UNIVERSITY OF NEW HAMPSHIRE
DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

ECE649 – Embedded Microcomputer Based Design Spring 2008

COURSE DESCRIPTION

An in-depth treatment of the design of embedded microcomputer systems. Topics include; advanced architectures for embedded processors, hardware and software aspects of interfacing, handling interrupts, advanced programming including debugging of real-time systems, and embedded application implementations. Laboratory studies will be required to reinforce theoretical and applied concepts in an actual embedded architecture. Prerequisite: ECE562 or permission, 4 cr.

COURSE WEBPAGE: www.ece.unh.edu/courses/ece649

CREDITS: 4 credits

PRE-REQUISITES: ECE562 – Computer Organization

CO-REQUISITES: None

TEXTBOOK: Han-Way Huang., ***"The HCS12/9S12: An Introduction to Software and Hardware Interfacing",*** Thomson Delmar Learning

INSTRUCTOR: Frank Hludik
Instructor
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PERCENTAGE OF THIS COURSE DESIGNATED:

ENGINEERING SCIENCE:	50%
ENGINEERING DESIGN:	50%

COURSE GOALS:

1. To understand and describe how modern computer architecture concepts are implemented in embedded devices.

2. To understand memory and I/O device interfacing to the address, control and data bus, along with an understanding of the related timing diagrams, which describe the set up and data transfer process.

2. To use analysis, simulation, and debugging tools for the Motorola HCS12 embedded device. Metrowerks Code Warrior Development Studio will be used to develop software applications.

3. To interface external devices to the embedded system at both the hardware and software levels. External devices may include; switches and keyboards, LED and LCD displays, amplifiers, analog filters, D/A and A/D converters, synchronous and asynchronous data ports, timers, counters, DC and stepper motors.

4. To apply advanced programming techniques such as; debugging of real time embedded systems, handle interrupts and real time events, understand and apply concepts of threads and semaphores, and implement timing measurements and signal generation.

5. To apply your knowledge of embedded systems to specific application areas.

Course Objectives:

a) To understand and describe how advanced computer architecture concepts are implemented in embedded devices.

b) To understand memory and I/O device interfacing to the address and data bus, along with an understanding of the related timing diagrams, which describe the set up and data transfer process.

c) To use analysis, simulation, and debugging tools for the Motorola HCS12 embedded device. Metrowerks Code Warrior Development Studio will be used to develop software applications.

d) To interface external devices to the embedded system at both the hardware and software levels. External devices may include; switches and keyboards, LED and LCD displays, amplifiers, analog filters, D/A and A/D converters, synchronous and asynchronous data ports, and DC and stepper motors.

e) To apply advanced programming techniques such as; debugging of real time embedded systems, handle interrupts and real time events, understand and apply concepts of threads and semaphores, implement timing measurement and signal generation routines, and design of control and digital signal processing algorithms.

f) To apply the student's knowledge of embedded systems to specific application areas.

g) To be able to design and implement an entire embedded system as specified.

Topics:

1. Overview of Embedded Systems
2. MC68HC12 and HCS12 Architectures
3. Embedded Peripherals
4. Software Development
5. Debugging Methodologies

6. Embedded Background Debuggers
7. Abstraction
8. Memory Allocation
9. Real-time Execution and Systems
10. Power and Clock Management
11. Device Drivers
12. Threads
13. Synchronization of Software with I/O Transfer State
14. Parallel I/O Interfacing
15. Input Switches and Keyboards
16. Features of Interrupts on the HCS12 Embedded Device
17. Interrupt Vectors and Priority
18. Polling
19. Interrupt Polling using Linked Lists
20. Multithreaded Preemptive Scheduler
21. Address Decoding
22. General Memory Bus Timing
23. External Bus Timing
24. Memory Interfacing
25. RS232 and RS422 Asynchronous Serial Communications
26. CAN and Synchronous Serial Communications Protocols
27. A/D and D/A Interfacing and Sampling Issues
28. Analog Interfacing and Sensors
29. DC and Stepper Motor Control and Interfacing
30. Control Applications
31. Digital Filtering
32. Advanced Timer and Counter Circuits
33. Applications of Timers and Counters

Relationship of Course Objectives to Program Outcomes:

(0= no support; 1=weak support; 2=moderate support; 3=strong support)

	Course Objectives							
Program Outcomes		a	b	c	d	e	f	g
An ability to apply knowledge of mathematics, science, and engineering		3	3	3	3	3	3	3
An ability to design and conduct experiments, as well as to analyze and interpret data		3	3	3	3	3	3	3
An ability to design a system, component, or process to meet desired needs		3	3	3	3	3	3	3
An ability to function on multi-disciplinary teams		0	0	0	0	0	1	1
An ability to identify, formulate, and solve engineering problems		3	3	3	3	3	3	3
An ability to communicate effectively		1	1	1	1	1	3	3
An understanding of professional and ethical responsibility		2	2	2	2	2	3	3
The broad education necessary to understand the impact of engineering solutions in a global and societal context		1	1	1	1	1	3	3
A recognition of the need for, and ability to engage in life-long learning		1	1	1	1	1	3	3
A knowledge of contemporary issues		2	1	1	1	2	3	3
An ability to use techniques, skills, and modern engineering tools necessary for engineering practice		3	3	3	3	3	3	3

RESPONSIBILITIES:

It is the student's responsibility to come to class prepared for that day's discussion. This includes reading the assigned text prior to lectures and completing all assigned homework primarily by your own individual efforts and problem-solving skills. You should also accept the responsibility for providing constructive and timely feedback to the instructor so that your learning experience can be enriched to the fullest.

The instructor accepts the responsibility for clearly defining the material to be covered during this course and for facilitating your learning processes. Examples and homework will be closely related to the assigned reading and lectures; quiz and examination problems will test not only basic factual knowledge, but also your ability to associate and utilize factual material and problem-solving techniques in a new context. This is the essence of engineering!

HOMEWORK:

Homework problems and exercises will be assigned so that students may develop and master both the analytic and design skills stressed in this course. Assignments will be handed out sufficiently in advance so that students have ample time to read the material, attempt solution of problems, and clarify points of difficulty and/or misunderstanding. One of the ECE homework boxes is labeled ECE649 and is where you will be placing completed assignments. In general, written homework is due in the homework box by 4:30 PM on the assigned date. Late assignments will be accepted with a late penalty of 5 points per day. Do all homework by yourself. **DO NOT COPY ANSWERS FROM OTHERS!** If you do not understand an assignment you cannot perform well on exams. If you have difficulties with the homework contact the course instructor.

LABORATORY:

This course consists of an extensive laboratory experience. The laboratory entails laboratory exploratory assignments on an Axiom HCS12 based single board computer. Documentation on the Motorola HCS12 device and the Axiom board itself is contained on the course web site. The Laboratory portion of the course will help students gain experience with the concepts and techniques that are presented in lecture and reading assignments.

GRADING:

Exam #1	20%	Exams will be closed books and no notes
Exam #2	20%	
Final Exam	20%	
Laboratory Exercises	30%	
Homework Assignments	5%	
Quizzes	5%	Closed books and no notes

OFFICE HOURS:

Instructor office hours will be posted on his/her office door, announced in class, and placed on the main course webpage. Students having difficulty should help from the course

instructor. If you would like to make an appointment with the instructor you should talk (or email) to him/her directly to work out a mutually agreeable time to meet.

Course Content:

The following is a tentative list (not in order of presentation) of the course content. While it will be adhered to as closely as reason dictates, minor changes may be necessary from time to time; such modifications will be announced in class.

A detailed list of reading assignments, homework assignments, exam schedules, and laboratory exercises is available on the course web site. The web site will be updated daily.

- Overview of Embedded Systems
- MC68HC12 and HCS12 Architectures
- Embedded Peripherals
- Software Development
- Debugging Methodologies
- Embedded Background Debuggers
- Abstraction
- Memory Allocation
- Real-time Execution and Systems
- Power and Clock Management
- Device Drivers
- Threads
- Synchronization of Software with I/O Transfer State
- Parallel I/O Interfacing
- Input Switches and Keyboards
- Features of Interrupts on the HCS12 Embedded Device
- Interrupt Vectors and Priority
- Polling
- Interrupt Polling using Linked Lists
- Multithreaded Preemptive Scheduler
- Address Decoding
- General Memory Bus Timing
- External Bus Timing
- Memory Interfacing
- RS232 and RS422 Asynchronous Serial Communications
- CAN and Synchronous Serial Communications Protocols
- A/D and D/A Interfacing and Sampling Issues
- Analog Interfacing and Sensors
- DC and Stepper Motor Control and Interfacing
- Control Applications
- Digital Filtering and Z Transforms

LABORATORY

The laboratory portion of this course consists of the following six labs:

LAB #1 - Introduction to the CodeWarrior Development Environment

LAB #2 – Parallel and Serial Interfacing, Keypad and LCD Display Interfacing

LAB #3 – Real-time Interrupts and Response-Time Latency

LAB #4 – Multitasking Using Threads and Hardware Timers

LAB #5 – External Device Interfacing, Bus Architecture, and Digital Filtering

LAB #6 – DC and Stepper Motor Interfacing and Control

LAB #7 – Using the CAN Serial Bus (Optional if time allows)

ECE649 LABORATORY SCHEDULE

An "open" lab will be run in Kingsbury Hall room S322. Any time a system is free, you are welcome to use it. However, do not "hog" the systems. Because of this open access policy, there could be security and safety problems. There will be no safety problems if you **DO NOT TRY TO OPEN OR FIX ANY OF THE EQUIPMENT**. Don't try and fix what you think is an equipment problem. However, please report it as soon as possible, and tag the equipment with a note which includes the time, date, your name, and problem encountered. Moreover, you should report any unprofessional or inappropriate activities in the room to the instructor. If use of the room is abused, it will be necessary to either restrict activities to normal working hours (8:00AM - 5:00PM), or schedule regular lab sessions. Either alternative will reduce the flexibility, which allows you to govern your time to your advantage. Please cooperate.

Don't leave any messes in the laboratory areas. Dispose of your unwanted scrap paper in the recycle can by the door. Do not bring any food or drinks into the lab. Please clean up any mess, which you see. Let's keep our laboratory area clean for all.

Each laboratory assignment will include a brief written report that will be graded. In addition, the examinations will include questions related directly to the lab assignments.

You will be given an official "due date" for each exercise. However, you should try to do the exercise immediately. If you wait until the last few days before it is due, you may not have enough time to enable you to complete the work. I will be very unsympathetic toward students who wait until the last minute to perform homework or laboratory exercises.

Please be a responsible citizen of the class so that it will not be necessary to restrict laboratory area usage.

GRADING POLICY FOR LATE ASSIGNMENTS:

Five (5) points will be deducted from the assigned grade for each day an assignment is submitted late. Weekends are not counted.

POLICY FOR PLAGIARISM, COPYING ASSIGNMENTS, OR CHEATING ON EXAMS and QUIZZES:

Each student should submit his or her own original assignments. The course instructor reserves the right to fail students who collaborate on assignments. Students caught cheating on exams or quizzes will receive a failing grade for the exam or quiz.

DISABILITY STATEMENT:

If you are a student with a documented disability who will require accommodations in this course, please register with the Access Office in the Memorial Union Building, Room 118 (862-2607) for assistance in developing a plan to address your academic needs.