Course Information

INSTRUCTOR	Daniel Llamocca
CONTACT INFO	email: llamocca@oakland.edu
OFFICE HOURS	Wednesday 2:00 to 4:00 pm @ Room EC-438, or by appointment
LECTURES	Tuesday/Thursday 5:30 pm - 7:17 pm @Room EC-279
LABORATORY	002: Friday 9:00 am - 11:59 am @ Room EC-560 003: Friday 1:00 pm - 3:59 pm @ Room EC-560 TAs: Lincoln Lorenz ljlorenz@oakland.edu Nitin Mohan nmohan@oakland.edu

COURSE CATALOG DESCRIPTION: ECE 470 - Microprocessor-Based System Design (4 credits)

Application of microprocessors and microcomputers to the solution of typical problems, interfacing microprocessors with external systems such as sensors, displays and keyboards; programming considerations, microcomputer system and memory system design. A laboratory, design course; several short design projects and one large design project. Written report and oral presentation required. Credit cannot be earned for both CSE 470 and ECE 470. Offered fall, winter. Prerequisites: ECE 378 and major standing.

COURSE WEBPAGE

- The course material will be hosted on Moodle (moodle.oakland.edu). Grades will be periodically posted via this system.
- As a backup resource, the material will also be posted at: www.secs.oakland.edu/~llamocca/Fall2014_ece470.html

TEXTBOOK:

- Han-Way Huang, *HCS12/9S12: An Introduction to Software and Hardware Interfacing*, 2nd Ed., Cengage Learning, 2009. (the first edition will also work)

EXTRA REFERENCES:

- S.F. Barrett and D.J. Pack, *Embedded Systems: Design and Applications with the 68HC12 and HCS12*, Prentice Hall, 2005.
- F.M. Caddy, *Software and Hardware Engineering: Assembly and C Programming for the Freescale HCS12 Microcontroller*, 2nd Ed., Oxford University Press, 2007.
- M.A. Mazidi, D. Causey, and J.G. Mazidi, *HCS12 Microcontrollers and Embedded Systems*, Prentice Hall, 2008.
- D.J. Pack and S.F. Barrett, *Microcontroller Theory and Applications: HC12 and S12,* 2nd Ed., Prentice Hall, 2007.
- R.E. Haskell and D.M. Hanna, *Programming the DRAGON12-Plus-USB in C and Assembly Language Using CodeWarrior*, LBE Books, 2008.
- K.A. Smith, *Teamwork and Project Management*, 4th Ed., McGraw-Hill, 2013.

COURSE OBJECTIVES

1. Write assembly language subroutines and call them as functions from a C program. (a,k)
2. Use an A/D converter to read analog signals into a microcontroller. (a,b)
3. Describe the Output Compare and Input Capture operations in a timer module of a microcontroller. (a,e)
4. Generate Pulse-width modulation (PWM) signals on a microcontroller suitable for controlling the speed of a DC motor or the position of a servo. (a,e)
5. Describe how hardware interrupts work on a microcontroller. (a,k)
6. Describe how serial data can be sent from one microcontroller to another using an SCI port, an SPI port, or a CAN bus. (i,k)
7. Demonstrate the ability to interface external devices (including sensors) to a microcontroller. (a,i,k)
8. Work in a team environment to design a microprocessor-based system and communicate the results in a written report and an oral presentation. (a,b,c,e,g,h,i,j,k)

Course Outcomes:

a	b	C	d	e	f	g	h	i	j	k

GRADING SCHEME:

Homeworks:	15%	**Final Project:**	15%
Quizzes:	10%	**Midterm Exam**:	20% (October 21st, 5:30-7:17 pm)
Laboratory:	20%	**Final Exam**:	20% (December 9th, 7:00-10:00 pm)

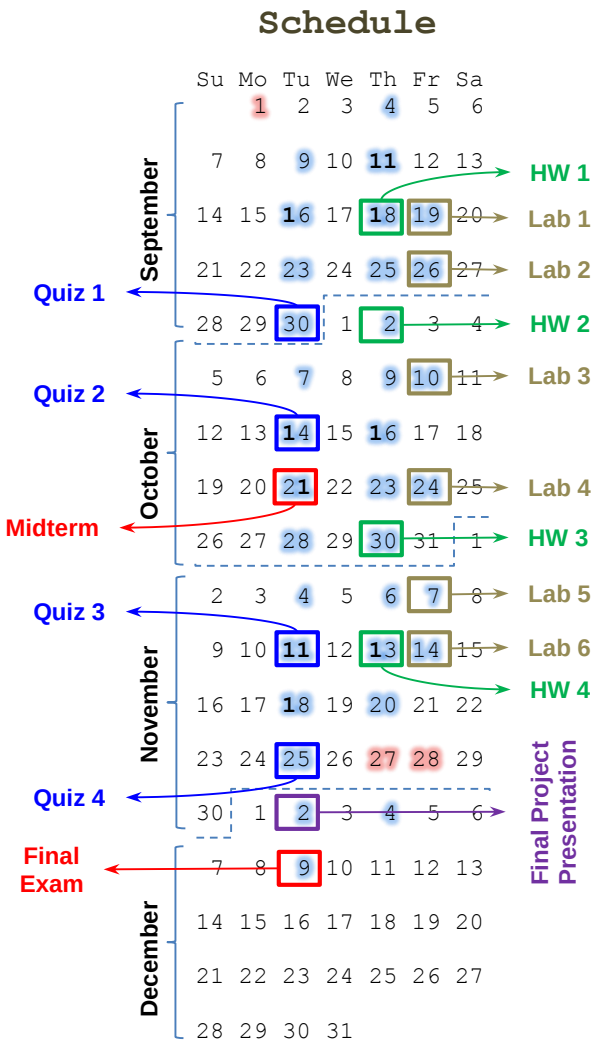
- **Homeworks:** Homework assignments are meant to strengthen your conceptual understanding of the topics. Completing homework assignments is a key component of this course as it will help students master the course material and prepare them for the exams.
  Homeworks will be posted according to the schedule (green rectangles). Students have one week to turn in the completed assignments in class. Late submissions are NOT accepted.

- **Quizzes:** They will have a duration of 20 minutes at the beginning of the class.

- **Exams:** Closed-books, closed-notes, in-class exams. The final exam will be a comprehensive test that will cover the whole syllabus. Students are not allowed to take the exams neither before nor after the exam date. Make-up exams are given *only* under extreme circumstances (such as a medical emergency).

- **Laboratory:** This is an important component of the class and it will reinforce your understanding of the topics. There will be six (6) labs throughout the semester.
  A TA will be present during the regularly scheduled laboratory times. Students can work during those hours or they can work at any other time and place.
  Students have one week to turn in the lab assignments and the lab report. This will only be checked by the TA during the regularly scheduled laboratory times.

- **Final Project:** Students will be expected to work on a Final Project (details will be announced after the Midterm). Students will work in groups. Each group will prepare an oral presentation and submit a final report. The presentation will take place on December 2nd.



GRADE ASSIGNMENT:

90-100	3.6 to 4.0 (A)
80-89	3.0 to 3.5 (B)
60-79	2.0 to 2.9 (C)
50-59	1.0 to 1.9 (D)
49 and below	0.0 (no credit)

LABORATORY MATERIALS

- **Hardware**: Dragon12-Light Board pre-loaded with Freescale Serial Monitor for CodeWarrior
  - ✓ To order the board, visit: http://www.evbplus.com/hcs12_9s12_store/students.html
    Select the Dragon12-Light-SM Board (Part Number DVB-023 SM)

- **Software**: CodeWarrior for HCS12(X) Microcontrollers (Classic) v5.1 (Special Edition):
  - ✓ To download, visit: http://www.freescale.com/webapp/sps/site/overview.jsp?code=CW_SPECIALEDITIONS
  - ✓ Select the "Special Edition: CodeWarrior for HCS12(X) Microcontrollers (Classic)"

OUTLINE OF TOPICS

Introduction to Microprocessor-based systems (Ch. 1 textbook: 1.1 - 1.6)	Computer Hardware Organization Memory Memory System Operation Program Execution
Review of number systems and binary arithmetic	Binary number system Octal and hexadecimal representations Binary codes: ASCII, Unicode, BCD Representation of signed numbers Binary arithmetic: addition and subtraction, arithmetic overflow Multiprecision addition and subtraction BCD Addition
Overview of the HCS12 Microcontroller (Ch. 1 textbook: 1.7 - 1.12)	HCS12 CPU Registers HCS12 Addressing modes Addressing more than 64 KB A Sample of HCS12 Instructions Instruction Queue
Assembly Language Programming (Ch. 2 textbook: 2.1 - 2.11, Ch. 4 textbook: 4.3-4.5)	Assembly Language Program Structure Assembler Directives Writing Programs to do Arithmetic Program Loops Shift and rotate Instructions Boolean Logic Instructions, Bit Test and Manipulate Instructions Program Execution Time The Multiply-and-Accumulate (emacs) Instruction The Stack, Subroutines
Hardware and Software Development Tools for the HCS12 (Ch. 3 textbook: 3.1, 3.2, 3.8, Ch. 4 textbook: 4.10, 4.11)	Development Tools for the HCS12 The Dragon12 Light Board Using CodeWarrior and the Serial Monitor Introduction to Parallel I/O Port and Simple I/O Devices
C Language Programming (Ch. 5 textbook: 5.1 - 5.8, 5.10, 5.11)	Introduction to C. Types, Operators and Expressions Control Flow, Input and Output Functions and Program Structure Pointers, Arrays, Structures, and Unions Writing C Programs to perform Simple I/O Using the CodeWarrior IDE to develop C Programs *Call assembly language subroutines as C functions*
Interrupts and Exceptions (Ch. 6 textbook: 6.1 - 6.6, 6.7, 6.8, 6.10)	Fundamental concepts of interrupts HCS12 Exceptions Interrupt Programming in C Language Real-Time Interrupt, Resets
Parallel I/O (Ch. 7 textbook: 7.1-7.6, 7.8)	I/O Related Issues, I/O Addressing Issue, I/O Synchronization The HCS12 Parallel Ports Electrical Characteristics Considerations for I/O Interfacing Using the Liquid Crystal Display (HD44780)
Timer functions (Ch. 8 textbook: 8.1-8.8, 8.10, 8.11)	Standard Timer Module. Timer Counter Register Input-Capture and Output-Compare Functions Pulse Accumulator Modulus Down Counter Pulse-Width Modulation (PWM) Function: DC Motor Control
Serial Communication (SCI, SPI, I^2C) (Chs. 9, 10, 11)	Serial Communication Interface (SCI) Serial Peripheral Interface (SPI): Using the D/A Converter (LTC1661 DAC) Inter-Integrated Circuit (I^2C) Interface
Analog to Digital Conversion (Ch. 12 textbook: 12.1-12.3, 12.5, 12.6)	Basics of A/D Conversion The HCS12 A/D Converter Procedure for Performing A/D Conversion Using the Temperature Sensor LM45
Introduction to Controller Area Network (CAN) (Ch. 13 textbook: 13.1-13.9)	Overview of CAN CAN Messages, Error Handling, Fault Confinement CAN Message Bit Timing Overview of the HCS12 CAN Module

CLASS POLICIES

- **Academic conduct policy**: All members of the academic community at Oakland University are expected to practice and uphold standards of academic integrity and honesty. Academic integrity means representing oneself and one's work honestly. Misrepresentation is cheating since it means students are claiming credit for ideas or work not actually theirs and are thereby seeking a grade that is not actually learned. Academic dishonesty will be dealt with seriously and appropriately. Academic dishonesty includes, but it is not limited to cheating on examinations, plagiarizing the works of others, cheating on lab reports, unauthorized collaboration in assignments, hindering the academic work of other students.

- **Special Considerations**: Students with disabilities who may require special consideration should make an appointment with campus Disability Support Services, 106 North Foundation Hall, phone 248 370-3266. Students should also bring their needs to the attention of the instructor as soon as possible. For academic help, such as study and reading skills, contact the Academic Skills/Tutoring Center, 103 North Foundation Hall, phone 248 370-4215.

- **Add/Drops**: The university policy will be explicitly followed. It is the student's responsibility to be aware of deadline dates for dropping courses.

- **Attendance**: It is assumed that the students are aware of and understand the university attendance policy. Attendance is mandatory and maybe monitored. Students are responsible for all material covered in classes that they miss. There will no excuses for being late to quizzes/exams.

- **Athlete Excused Absences**: Students shall inform the instructor of dates they will miss class due to an excused absence prior to the date of that anticipated absence. For activities such as athletic competitions whose schedules are known prior to the start of a term, students must provide their instructors during the first week of each term a written schedule showing days they expect to miss classes. For other university excused absences, students must provide the instructor at the earliest possible the dates that they will miss.

- **Special Circumstances:** The instructor should be notified as early as possible regarding any special conditions or circumstances which may affect a student's performance during the course timeframe (e.g., medical emergencies, family circumstances).

- **Cellphones**: A ringing cellphone going off during a lecture is disruptive to other students as well as the instructor. Students are strongly advised to set their cellphones to vibrate (not ringing) and leave the classroom discretely to answer the phone.