. 9, 2016
 Late add with permission numbers: Feb. 10 – 23, 2016
 Last day to withdraw: Apr. 26, 2016
 Holiday: Thursday, Mar. 31, 2016 (Cesar Chavez Day)
 Spring break: Mar. 21-26, 2016

Grading Policy:

Grades will be based on total points earned through the following activities:

Midterm Exam	15%
Final Exam	30%
Labs	30%
Project	10%
Homework	10%
Attendance	10%
Total	105%

Important Dates:

- Midterm exam: Tuesday April 5 (in class)
- Project presentation and demo: May 12, 17 (in lab)
- Final exam: Thursday May 19, 10:45am-1:15pm, HSS 213

Grade assignment:

A from 100 to 94	A- from 93 to 89		
B+ from 88 to 84	B from 83 to 80	B- from 79 to 75	
C+ from 74 to 70	C from 69 to 65	C- from 64 to 60	
D+ from 59 to 55	D from 54 to 50	D- from 49 to 45	F below 45

Notes on grading:

- Generally, there will be **no make-up exam and no incomplete** grades given. If you miss an exam, you must notify the instructor before the exam or, if physically impossible, soon after. If you have an acceptable, documented excuse, you may be given a make-up exam. If you do not have an acceptable reason for missing the exam, you will receive zero points for the exam.
- The due date of homework assignments/lab reports will be specified in the homework/lab handouts. ZERO point will be given to late submission without justified excuses. Though you can collaborate during homework assignments and labs, **direct copying of solutions, in part or in whole, is not permitted.**
- The labs and the project are to be done in student groups of no more than 3. You will be evaluated as a group as well as individually.
- **Attendance is mandatory.** Students missing six lectures or more need to withdraw from the class. You must come to class if you plan to pass the course. The information covered in class is essential for you to complete homework assignments and labs, as well as prepare for exams and quizzes. Students late for over 10 minutes will be considered "absent" from that class.

Group Work

The students are required to form groups to complete all the labs and the term project.

- Group size: 2 or 3
- Group members must share work equally and each member must know all work done by the group.
- You may not be able to complete all the work during lab time so choose partners who you can work together for a few hours a week on labs and projects.
- Every student needs to get a TI TM4C123 LaunchPad.

Policies on Plagiarism

Plagiarism is defined as using someone else's ideas or work as one's own without giving proper credit to the source. The source include public (books, journals, magazines, newspapers, internet, etc.) as well as private (unpublished reports, internal documents, personal work, etc.) materials. The instructor will not accept excuses such as "I forgot to give credit to ...," "It's an oversight," or "It's a clerical error."

Students are solely responsible for materials submitted for the course so "My roommate must have done that without my knowledge" is not an acceptable excuse either. That is, no excuses will be accepted if plagiarism is discovered. If a submitted work is found to contain plagiarized material, the work will receive zero credit and the student may be reported to the Student Judiciary Affairs for disciplinary actions. Cheating on tests will also be reported to the Student Judiciary Affairs. Disciplinary actions may include disqualification from the university.

Disability Policy Statement

Students with disabilities who need reasonable accommodations are encouraged to contact the instructor. The Disability Programs and Resource Center (DPRC) is available to facilitate the reasonable accommodations process. The DPRC is located in the Student Service Building and can be reached by telephone (voice/TTY 415-338-2472) or by email (dprc@sfsu.edu).

(<http://www.sfsu.edu/~dprc>)

Student disclosures of sexual violence

SF State fosters a campus free of sexual violence including sexual harassment, domestic violence, dating violence, stalking, and/or any form of sex or gender discrimination. If you disclose a personal experience as an SF State student, the course instructor is required to notify the **Dean of Students**. To disclose any such violence confidentially, contact:

The SAFE Place - (415) 338-2208; http://www.sfsu.edu/~safe_plc/

Counseling and Psychological Services Center - (415) 338-2208; <http://psyservs.sfsu.edu/>

For more information on your rights and available resources: <http://titleix.sfsu.edu>

Policy on observance of religious holidays

If a student wishes to observe religious holidays and such observances require the student to be absent from class activities, it is the responsibility of the student to inform the instructor, in writing, about such holidays during the first two weeks of the class each semester. If such holidays occur during the first two weeks of the semester, the student must notify the instructor, in writing, at least three days before the date that he/she will be absent. Please check <http://www.interfaithcalendar.org/> for world religious days.