San Francisco State University

School of Engineering

ENGR 844: Embedded Systems (3 units)

Course Objective:

The primary objectives of this course are

- For the students to develop the ability to design real-time embedded systems by combining principles of microcontroller interfacing, software development, memory and power management into the design of microcontroller-based systems.

- To give the students an understanding of trends and challenges of modern embedded systems and applications.

Specific Learning Outcomes:

Students completing the course successfully will demonstrate

- an in-depth knowledge of ARM Cortex-M architecture
- a deep understanding of synchronization methods (e.g. busy-waiting, interrupt, and DMA) and communication systems (e.g. serial and parallel communication interfaces, wireless communication)
- an ability to interface a microcontroller with other analog and digital devices though various I/Os.
- an ability to apply timing control, memory and power management strategies to real-time embedded system designs
- a skill to trouble shooting a microcontroller-based system
- an understanding of trends and challenges of modern embedded systems and applications (e.g. smart devices, internet of things, wearable technologies)

Prerequisites:

- For undergrads, grade of C- or better in ENGR 478 or equivalent
- Basic knowledge of computer organization, microcontroller architecture, memory structure, system bus and interfacing with memory and I/O devices, etc.
- Familiarity with C programming

ENGR 844 Spring 2016

Instructor:	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.)

Class Schedule

ENGR 844:	Monday 6:10pm-8:55pm
Location:	Thornton Hall 325

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-tm4c123gxl.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#.VMXPpP54o7I

(Other readings will be posted on the course website)

Tentative Weekly Schedule

Week	Date	Topics
1	2/1	Course overview; Students self-introduction; Project group formation; First-class questionnaire
2	2/8	Introduction to embedded systems; Trend and challenges; Introduction to TM4C123 and ARM Cortex-M architecture
3	2/15	TM4C system bus; Parallel I/O
4	2/22	Interrupt handling
5	2/29	Interrupt handling and direction memory access (DMA)

6	3/7	Serial communication interface
7	3/14	A/D conversion; circular buffer
8	3/21	Spring break
9	3/28	Real-time system design; data sampling and memory management
10	4/4	Sensor interface
11	4/11	Wireless communication
12	4/18	Power management
13	4/25	Midterm exam
14	5/2	Advanced topics in embedded system applications
15	5/9	Advanced topics in embedded system applications
16	5/16	Final project presentation

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:

Homework Assignments	30%
Midterm Exam	30%
Project	35%
Attendance and Quizzes	10%
Total	105%

Important Dates:

- Project proposal due: Mon Mar. 7
- Midterm exam: Mon Apr. 25
- Final project presentation: Mon May 16
- Final project report due: Mon May 23

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.

- ➢ Though you can collaborate during homework assignments, **direct copying of solutions, in part or in whole, is not permitted. All code required for the homework assignments should be individually designed and developed**.

- ➢ A term project will be published in the class. The project is to be done in student groups of no more than 3. You will be evaluated as a group as well as individually.

- ➢ Attendance will be taken at the beginning of each class. **Students absent from class without prior approval of the instructor for more than three times will not receive a grade above "C".** Students late for over 10 minutes will be considered "absent" from that class.

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.