ELECTRICAL ENGINEERING 382

Microcomputer Programming

POLICIES AND ADMINISTRATION

1. **Instructors:**

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2. **Course Goals**

Cadets shall develop the skills to design, implement, test, and debug microcontroller-based systems by developing operational assembly language programs that incorporate the built-in microcontroller functions, and by successfully interfacing the microcontroller to the external world.

3. **Course Objectives:**

Each cadet should be able to:

1. Design assembly language programs which utilize the built-in functional units of a specified microcontroller
2. Interpret and explain orally and in writing the functions of a given assembly language program as well as laboratory work
3. Evaluate, analyze, debug, and modify a given program to improve its execution of a specified task
4. Demonstrate a working knowledge of the on-board hardware components of a microcontroller and implement an interface between a specified microcontroller and other hardware.
5. Demonstrate the ability to solve well and ill defined problems
6. Demonstrate knowledge of the role of Air Force engineering officers in our global society and contemporary military and engineering issues.

4. **Course Prerequisites:** Comp Sci 110 and El Engr 281.

5. **Grade Distribution and Policy:**

	Prog	**Final**
GRs	40 (1)	20 (2)
Labs*	45 (3)	40 (8)
HW/Quizzes	15	10
Final		25
Subjective		5
TOTAL	100	100

Grade	Grade
$90 \le A \le 100$	$74 \le C+ < 77$
$87 \le A- < 90$	$70 \le C < 74$
$84 \le B+ < 87$	$67 \le C- < 70$
$80 \le B < 84$	$60 \le D < 67$
$77 \le B- < 80$	$0 \le F < 60$

*** You must complete every lab (even for zero credit) to pass the course.**

6. **Early and Late Work Policy:** All work is due as shown on the syllabus.

Early: As a reward for early completion of work, an additional 5% per duty-day (up to a maximum of 10%) may be earned for turning in work ahead of schedule. Note that early work must be complete and of the highest standard to qualify for this bonus (i.e., deserving of an "A" prior to the addition of the bonus).

Late: If problems arise with graded assignments, see your instructor in advance. Assignments turned in later than the due date without prior permission from the instructor will be penalized as follows (note change in DFEC late policy from "Duty Day" to "Day"):

How Late?	Penalty
0 – 24 hours	**10%**
24 – 48 hours	**30%**
48 – 72 hours	**60%**
> 72 hours	**100%**

7. **Course Materials.**
Course Text: *Microcontroller Theory and Applications: HC12 & S12, 2nd edition*, Daniel J. Pack and Steven F. Barrett, Prentice Hall, 2008.
Text Errata: http://wwweng.uwyo.edu/electrical/faculty/barrett/68hc12/errata.pdf
Course URL: http://discovery/ee382

8. **EI Policy:** Schedule EI with your instructor if you are having difficulty with the course material. You must have read the assignment and attempted the homework BEFORE requesting EI. Note: You are responsible for material if you miss class, so get notes from someone in your section. For example, if you miss the lesson where the instructor announces a quiz for the next lesson or the instructor assigns homework due next lesson, you are still responsible for the quiz, homework, or any other assignments made. It is in your best interest to check with your classmates after an absence. After you've read the assignment, attempted the homework, and checked with your classmates, you may then schedule EI if you have difficulty with the material—not to make up class.

9. **CAS Policy:** You must notify your instructor of any class absence (with a descriptive reason—don't send just the SCA number) as soon as possible, preferably before the absence occurs. You must use e-mail to notify your instructor.

10. **Collaboration Policy:** For all assignments in this course, you may work with any faculty members or student *currently* enrolled in EE 382 unless otherwise indicated. We expect all graded work, to include software programs, wired circuits, lab notebooks, and written reports, to be your own work. If they aren't, you've copied and will receive **no academic credit** even if the copying is documented. Further, copying without attribution is dishonorable and will be dealt with as a suspected honor code violation. As in all courses, cadets must document any assistance received in the execution of any graded work. If you receive no assistance on an exercise, the use of the **Documentation: None** statement is mandatory. If no documentation statement exists, the assignment will be returned for correction and the work will be considered late.

11. **Homework:** Reading assignments are provided in the syllabus and should be accomplished ***prior*** to the designated class. Homework problems are also provided in the syllabus. It will be your instructor's prerogative to collect or grade homework.

12. **Laboratories:** The labs make up a significant portion of both your prog and final grades and you must complete each one (even for zero credit) to pass the course. A disciplined approach to design, implementation and testing are key to your success! Wiring and coding the entire lab and then trying to figure out why it doesn't work (they almost never do), can be incredibly painful and time consuming. Our experience shows that students who get behind on the labs need to catch up immediately, else the burden of uncompleted labs builds to inescapable levels.

13. **Lab Notebooks:** Lab notebooks are heavily emphasized in this course and will be our primary tool for assigning lab grades. Their format must follow the *DFEC Standard for Writing Lab Notebooks.* The lab notebook is maintained as a journal of your lab experience and should allow you, or any knowledgeable engineer, to recreate your project. For this course, your notebook should contain at least the following (as applicable to the particular lab):

a. Descriptive title
b. Objectives or purpose
c. Preliminary design
d. Software algorithms
e. The .LST file for code
f. Hardware schematic
g. Testing data
h. Answers to Lab Questions
i. Observations and Conclusions
j. Documentation

The actual format is flexible, so don't be afraid to add something later. All lab reports must stand up to the "**hit by a bus**" standard. Should you die, another engineer must be able to continue your work without trouble. Although handwritten (and in ink), it must be neat. Erroneous entries (and large amounts of white space) must be lined out with a single line, never obliterated. Each page of the notebook must be signed and dated by you. Papers such as computer printouts may be pasted in the notebook with the following restrictions: do not cover up any writing, be sure the edges of the pasted paper don't hang out beyond the edge of the notebook page. Cut and paste the grading criteria on the first page of the lab. In general, the lab handout may be cut-n-pasted in as parts a & b from the list above.

All schematics will be done with a computer program. Pen and Ink changes are fine.

You are expected to keep your notebooks current as you work on a lab. An automatic 10% deduction will be assessed against your lab grade if an instructor finds an incomplete write-up.

14. **Exams:** All exams are closed textbook and notes. Cadets are allowed to use only the provided Motorola documents and data sheets for exams and quizzes. Both laboratory and classroom work will appear on exams. For missed GRs, the following policies are outlined in USAFA FOI 537-3:

- Scheduled Absence - If you know that you will be unable to take the GR during the scheduled GR period, you are required to inform your instructor as soon as possible before the GR and to schedule a make-up exam.

- Unscheduled Absence - If you miss the GR for reasons beyond your control (e.g. hospitalization, emergency leave, delayed field trip return, etc.) you must contact DFEC (x3190) within two working days to schedule a makeup. Exceptions can only be granted by the Department Head.

15. **Professional Component Items:** This course discusses economic considerations and manufacturability and sustainability as they pertain to engineering. It also addresses the role of Air Force engineering officers in our global society as well as contemporary military and engineering issues.

16. **Miscellaneous:** This course is designed to help you in your development as an electrical and computer engineer. Feel free to provide feedback on the lessons and labs at any time. If you have ideas to improve or enhance the course, please let me know. The class builds on concepts from the prerequisites so it is important for you to seek help as soon as you need it. Procrastination is truly the enemy in an assembly language course. A little foresight and planning and a lot of effort will result in an extremely rewarding experience serving as the basis for future microcontroller work.

DR. DANIEL J PACK
Course Director, ECE 382

EE 382 Fall 2008 Syllabus
Block 1 Objectives and Assignments

This block introduces you to the 68HC12A4 Evaluation Board (EVB) and assembly language. By the end of the block, you should feel comfortable with writing, assembling, downloading, and running assembly language programs on the 68HC12A4 EVB.

In this block, you should learn how to:

- Design assembly language programs, which use the built-in functional units of a specified microcontroller.
- Interpret and explain, orally and in writing, the functions of a given assembly language program.
- Evaluate, analyze, debug, and modify a given program to improve its execution of a specified task.

Lsn	Lab	Topic	Reading	Assignments	Items Due
1		Course Introduction. Intro to the HC12 & S12.	pgs 1 – 15	Numbering Systems Review	
2		Programming Model. HC12/S12 Instruction Set & Execution.	pgs 16 – 25	F2.1, F2.5	
3		Addressing Modes. Lab 1 Introduction.	pgs 49 – 54 Lab 1	F2.3, F2.7, F2.8, F2.9, F2.14, A2.3 — A2.8	**Numbering Systems Review**
4	√	Lab 1 – Introduction to the HC12/S12.		Lab 1	
5		Branch Instructions.	pgs 54 – 60	A2.2, A2.9	**Lab 1 Worksheet**
6		Basic Instruction Set.	pgs 25 – 32 pgs 45 – 46 pgs 77 – 79	C2.1	
7		Logical, Arithmetic Operations.	pgs 32 – 45		
8		Directives. Assembly Process. Lab 2 Introduction.	pgs 60 – 62 pgs 73 – 77 Lab 2	F2.12, F3.1, F3.3 Lab 2 Pre-lab	
9	√	Lab 2 – Loops/Branches "Simple Calculator"		Lab 2	**Lab 2 Pre-lab**
10	√	Lab 2 – Loops/Branches		Lab 2	
11		The Stack. Subroutines.	pgs 79 – 84 pgs 84 – 92	F3.5, F3.6, A3.2	**Lab 2 Notebook**
12		Structured Design and Test. Lab 3 Introduction.	pgs 100 – 110 Lab 3	F3.4 Lab 3 Pre-lab	
13	√	Lab 3 – Subroutines.		Lab 3	**Lab 3 Pre-lab**
14		GR #1			

EE 382 Fall 2008 Syllabus
Block 2 Objectives and Assignments

This block shifts focus from assembly language programming to the hardware components of a basic microcontroller. You will need the skills from the previous block to write programs to control these components as well as hardware interfacing skills. We also introduce the 68HC9S12 microcontroller in this block.

In this block, you should learn how to:
- Interface with provided D-Bug12 subroutines to perform Input/Output (I/O) operations.
- Interface with external devices and perform I/O using the 68HC12's parallel I/O hardware.
- Initialize, program, and interface with the 68HC12's interrupt system.
- Use the 68HC12's powerful timing system to perform "real-time" processing.

Lsn	Lab	Topic	Reading	Assignments	Items Due
15		D-Bug12 Subroutines.	pgs 93 – 100 Lab 4	Lab 4 Pre-lab	
16		Ports and Parallel I/O.	pgs 177 – 189	A5.6, A5.7	**Lab 3 Notebook**
17		Parallel I/O and Polling. Software Delay Routines. Lab 4 Introduction.	pgs 195 - 212	Lab 4 Pre-lab	
18	√	Lab 4 - Polling & D-Bug12 Subroutines.		Lab 4	**Lab 4 Pre-lab**
19	√	Lab 4 – Polling/D-Bug12		Lab 4	
20	√	Lab 4 – Polling/D-Bug12		Lab 4	
21		Interrupts & Interrupt Service Routines.	pgs 189 – 192 pgs 217 – 224	A5.1, A5.2	
22		HC12/S12 Interrupt System. Lab 5 Introduction.	pgs 224 – 250 Lab 5	Lab 5 Pre-lab	**Lab 4 Report**
23	√	Lab 5 – Parallel I/O & Interrupts		Lab 5	**Lab 5 Pre-lab**
24		HC12/S12 H/W Config. External Flags. Timing System.	pgs 163 – 177 pgs 267 – 285 pgs 309 – 310	A5.8, A5.9	**Lab 5 Notebook**
25		Input Capture.	pgs 285 – 290 pgs 293 – 297 pgs 302 – 304	F7.1, F7.2	
26		Output Compare. Lab 6 Introduction.	pgs 290 – 297 pgs 304 – 308 Lab 6	C7.1 Lab 6 Pre-lab	
27	√	Lab 6 – Robot Motion.	pgs 337 – 347	Lab 6	**Lab 6 Pre-lab**
28	√	Lab 6 – Robot Motion.		Lab 6	
29	√	Lab 6 – Robot Motion.		Lab 6	
30	√	Lab 6 – Robot Motion.		Lab 6	
31		GR #2			

EE 382 Fall 2008 Syllabus
Block 3 Objectives and Assignments

This block requires you to synthesize all that you've learned to analyze, design, and build a mobile robot. The only new microcontroller subsystems that are introduced are the pulse accumulator and the A/D converter. At the end of the block, you and your robot will compete in a maze competition.

In this block, you should:
- Use your knowledge of the S12's Timer System to control your mobile robot.
- Interface Infrared (IR) sensors with the S12's A/D Converter to give your robot the ability to sense its environment.
- Program your robot to navigate through a maze.

Lsn	Lab	Topic	Reading	Assignments	Items Due
32		Serial I/O	Pgs 468 – 492	F10.1, F10.2, F10.4, F10.5, F10.6	**Lab 6 Notebook**
33		Serial I/O (with ICE) A/D converter. Lab 7/8 Introduction.	pgs 417 – 463 Lab 7/8	F9.1, F9.2, F9.3, F9.7, F9.8, F9.9	
34	√	Lab 7 – A/D converter.		Lab 7	
35	√	Lab 7 – A/D converter.		Lab 7	
36	√	Lab 7 – A/D converter.		Lab 7	
37	√	Lab 8 – Maze Navigation.		Lab 8	**Lab 7 Sign Off (BOC)**
38	√	Lab 8 – Maze Navigation.		Lab 8	
39	√	Lab 8 – Maze Navigation.		Lab 8	
40	√	Maze Competition.			**Lab 7 & 8 Notebook**