ECSE-4790 Microprocessor Systems Design

Fall 2003 Schedule

WEEK	TOPICS (to support lab exercises & team project)	READING TEXT/NOTES	EVB LAB EXERCISES	DUE DATE
1 8/25	Introduction Resources (S/W, WebCT, CStudio), ANSI escape sequences	Chapters 1, 2, (3), 5	Lab tools: HyperTerm, ProComm, D-Bug12/ANSI Display	
2 9/1	Instruction Set, Assembler/C Compiler, Parallel I/O, [Labor Day, no class Mon]	Chapters (4), 6, 7	D-Bug12/ANSI Display (cont.)	9/11
3 9/8	Interrupts & Timers Team formation & Project selection†	Chapters 8, 10	Interrupts & Timers	9/18
4 9/15	Bus Interfacing	Chapter 9	Adding Memory	9/29
5 9/22	Serial I/O Project Description	Chapter 11	Serial Communications*	10/6
6 9/29	Analog Conversion Project Descriptions & Sample reports	Chapter 12	A/D Converter*	10/14
7 10/6	LCD Screen, Keypad, Key Wakeup Interrupts	LCD handout User Man. handout	Magic 8 Ball Lab	(Prj Prop 10/9)
8 10/13	[Columbus Day Vacation, Tues is Mon]		Magic 8 Ball Lab (cont.)	
9 10/20			Magic 8 Ball Lab (cont.)	10/27
10 10/27			Semester Project	
11 11/3			Semester Project	
12 11/10	Interim Project Demonstration		Semester Project	(Prg Rpt 11/13)
13 11/17			Semester Project	
14 11/24	[Thanksgiving Vacation]		Semester Project	
15 12/1	IDEA course survey 12/2 [Last week of class]		Project Presentations and Demonstrations	(Fin Rpt 12/10)

† Each student must write a brief memo listing their interests and capabilities in engineering design and what they would like to learn in the experience to be used in the process of selecting a team and determining an appropriate project. Due date: 9/18

*** Due to equipment limitations, about half the class should opt to do the A/D Converter exercise first and the Serial Communications exercise second.**

SYLLABUS

A capstone design experience in microprocessor-based digital systems that uniformly integrates hardware and software. Laboratory exercises are included to facilitate hardware and software development techniques practiced in industry. Evaluation is based on individual and team performance. This is a writing intensive course.

PREREQUISITE: ECSE-2740 Computer Components and Operations

TEXTBOOK: Fredrick Cady & James Sibigtroth, Software and Hardware Engineering, Oxford University Press, New York, NY 2000.

REFERENCE: Gene H. Miller, *Microcomputer Engineering*, Second Edition, Prentice Hall, Englewood Cliffs, NJ 1998. (First Edition is fine.)
Thomas L. Harman, *The Motorola MC68332 Microcontroller,* Prentice-Hall, Englewood Cliffs, NJ, 1991. (Easier to read than Motorola literature.)
Alan Clements, *Microprocessor Systems Design*, PWS Publishing Company, Boston, MA, 1992
Kim R. Fowler, *Electronic Instrument Design*, Oxford University Press, New York, NY 1996
Online www.ecse.rpi.edu/Courses/CStudio
webct.rpi.edu/webct/homearea/homearea & pick Microprocessor Systems

COURSE COORDINATOR: Russell P. Kraft, Adjunct Faculty, ECSE
CII 6219 276-2765 kraftr2@rpi.edu

COURSE OBJECTIVES: To provide senior ECSE students with a team-based capstone experience in microprocessor system design and to enhance their oral and written communication skills.

PREREQUISITES BY TOPIC: Fundamentals of logic design, circuit theory, computer programming, and computer instruction sets and microcontroller operations.

PROJECT SUPPORT TOPICS: The most advantageous use of the MC68HC12 microcontroller evaluation board in the course project requires a broad understanding of its features and options. These topics have been selected to facilitate the comprehension of the general functions most widely used in real-time controllers and are accompanied by lab exercises. After a brief overview of the available development environment tools (cross-assembler, C cross-compiler, & simulator/debugger) and other platforms (MC6811 & MC68332 microcontrollers), topics include hardware and software development techniques, ANSI terminal escape sequences, interrupts, timers, memory bus interfacing, synchronous & asynchronous serial communications, A/D conversion, I/O interfacing of a keypad & LCD panel, inter-processor communication, and fuzzy logic control.

GRADING:

Part of each grade will be determined by the team effort and part by individual effort. For the lab exercise reports, individual responses to TA questions while verifying the exercise results determines 15% of the grade while 85% is determined by the team. A more detailed breakdown of the team vs. individual grading on the semester project is given in the course project description handout.

Teams of 2	
38%	6 MC6812 exercises (breakdown below)
Teams of 3 or 4 (5 in special cases)	
62%	Student selected course project
5%	Course project proposal
10%	Interim demonstration
12%	Interim progress report
34%	Final demonstration
25%	Final project report
4%	Project Notebook
10%	Post-project clean up, peer reviews, & teamwork
100%	TOTAL (x 62%)

NOTE: The six exercises are not weighted equally in adding up to the 38% of your overall course grade. The weights are:

D-Bug 12/ANSI Terminal	10%
Interrupts	10%
Memory Interfacing	20%
Serial Communications	15%
AD Conversions	15%
Magic 8 Ball	30%
TOTAL (x 38%)	100%

ACADEMIC INTEGRITY: Academic dishonesty is intolerable! All work turned in must be your own. Changing experimental data to purposely hide poor laboratory techniques or following a wrong procedure is inexcusable.

Student-teacher relationships are built on trust. For example, students must trust that teachers have made appropriate decisions about the structure and content of the courses they teach, and teachers must trust that the assignments that students turn in are their own. Acts, which violate this trust, undermine the educational process. The Rensselaer Handbook of Student Rights and Responsibilities defines various forms of Academic Dishonesty and you should make yourself familiar with these. In this class, all assignments that are turned in for a grade must represent the student's own work. In cases where help was received, or teamwork was allowed, a notation on the assignment should indicate your collaboration. Submission of any assignment that is in violation of this policy will result in a significant grade penalty. If you have any question concerning this policy before submitting an assignment, please ask for clarification.

Requirements and Format for Lab Reports.

Goal

The objective of the Lab Exercise Report is to have you document what you did, how you did it, and what you learned.

Requirements

You are required to write a brief team Lab Report for each exercise. Details should document what you did and the observed results. Use titles and headings to separate sections for easier reading. Use paragraphs and write in complete sentences. The following sections should be included, but renamed appropriately, depending on the experiment and results and the style of your report. These reports are not expected to be as detailed as your project report, but will be graded on accuracy and completeness along with your performance of the exercise.

Format of the Report

Front Matter

Title Section
Place the title at the top of the page.
Authors' names go under the title with class designation and date in the title section

Report Body

Introduction/Background Information
A description of the objective and purpose of the exercise goes here. Keep this section brief (no more than half a page).

Materials and Methods/Procedure (with Calculations)
What did you do to develop a solution to the problem? What methods did you use? Describe the way you got to your final configuration. Write this so that one of your classmates could duplicate your work based on your report alone.

Results/Analysis (Highlight special features)
What did you accomplish? Take care to state your result precisely. State all significant results. Use data, figures, tables, etc, to support your claims.

Discussion/Conclusions/Evaluations/Observations
This is the section where you can explain why your final result was different from your initial goal. Or you can point out where you might take the project given more time, resources, etc.

Back Material

Appendices
This is the appropriate place for details such as testing procedures, all software source code listings, flow charts, hardware drawings and electrical schematics.

References
List any sources of information you referred to in the report.

Requirements and Procedures for the Course Project

Goal

The objective of the Course Project is to have you design a product that you select. Whenever possible, the functionality of the product should be demonstrated both in simulation and in a working, physical mock-up.

Writing requirements

The written requirements include a Project Proposal, a Progress Report, and a Final Project Report. Details for these are given on their individual pages that follow.

Important Dates

- Team Formation & Project Selection due Thursday, Sept. 18
- Project Proposals due Thursday, Oct. 9 (all sections) in the studio at 6:00pm
- Projects start the week of Oct. 13 (all sections)
- Interim Demonstrations on Nov. 10 (sec. 1), Nov. 12 (sec. 3), and Nov. 13 (sec. 2)
- Progress Reports due Nov. 13 (all sections)
- Final Demonstrations on Dec. 1 (sec. 1), Dec. 3 (sec. 3) and Dec. 4 (sec. 2)
- Final Project Reports due Tuesday, Dec. 10 in my office or JEC-6048 at 4:00pm

• Opportunity

This is your opportunity to propose and implement a project of your own design. Your project should be based on a Motorola microcontroller (M68HC11, M68HC12, and M68332). Your project should use some of the on-chip capabilities of a microcontroller. The project should not be all software or hardware but, rather, a comfortable mixture of both. There should be a requirement for real-time control and digital and/or analog I/O. Avoid projects that could be developed on a standard PC.

You might want to check out the built in Fuzzy Logic capabilities of the M68HC12 or the table interpolation capabilities of the M68332. Tired of brute force control of stepper motors? Then check out the TPU. Need to do something else instead of babysitting for a slow serial transfer? Check out the Queued Serial Module. Here is an opportunity to do compare more than one microcontroller for a given set of tasks. How does the MCU clock speed impact analog-to-digital converter processing in implementing an RMS voltmeter, for example?

Every project must include aspects of economical analysis, reliability, manufacturability, environmental impact, awareness of potential ethical and/or social issues along with the application of previous mathematics, science, and engineering. This analysis must be completed by the end of the project and discussed in the project presentation and final report.

Some suggestions

- A temperature controller satisfying more than one criterion
- A working model of an automotive engine controller (cruise controller)
- A functional simulator to test an elevator controller (e.g., for the JEC or CII elevators)
- A model train layout controller
- A Morse code interface (sending and receiving)
- A computer controlled chain of robots

In addition to the standard kind of project, you might elect to develop several introductory lab exercises for the M68HC12 and M68332 microcontrollers. These would build upon preceding M68HC11 lab exercises and emphasize what is new and different.

Constraints

The Motorola microcontrollers are available for you to use in the lab. You have been assigned a protoboard for your use in the lab, also. These cannot be taken from the lab between lab sessions.

The lab does not have a budget for special parts. So, if you need anything not in the lab, you will have to get it yourself. If parts are not available locally, several weeks can elapse between the time you order the parts and when they arrival. This can happen even when you have been told the parts are in stock.

The TAs will do what they can to help you with your project; but they aren't guaranteed to be an expert on your specific project.

Grading

The Course Project represents more than half the course grade. The project grading is broken down further as follows:

• Proposal	5%	
• Interim Demonstration	10%	5 team/5 individual
• Progress Report	12%	
• Final Demonstration	34%	17 team/17 individual
• Final Project Report	25%	
• Project Notebook	4%	4 individual
• Post-project clean up Peer Review attendance & Teamwork	10%	10 individual

Post-project clean up

Disassemble all components and wires on the protoboard. **Return them to where they belong.** Be sure to get checked off.

Late Reports

Any late progress reports should be given to the secretary in JEC 6049. A received date stamp will be put on it. A lateness penalty of 5% per day will be assessed against the report grade. Final project reports must be turned in by the drop-dead due date of the last day before final exams begin to receive any credit.

Proposal Memo (5%)

This project will be done by a small team. All team members are expected to contribute to the final product. The total amount of work should be about 50 hours per student. This should be reflected in the Project Proposal

The proposal consists of a brief (cover) memo that states what you have selected for your project. Answer why it is appropriate to the goals of this course. Give a detailed explanation of what you have in mind. Be as specific as you can about what your final product will be. Be sure to think the entire project through. Be realistic.

Proposals that are too vague will not be approved, and cost you lost time. Proposals that do not provide enough challenge will not be approved. If your proposed project is overly difficult, you will be advised but your project will not be rejected. You will be invited to modify your goals as you see fit to finish within the time constraints given. See the **Guidelines for Design Project Proposal** for formatting information.

Interim Project Demonstration (10%)

The interim demonstration will take place in the lab. The TAs and instructor are your primary audience. The purpose of this demonstration is to confirm your project is on track. If it is not, now is the time to revise your project goals.

Your proposed schedule is the one attached to your Project Proposal memo. You should update your task schedule as is necessary to reflect any revised goals, etc. Any delays, advances, or changes from your original proposal need to be explained. Remember the end of the semester does not move! This will be reported in the Interim Progress Report. Half of the points will be by the team and half by the individuals.

Interim Project Report (12%)

Submit this report in a similar format to that of the proposal. It should be brief and report on how well your project is going, including information on the following:

- *Project and Purpose*
  Briefly reintroduce your project. Summarize what you are doing, why you are doing it and what your approach is.

- *Progress Made*
  What progress have you made so far? How do your activities relate to those in your task time line schedule?

- *Practical Implications*
  Will anything need to be adjusted? Do you need to make any changes in your work schedule? Do you need additional parts, etc.?

- If you think your work may result in a publishable article (e.g., as an Application Note or a magazine article), indicate where it may be published. This will impact the format of the Final Project Report.

- *Attachments*
  Append your original Project Proposal including the original task time-line (Gantt Chart) for the entire project period (Oct. - Dec.). Attach your revised task time line for the remaining project period (Nov. - Dec.).

Final Demonstration (34%)

This is the functional day of reckoning. Your product should meet your (revised) objectives. The audience for this demonstration is the class. You will have to prepare a brief oral presentation. You are encouraged to use the studio presentation equipment for your visual aids. The oral presentation is an integral part of the Final Demonstration. You will be evaluated by your peers for a portion of your total points.

Your project design should be frozen at this point. Any improvement can be suggested in the Final Project Report, but not implemented. (You must stop changing things at some point in time. This is it.)

The entire class is expected to participate in the evaluation of the demonstration and presentation. Each student will fill out a form rating speaker qualities such as eye contact, quality of visual aids, technical merit, and knowledge of the subject. Although the instructor and TA ratings will be weighted more heavily, the student ratings will have a definite impact on the overall project grade. (Students who do not participate in the rating of speakers will also be penalized through the loss of points on their class average.)

Your grade here will be an accumulation of points based on:
1. Your general effort level and laboratory techniques
2. Degree of difficulty of the project relative to the team size
3. Amount of work actually completed and demonstrated to function as proposed
4. Neatness of the project (wiring, mechanical components, etc.) and quality of the presentation
5. Results of the peer reviews of your project presentation

A set of guidelines are provided for the oral presentations and demonstrations.

Final Project Report (25%)

The format of your Final Project Report depends on whether it may be publishable or not. If it is, the format is that of the target publication. If it is not publishable, the format is that of a formal technical report. The basic elements are likely to be the same in both types of document. Just as with a published article, the Final report should reflect the most recent state of the project. Do not include failures, false paths, unless they are germane to the goals of the project.

A set of guidelines is given for the final written report. Students are expected to go beyond these requirements if they desire to earn a superior grade for their project. Note: the 25-page limit does **not** include the appendices.

Project Notebook (4%)

Every student is required to keep a daily log of all work performed on the project portion of the course. A dated summary in a few sentences with notes, contact information, references located, worked out calculations, revelations, etc. at the end of each day during which time was spent on the project should be recorded and kept in a notebook. A formal lab notebook isn't necessary, but all pages should be entered sequentially and dated with an estimation as to how much time was spent that day.

This notebook will be checked as part of the interim project demonstration (spot checks will also be done randomly throughout the semester) and collected at the end of the semester with the final project report. The points assigned will count toward the individual's rather than the team's grade. Additional information and a set of guidelines for keep a log are included later in this handout

Post-project clean up, Peer Review attendance & Teamwork (10%)

This is the last 10% of your project grade. Please help get the lab ready for the students who follow. Let's leave the lab and the equipment in it as tidy as we would like to find it.

Part of your project grade is based on the peer reviews of the rest of the class as well as evaluations from other members of your own team. It is important that every student participate in this process by reviewing as many of the presentations as possible to remove statistical variations from varying reviewer distributions. When the schedule is finalized toward the end of the semester the number of reviews each student will be allowed to miss without losing points will be determined. Your final clean up points will be determined by the number of reviews in which you participate and being checked off for having cleaned up your protoboard, work space, and properly returned all parts to the parts bins.

Project Hardware Available in the Studio

A number of processors, including DSPs, are available in the lab for use with projects. Additionally, a number of peripherals and systems are available such as simple robots, a magnetic stripe card reader, and a barcode reader. The devices and specific details are listed below.

M68HC11 EVB

M68HC12 EVB

M68332 Processor System

Several DSP boards from Analog Devices and Motorola

TeachMover MICROBOT Computer Controlled Robot

Shadow Boxes for shape recognition

American Magnetics Magstripe Card Reader

Hewlett Packard HEDS-300 Digital Bar Code Wand

Fuzzy Logic Controller (available on the 68HC12 through fuzzy logic instructions)

Temperature Sensitive Transistors,

MC146818 Real Time Clock/Calendar chip

Misc. Components (op amps, discrete logic, solid-state relays, small motors, stepper motors,

+5 V, ±12 V Power Supplies

References

M68HC11 Reference Manual, Rev. 3, Motorola (1991).

"Microcomputer Engineering" by Gene H. Miller, Prentice-Hall (1993).

"Lab Manual for Single- and Multiple-Chip Microcomputer Interfacing" by Peter Song and G.J. Lipovski Prentice-Hall (1988); a copy is available in the CML TA cabinet.

"Operation Manual of the Five-Axis Robot Model TCM" by Microbot Inc., Edition 2, (1982). All the information you need to check out the robot and to interface using the serial port connection for the robot's 6502 microprocessor. A copy is available in the studio TA cabinet.

Microprocessor, Microcontroller, and Peripheral Data, Volume II, available in the lab, on pp. 3-1653 to 3-1672. (information about the MC146818)