# CSE325 (24944) Embedded Microprocessor Systems

## Spring 2008—Date, Time, Location
MWF 10:40-11:30 COOR 88

## Catalog Course Description
System-level programming and analysis of embedded microprocessors systems. Fundamental concepts of digital system design for embedded system applications. Prerequisites: CSE 220 Programming for Computer Engineering and CSE230 Computer Organization and Assembly Language. Three (3) credit hours. Lecture/No lab.

## Major Topics
The material to be covered in this course includes (39 lecture hours):
1. Review of instruction set and assembly language programming, instruction execution cycle and timing (1 week)
2. Introduction of embedded microprocessor systems and development environment (1 week)
3. Memory devices, SRAM, DRAM, flash memory, and SDRAM controller (2 weeks)
4. Interrupts and DMA (1 week)
5. Timers and counters (1 week)
6. Serial communication: UART, SPI, and I2C (2.5 weeks)
7. Parallel I/O interface and signal handshaking (1.5 weeks)
8. Keyboards, LCD, VGA interfaces (2 weeks)
9. Transducers and sensors, touch panel, A/D-D/A converters (1 week)
10. Buses, access arbitration, timing, and protocols (2 weeks)

## Course Objectives
1. To develop an ability to analyze microprocessor-based embedded systems, memory components, and bus connection:
   - Analyze the schematic diagrams of microprocessor-based embedded systems to understand the functions and interactions of major components.
   - Students understand the characteristics of memory components such as SRAM, DRAM, and flash memory.
   - Students understand and analyze memory and I/O bus protocols, access arbitration, data transfer operation, and bus timing mechanisms.
   - Students can analyze address scheme of memory and I/O components in microprocessor-based embedded systems.
2. To develop design skills for modular application and system software in microprocessor-based embedded systems:
   - Students can develop time- and event-triggered execution of software task for embedded applications.
   - Students understand memory segments and configuration, parameter passing schemes between high-level and assembly language programs, and the structure of interrupt service routines.
   - Students can develop efficient and well-structured programs and interrupt service routines using high-level language and assembly language, whenever appropriate, for microprocessor applications.
3. To apply software development tools to efficiently implement and debug programs running in microprocessor systems:
   - Students understand host and target development environment for microprocessor systems.
   - Students can use a tool chain (compiler, assembler, linker, loader, debugger, etc.) or an IDE (integrated development environment) to develop application programs in microprocessor systems.
4. To gain an ability to analyze I/O interface units and to design software for managing I/O operations.
   - Students can develop programs to manage I/O operations and to handle external events via polling and interrupts.
   - Students can develop software to control the operations of I/O units (e.g., timers, synchronous and asynchronous serial communication interfaces, parallel interfaces with signal handshaking, and data acquisition interfaces).
   - Students can develop software for the operations of computer-human interfaces (e.g., display, touch panel, and keypad).
   - Students can modify or synthesize a schematic to implement a specified addressing scheme.

## Office Hours & Teaching Assistants
The instructor will be available during his office hours (MW: 9:15-10:15, 2:45-3:45; F: 9:15-10:15; TuTh: By appt) to answer any questions you may have about the course, the material, or the assignments. I'm a friendly guy, and willing to talk with you and help you as much as I can, so stop by if you want, but please be aware that I also teach other courses and have other duties as well, so I am quite busy. When you come in for help, please be prepared with a printout of your program or assignment solution ready for discussion, bring your book, and be ready to ask pointed and specific questions about what you do not understand or are having difficulty with. It is next to impossible for me to help you if you come in and say, "I don't understand anything." Also, a final word of advice. I may not be available as much as you would like the day before or the day an assignment is due. I will give you plenty of time to complete the assignments as long as you start working on them well before the due date. This will give you ample time to meet with me or the TA to discuss your questions as you are working on the assignment.

If you find that you need more assistance than I am able to provide, you might want to work with the TA for this course. His name is Amit Pabalkar (email: amit.pabalkar@asu.edu) and his office hours are TBD in the second-floor BY computer lab.

Additionally the Fulton School of Engineering provides free tutors for various courses including this one. See their web site.

## Course Materials & Resources

The Embedded Systems Lab on the second floor of the Brickyard Engineering Building contains the Freescale microprocessor boards with the ColdFire MFC5211 student learning kits that we will be using. The PC's attached to each board have the Freescale CodeWarrior IDE Version 5.7 installed on them. Unless you buy your own project board and MFC5211 student learning kit from Freescale (around $250 including shipping) you will have to complete the programming projects in the lab. Make sure your ASU Sun card will permit you entry to the lab before the first assignment is due.

There is no textbook for the course. Instead, current reference manuals will be used:

**ColdFire**

- ColdFire Family Fact Sheet
- ColdFire Programmer's Reference Manual
- ColdFire Serial Boot Facility Application Note
- ColdFire MAC/eMAC DSP Reference Manual
- ColdFire V2 Core Reference Manual
- ColdFire V2 Core Reference Manual Addendum
- ColdFire V2 Core Intellectual Property Fact Sheet
- ColdFire V4 Core Reference Manual
- MCF521x Fact Sheet
- MCF521x Product Brief
- MCF521x ColdFire Microcontroller Data Sheet
- MCF521x ColdFire Integrated Microcontroller Reference Manual
- MCF521x ColdFire Integrated Microcontroller Reference Manual Errata
- MCF521x General Purpose I/O Application Note
- MCF521x DMA Controller Application Note
- MCF521x Programmable Interrupt Timer Application Note
- MCF521x Device Errata
- MCF521x Flash Module Application Note

**CodeWarrior**

- CodeWarrior Quick Start Guide
- CodeWarrior IDE 5.7 Reference Manual
- CodeWarrior Assembler Reference Manual
- CodeWarrior C/C++ Compiler Reference Manual
- CodeWarrior C Main Standard Library Reference Manual
- CodeWarrior Microcontrollers Debuggers Reference Manual
- CodeWarrior Build Tools Reference Manual
- CodeWarrior Targeting for ColdFire V5 Reference Manual
- CodeWarrior Targeting for ColdFire V6.3 Reference Manual
- CodeWarrior MetroTRK Reference Manual

**MCU Project Board**

- Freescale's Microcontroller Student Learning Kits Fact Sheet
- MCU Project Board Student Learning Kit User's Guide
- MCU Project Board Rev B. Schematic
- MCU Project Board LCD Display Quick Reference Guide

**M52110DEMO**

- M5211DEMO at Freescale.com
- M5211DEMO User's Guide
- M5211DEMO Schematic
- Student Learning Kits Pinouts

**Other**

- AMBA Rev 2.0 Specification
- Microchip 25xx160A/B 16K SPI Bus Serial EEPROM
- Micron 16Mb SDRAM
- Micron 256Mb SDRAM
- Serial I/O SPI Reference Manual

## Assessment

There will be two (2) in-class regular semester examinations, each worth 17.5% of your final grade. There will be one (1) final exam given during the final exam period, worth 25% of your final grade. The dates for the exams are listed in the schedule below. Makeup exams are not given in general (the only exception is for observance of an approved religious holiday which requires you miss class). If you know you must be absent on the date of the exam, then you must make arrangements to complete the exam **before** the exam date.

There will be several out-of-class readings and assignments given. The readings **must** be completed before the next class in order for you to be prepared to understand the lectures and discuss the material. We will cover the material **very quickly** in this course. If you have not read the assigned material before class, you will probably **fall behind** in your understanding of the material and your performance and grade may suffer.

The assignments are worth 40% of your final letter grade. Late assignments will not be accepted **for any reason**, and **all** assignment scores are included in determining your final letter grade. Throughout the semester, **bonus exercises** may be given which can be used to earn points for missed assignments or low assignment scores. If you fail to turn in any of the assignments, I highly advise you to complete the bonus exercises. Bonus exercises cannot be used to earn extra credit (i.e., your maximum assignment percentage can be 100%).

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|---|---|
| Assignments | 40% |
| Exam 1 | 17.5% |
| Exam 2 | 17.5% |
| Final Exam | 25% |

The final grade will be based on the percentage of the total points earned: A+ (≥ 98%), A (≥ 94%), A- (≥ 90%) B+ (≥ 88%), B (≥ 84%), B- (≥ 80%), C+ (≥ 77%), C (≥ 70%), D (≥ 60%), E (below 60%). The instructor may round percentages up at his discretion at the end of the term after all student percentages have been determined (e.g., a 83.35% B- may be rounded up to an 84% B, but then again, it might not). The only guarantee is that percentages will not be lowered).

## Academic Misconduct

In general, the instructor believes learning is a collaborative activity and students are encouraged to learn from and teach each other. These activities would include discussing solutions to homework exercises and jointly studying for exams. In completing homework assignments, student-pair collaboration is encouraged and will be permitted to the extent that the instructor is informed of such collaboration in advance, and each member of the pair contributes equally to the work. Collaboration is only acceptable between members of the same pair-team; inter-team collaboration is forbidden and violators may be sanctioned. Pair-teams will be assigned methodically or randomly at the instructor's whim, and may changed during the semester at the instructor's whim. Collaboration on examinations is not permitted; each exam must be completed by the individual student. Failure to abide by these rules will results in a score of zero being assigned to one or both members of the team (i.e., if I have a reasonable hunch that one student did all of the work on an assignment and the other student simply put his/her name on it, then the student who did all of the work will receive the assignment score and the other student will be given a score of zero).

The ASU Student Academic Integrity Policy will be enforced. I suggest you acquaint yourself with this policy to avoid any intentional or unintentional violations. Note that the allowable sanctions available to the instructor include: a reduced or failing grade on the assignment, or a reduced or failing grade for the course. Violators may be referred to the School of Engineering Dean's office, and the most severe penalty may be expulsion from the University. Any incidents will be handled on an individual case-by-case basis, and different sanctions may be imposed for different reasons for different offenders.

## Classroom Behavior

The ASU University Student Initiatives Policies and Procedures Manual (USI) permits the instructor to withdraw a student from a course for disruptive behavior with a mark of **W** or **E**. Note that "disruptive behavior" is defined **by the instructor**, not by the University or the student.

In my courses, appropriate classroom behavior is expected and required. Inappropriate behavior includes, but is not limited to: talking without being given permission to do so; verbally or sexually harassing another student or the instructor; being disrespectful or rude toward another student or the instructor; complaining/whining about assignments, grades, course policies, etcetera; using a computer or other electronic device for anything other than an assigned task; using electronic portable stereos or entertainment devices, disruptive pagers or cell phones, using any tobacco or alcoholic product, or being under the influence of alcohol or illicit drugs. This list is not inclusive and any other behavior that is deemed inappropriate by the instructor is also forbidden.

Violation of any of these unacceptable behaviors will result in the offender being removed from the classroom and notification of the offense to the School of Engineering's Dean's Office. A warning may or may not be provided.

## Attendance Policy

There is a strong and well-established correlation between class attendance, learning, and performance; therefore, regular class attendance and participation is expected. I intend to begin class each day on time, and I expect you to be pre-

sent with your book open and notes ready at that time. However, you are adults, and you (or someone who may or may not love you) are paying for your education, and ultimately, it is **your** education. If you want to squander this opportunity, then no gimmick I devise to try to get you to come to class and participate will be successful, so attendance will not count toward your final course grade.

## Requirements for Success in this Course

The instructor assumes that you are mature and responsible adults, that you are enrolled in this course because you wish to learn the material, that you will read any assigned readings before class begins, that you will come to class prepared to discuss the reading and ask questions, that you will complete the assignments to the best of your ability on time, that you will actively participate in class discussions, and that you will ask questions about material you find confusing. The instructor believes that college students must be actively involved in their own learning process, that they cannot just sit and listen to lectures and expect to learn the material, that one of the purposes of college education and the Arizona State University mission is for the student to self-develop skills such as problem solving, independent learning, critical thinking, and effective written and spoken communication. To succeed in this course you must:

- Be prepared for and attend every class
- Read the textbook and other assigned readings prior to class
- Begin and complete the assignments well before the due date
- Prepare thoroughly for and complete every exam
- Do any additional exercises you must to understand the material
- Ask as many questions as it takes for you to comprehend the material
- Seek assistance from the instructor or the TA before you are too far behind on your understanding of the subject

Having said all that, I want you to know that I **care** about all of my students and their education. I want all of you to **succeed**, to feel you have gained something from the course, to have some **fun** in the process, and I will do all I reasonably can to assist you in your efforts!

## Statement on Accommodations

The Disability Resource Center (480-965-1234; Matthews Center; email: disability-q@asu.edu) is the central location for students requiring accommodation. Any student requiring accommodation must contact and register with the Center before any accommodation requests can be granted by the instructor. If you require accommodation, please contact the Center as soon as possible so the instructor can work with you to ensure your success.

## Schedule

This is the *planned* schedule, but like most things in life, is subject to change.

| Week Of | Topic | Material |
|---|---|---|
| Jan 14 | Course Introduction | Syllabus |
| Jan 21 | Jan 21: No class—MLK Day; | |
| Jan 28 | | |
| Feb 4 | | |
| Feb 11 | Feb 15: Exam 1 | |
| Feb 18 | | |
| Feb 25 | | |
| Mar 3 | | |
| Mar 10 | Mar 9-16: Spring Break | |
| Mar 17 | | |
| Mar 24 | Mar 28: Exam 2 | |
| Mar 31 | | |
| Apr 7 | | |
| Apr 14 | | |
| Apr 21 | | |
| Apr 28 | Apr 28: Last day of class; Apr 30: Reading Day | |
| May 5 | Final Exam: Monday May 5 12:20-2:10 | |

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*Kevin R. Burger*
*Ira A. Fulton School of Engineering*
*School of Computing & Informatics—Dept. of Computer Science & Engineering*
*Arizona State University, Tempe, Arizona, USA, 85287-8809*
*Office: Brickyard 516*
*Email: burgerk[@-sign]asu.edu, Phone: +1 480.965.1493, Fax: +1 480.965-2751*
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