Microcomputer Architecture and Interfacing – EENG383
http://inside.mines.edu/~coulston/courses/EENG383
Spring 2017

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Office:	**BB 310F (Brown Hall)**				
Office hours:	MWF 12:00 – 1:30				
Course Title:	**Microcomputer Architecture and Interfacing**				
Course Meeting:	Lecture	MWF	8:00-8:50	235 Marquez Hall	Chris Coulston
	Lab A	R	8:00-10:50	305 Brown	Hisham Hamida
	Lab B	R	11:00-1:50	305 Brown	Hisham Hamida

Course Description: Microprocessor and microcontroller architecture focusing on hardware structures and elementary machine and assembly language programming skills essential for use of microprocessors in data acquisition, control, and instrumentation systems. Analog and digital signal conditioning, communication, and processing. A/D and D/A converters for microprocessors. RS232 and other communication standards. Laboratory study and evaluation of microcomputer system; design and implementation of interfacing projects.

Prerequisite(s): EENG 284 – Digital Logic

Textbook(s):
(Required) PIC 18F26K22 Technical Documents

Course Objectives:
Design and build microprocessor based data acquisition and control systems. In order to accomplish this, there are detailed objectives for specific topics:

1. Microcomputer programming. The student will have the ability to design programs for microcontrollers in assembly language, with the use of different addressing modes, subroutines and stack operations, and interrupts. The student will have the ability to explain the instruction execution cycle, and derive the results of instruction execution. The student will have the ability to classify flowcharts and pseudo-code documentation as to whether they are correctly structured or incorrectly structured.
2. Microcontroller architecture. The student will have the ability to explain the overall hardware architecture of microcontrollers, including busses, memories, and input/output subsystems. The student will have the ability to apply timer and A/D subsystems to solve measurement and control tasks. The student will have the ability to derive the signals on the address, data, and control busses at each clock cycle. The student will have the ability to design modifications and enhancements to a microcontroller system.
3. Microcontroller interfacing. The student will have the ability to derive waveforms for serial communications interfaces. The student will have the ability to apply microcontrollers and external circuitry to interface to a variety of sensors.

ABET Student Outcomes Addressed by Course:
Criteria A: An ability to apply the knowledge of mathematics science and engineering.
Criteria C: An ability to design a system, component or process to meet the desired needs within realistic constraints such as economic, environmental, social political, health and safety, manufacturability and sustainability.
Criteria E: An ability to identify, formulate and solve engineering problems.
Criteria K: An ability to use techniques, skills and modern engineering tools necessary for engineering practice.

Topics Covered: This is an approximate timeline; changes may be made through the semester.

Session	Date	Topic	Assignment
1	Jan10 (M)	Introduction and data representations	
2	Jan 11	Embedded C programming – operations	
3	Jan 13	Embedded C programming – conditionals	
	Jan 16 (M)	Martin Luther Day – No class	
4	Jan 18	Embedded C programming – looping	
Lab 1	Jan 19	CodeWarrior "Hello world"	
5	Jan 20	Embedded C programming – arrays	Turn-in: In-lab 1
6	Jan 23 (M)	Embedded C programming – subroutines	
7	Jan 25	General purpose input/output (GPIO)	
Lab 2	Jan 26	Buttons and LEDs	Turn-in: Lab 1
8	Jan 27	Timers	Turn-in: In-lab 2
9	Jan 30 (M)	Timers	
10	Feb 1	Timers	
Lab 3	Feb 2	Tones	Turn-in: Lab 2
11	Feb 3	Compare	Turn-in: In-lab 3
12	Feb 6 (M)	PWM	
13	Feb 8	Capture	
Lab 4	Feb 9	RS-232 and DC motors	Turn-in: Lab 3
14	Feb 10	Interrupts	Turn-in: In-lab 4
15	Feb 13 (M)	Interrupts	
16	Feb 15	Interrupts	
Lab 5	Feb 16	Servo motor	Turn-in: Lab 4
17	Feb 17	Exam Review	Turn-in: In-lab 5
	Feb 20 (M)	Presidents Day – No class	
18	Feb 22	Exam I	
Lab 6	Feb 23	IR Decode	Turn-in: Lab 5
19	Feb 24	Analog to Digital Conversion	Turn-in: In-lab 6
20	Feb 27 (M)	Anti-Alias Filter	
21	March 1	Anti-Alias Filter	
Lab 7	March 2	Ultrasonic range finder	Turn-in: Lab 6
22	March 3	DAC with PWM	Turn-in: In-lab 7
23	March 6 (M)	Fixed Point	
24	March 8	Fixed Point	
Lab 8	March 9	LCD	Turn-in: Lab 7
25	March 10	Fixed Point	Turn-in: In-lab 8
26	March 13 (M)	Look-up tables	Turn-in: project proposal
27	March 15	Direct Digital Synthesis	
Lab 9	March 16	ADC - microphone	Turn-in: Lab 8
28	March 17	Direct Digital Synthesis	Turn-in: In-lab 9 Return: Project proposal
29	March 20 (M)	Watch dog timers	Turn-in: Revised project proposal
30	March 22	Memory organization	
Lab 10	March 23	Function generator	Turn-in: Lab 9
31	March 24	Pointers	Turn-in: In-lab 10 Return: Revised project proposal
	March 25-31	Spring Break – No class	
32	April 3 (M)	Hardware Programmers Model	Turn-in: Project plan
33	April 5	Assembly Language – operations	
Lab 11	April 6	Capacitive touch sensor	Turn-in: Lab 10
34	April 7	Assembly Language – conditionals	Turn-in: In-lab 11 Return: Project plan
35	April 10 (M)	Assembly Language – looping	Turn-in: Revised project plan
36	April 12	Assembly Language – subroutines	
Lab 12	April 13	Assembly Language "Hello world"	Turn-in: Lab 11
37	April 14	Exam Review	Turn-in: In-lab 12 Return: Revised project plan
38	April 17 (M)	Exam II	
39	April 19	Project – no class	
Lab 13	April 20	Project work	Turn-in: Lab 12
	April 21	E-Days – No class	
40	April 24 (M)	Project – no class	
41	April 26	Project – no class	
Lab 14	April 27	Project work	Grade milestone 1
42	April 28	Project – no class	
43	May 1 (M)	Project – no class	

44	May 3	Project – no class	
Lab 15	May 4		Grade milestone 2
	May 5	Dead day – No class	

Lab: We will meet weekly in room BB305 in Brown Hall. The lab assignments consist of two parts, an In-lab and a lab. The In-lab is intended to be worked on during the scheduled lab period, the lab is designed to be completed outside the lab period. Unless otherwise instructed, students will work in teams of two. Each team will check out a kit from the technician in room, containing the parts that will be used throughout the semester. You can take the kits home to work on assignments, or leave them in the lab. We will have a series of lab projects; usually one per week. All handouts, data sheets, and other material are on the course website. Bring the kit, and a notebook for taking notes and data. It will also be helpful to bring a USB drive, for capturing oscilloscope displays. You are to email the completed lab report (in pdf format) to the lab instructor after each lab. Please send See Lab Report Guidelines for instructions posted on the class web page for further details. The report is due prior to the beginning of the next lab period on the following week. Your team should only submit a single lab report from each team. The report should be professional in writing style, content, and appearance. If figures are hand drawn, they must be neat. Scan any hand-drawn figures and paste them into your document. It is acceptable to attach long figures and program listings to the end of the report (be sure to label them with a figure number and caption). Grading will be based on the rubric attached to each lab assignment.

Office Hours: I like to pile everyone in my office during office hours. What this means is I generally like to have everybody in the office asking questions. In this way many problems can be addressed at once. If you would like to talk one on one, please let me know so that I can clear everyone out.

Computers: We will be working with computers throughout this semester. Inevitably there will be problems that you will encounter. If a computer or its software are malfunctioning, then please report it. I want you to deal with HW/SW problems in a manner conducive to engineering students; deal with the lab staff in an objective and rational manner. The computer center staff works hard to keep our problems to a minimum. Establishing a positive relationship with them will help expedite solutions to any problems we may have. If there are major problems with the system during critical times, I will have been made aware of them and will determine an appropriate course of action.

Programs: Programming assignments will be evaluated using a two stage process. The first step will assess the state of the implementation. I have identified three broad categories below.

Symptom	Max grade	Min Grade
Does not compile	0%	0%
Does not meet minimum spec	60%	0%
Functions correctly	100%	60%

If a program functions correctly then it will be evaluated according to the following rubric.

Comments	10%
Style	20%
Correctness	70%

- **Comments** All files turned in must have at a minimum description declaring the basic fact about your program. At a minimum the following comment block needs to be at the top of the file.

```
-----------------------------------------------------------------
-- Name: <Your Name>
-- Date: <This file's name>
-- Lab:  <Lab# and name>
--
-- Purp:      A brief description of what this program does and
--            the general solution strategy.
-- Assisted:    <list the names of the people who you helped>
-- Assisted by: <list the names of the people who assisted you>
--
-- Academic Integrity Statement: I certify that, while others may have
-- assisted me in brain storming, debugging and validating this program,
-- the program itself is my own work. I understand that submitting code
-- which is the work of other individuals is a violation of the course
-- Academic Integrity Policy and may result in a zero credit for the
-- assignment, or course failure and a report to the Academic Dishonesty
-- Board. I also understand that if I knowingly give my original work to
-- another individual that it could also result in a zero credit for the
-- assignment, or course failure and a report to the Academic Dishonesty
-- Board.
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- **Style** is a subjective measure which evaluates how effectively the solution was arrived at. The following are attributes which constitute good style practices.
    - Minimizing the amount of code (within reasons).
    - Minimizing the amount of data storage (within reason).
    - Approach the problem in an obvious manner.
    - Breaking the problem into logical subcomponents.
    - Writing reusable code.
    - Consistently use all upper-case letters for constants (#define's)
    - Consistently use camel case for variables
    - Consistently use all upper-case letters for function names
- **Correctness** You may be asked to demonstrate your program. If so I will query you on its operation and behavior.

Exams: Please:

1. Arrive at least 10 minutes before the exam starts.
2. Bring a pencil, not a pen.

Makeup Exams: Makeup exams will be offered in the case of exam conflicts. If some major emergency should arise and you cannot make it to an exam it is your responsibility to:

1. Contact me at my office phone (303.273.3265), or
2. Contact me by email (coulston@mines.edu).

Contact me as soon as you are able to return to campus. In general, I am pretty understanding about makeup exams – I do not want anyone hurt attempting to make it to campus as a result of foul weather. Please show me the same respect as you would like me to show you in complying with these guidelines.

Grades:
The grade you earn in this class will based on the following distribution of points:

Exam 1	15%
Exam 2	15%
Labs	30%
Project	25%
HW+Quiz	15%

Grade	Upper	Lower
A	100	92.5+
A-	92.5-	90.0+
B+	90.0-	87.5+
B	87.5-	82.5+
B-	82.5-	80.0+
C+	80.0-	77.5+
C	77.5-	72.5+
C-	72.5-	70.0+
D+	70.0-	67.5+
D	67.5-	62.5+
D-	62.5-	60.0+
F	60.0-	0.0

Academic Integrity:
The Colorado School of Mines affirms the principle that all individuals associated with the Mines academic community have a responsibility for establishing, maintaining and fostering an understanding and appreciation for academic integrity. In broad terms, this implies protecting the environment of mutual trust within which scholarly exchange occurs, supporting the ability of the faculty to fairly and effectively evaluate every student's academic achievements, and giving credence to the university's educational mission, its scholarly objectives and the substance of the degrees it awards. The protection of academic integrity requires there to be clear and consistent standards, as well as confrontation and sanctions when individuals violate those standards. The Colorado School of Mines desires an environment free of any and all forms of academic misconduct and expects students to act with integrity at all times. Academic misconduct is the intentional act of fraud, in which an individual seeks to claim credit for the work and efforts of another without authorization, or uses unauthorized materials or fabricated information in any academic exercise. Student Academic Misconduct arises when a student violates the principle of academic integrity. Such behavior erodes mutual trust, distorts the fair evaluation of academic achievements, violates the ethical code of behavior upon which education and scholarship rest, and undermines the credibility of the university. Because of the serious institutional and individual ramifications, student misconduct arising from violations of academic integrity is not tolerated at Mines. If a student is found to have engaged in such misconduct sanctions such as change of a grade, loss of institutional privileges, or academic suspension or dismissal may be imposed. For this course, the following rules should be followed.

- All students must turn in individual homework (unless otherwise stated) and they must understand what they turn in.
- Copying of solutions without understanding them is not allowed; if a student copies a solution and cannot explain it adequately this is considered academic dishonesty.
- For computer exercises, each student is expected to generate his/her own solution (i.e. one cannot simply copy another person's computer solution and modify it slightly to make it look like it is your own work).
- During quizzes and exams (both in-class and take-home), students must do 100 percent of the work on their own.
- The nominal penalty for academic dishonesty is an 'F' in the course.

Disability Support Statement:
The Colorado School of Mines is committed to ensuring the full participation of all students in its programs, including students with disabilities. If you are registered with Disability Support Services (DSS) and I have received your letter of accommodations, please contact me at your earliest convenience so we can discuss your needs in this course. For questions or other inquiries regarding disabilities, I encourage you to visit disabilities.mines.edu for more information.