Tentative Syllabus: Spring 2011
Microprocessors and Controls (EET K258)
Prof. Rhoades

Office: Room C232 MW 3:00 p.m.-4:00 p.m., T 4:00-5:00 p.m.

Class: Tuesdays 5:00-7:45 p.m., Room D124
(no class on 3/15, Spring Break).

Lab: Thursdays 5:00-7:45 p.m., Room B229
(no lab on 2/3, College Professional Day, or 3/17, Spring Break).

Textbook:

Using the MCS-51 Microcontroller; Han-Way Huang; Oxford University Press, 2000. This includes a CD-ROM from Keil Software, Inc., including the μVision software development system and dScope debugger. It would be helpful to install this on the student's home computer if possible.

Other Resources:

It must be emphasized that there is no such thing as a perfect textbook, and for advanced courses even adequate may be a stretch. This course is no exception and may be one of the worst offenders. Please try to show up for classes: You have made a commitment to try to get your money's worth.

As in other courses, outside material has been found or generated to present as part of the course. These have as much weight as the text and should be kept as a supplement to the text and lecture notes. There is a lot of information on the Internet: Search on "MCS-51" or go to a web site for Intel or one of the other companies mentioned in Appendix F of the text. The instruction-set handout was downloaded from Atmel, and is similar to Appendix G but more readable. Intel application note AP-69 "An Introduction to the Intel® MCS-51™ Single-Chip Microcomputer Family," thirty pamphlet-size pages, which is quite good as a supplement to the text, was also a download, and other info is available. There is a lot of academic and industrial interest in these processors: many FAQ sites, conference papers and even an on-line textbook. You may find something good to share with the class. Changes in our course assessment procedure may result in an assignment along these lines (TBD).

Lab Materials:

All lab parts will be provided this term. Copies of the software bundled with the text are installed on four of the PCs in Room B-229, and will be used to create and debug programs. A memory programmer from XELTEK is installed on two of these PCs and will be used to load programs into the internal memory of the 8751H and AT89C51 microcontrollers and 2732 EPROMs for the lab experiments.

Two sets of extra-large breadboards and processors will be available for each lab group, since most experiments build on earlier ones with similar hardware, but the external memory lab pursues side issues with a different hardware configuration. This will also allow for a processor with a blank EPROM to be on hand without waiting for the previous memory to be erased.

No student media (floppies, etc.) in the lab, please. We have a box of disks with labels in the lab. These will probably be used somehow for grading the students' programming work. We can't afford to chase computer viruses, and any infractions/infections will be treated seriously. We have been getting by without having a hard-copy printer so far. Lab experiments will generally have a hardware part and a software part, with analysis emphasized rather than code writing.

Why are we looking at a microcontroller?

We have been using this text since 2001. As implied in the new course title, the microprocessor category has split into the far more visible computer chips (PCs: 8086, 80286, 80386, 80486, assorted "Pentia"; Macs: Various Motorola 6800-family descendants) and the embedded processors found in toys, cars, appliances, etc. Some of these are similar to the computer chips (80186 and embedded versions of the '386, etc.) but others are more specialized for control. Like the 8086 family (iAPX86), the MCS-51 family has added on more capabilities and has been built in low-power and ultrafast versions but is still upwardly compatible with the original 8051. The programmable logic controllers (PLCs) used in Robotic Control Systems Lab uses a variant. Besides the MCS-51 family, there are microcontroller competitors such as the Motorola MC68HC11 and various PIC models originated by General Radio. Some recently-developed microcontrollers are tremendously powerful but have "too many options" for this course and are usually programmed in the C language.

An introduction to microprocessors should involve a unit that is both useful and comprehensible, and is lab-friendly. The 8086 was both too complex and too far from the present family members for the lecture, and using the 80C85 for lab was a problem with suppliers. There wasn't a "real assembler" available for the 8085, making software development tedious, although the DOS DEBUG utility was available for simulating an 8086. This new textbook came with "free" software development tools and an integrated debugger (limited "evaluation" versions) that everyone would have access to for homework, etc. The 8-bit 8751H operating at one of the standard clock rates (7.3728 MHz) was chosen as being hands-on-friendly. The basic instruction-cycle rate (614.4 kHz) is $^1/_{12}$ of the clock rate and the highest breadboard frequency is ALE ("address latch enable") at twice that frequency, or 1.2288 MHz, which presents no problems if proper breadboarding techniques are used. Using this for the internal timers works nicely for generating delays in multiples of 5 ms. This clock frequency is below the rating of 12 MHz, but is used in industry for generating the standard baud rates for data communications (2400 bits/sec, etc.).

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What are we covering in the text?

Naturally, we can get more of a handle on 8051 functions than on some of the features added in the 8052 and later versions, but we will try to keep things fairly general. We will follow chapter order in class, although in lab we need to get a working knowledge of ports and timers very early.

Chapter	Topic	Coverage	Comments
1	Introduction	All sections	See also Intel info. **Test 1.**
2	Assembly-language Programming	All sections	Not all subsections: nothing that doesn't work in lab...
3	Advanced Assembly Programming	Sections 1-3, 6-8 mostly (topics)	I have some opinions, case studies, etc. Some examples will be replaced... **Test 2.**
4	External Memory	Most sections	Again, I have my opinions... We will do a lab on this.
5	Interrupts, etc.	All sections?	Very important for control. Lab, "CEPHAS" game case-study, etc.
6	Parallel I/O Ports	Most sections	Will gloss over 6.9, tough. I have other examples. We will have some experience in lab.
7	Timers and Counters	Sections 1-3 (modes 1 & 2)	Gloss over non-8051 issues. We will be doing a lot of lab work and case studies.
8	A/D Converter	Not much	Some types have built-in A/D. We are doing a lab.
9	Serial I/O	Section 4 & mode 1 mostly	Important. This will be the final lab experiment. **Test 3.**

We usually have three weighted tests, worth 85% of the total grade.
A research paper will be assigned, worth 10% of the grade.
Homework counts 5%: A few sets will be collected, unannounced, for assessment and each student, at random, will present the solution to a selected problem before the instructor's solution is revealed.

Course Outcomes

ABET Outcome Requirements

a) an appropriate mastery of the knowledge, techniques, skills, and modern tools of their disciplines
b) an ability to apply current knowledge and adapt to emerging applications of mathematics, science, engineering, and technology
c) an ability to conduct, analyze and interpret experiments, and apply experimental results to improve processes
d) an ability to apply creativity in the design of systems, components, or processes appropriate to program educational objectives
e) an ability to function effectively on teams
f) an ability to identify, analyze and solve technical problems
g) an ability to communicate effectively
h) a recognition of the need for, and an ability to engage in lifelong learning
i) an ability to understand professional, ethical and social responsibilities
j) a respect for diversity and a knowledge of contemporary professional, societal and global issues
k) a commitment to quality, timeliness, and continuous improvement

TRCC EET Stated Outcomes

1. Students will practice the skills needed to work effectively in teams and as an individual.
2. Students will demonstrate the ability to use appropriate mathematical and computational skills needed for engineering technology applications.
3. Students will combine oral, graphical, and written communication skills to present and exchange information effectively and to direct technical activities.
4. Students will know of a professional code of ethics.
5. Students will describe concepts relating to quality, timeliness, and continuous improvement.
6. Students will describe how the concepts of electric circuits, electrical measurements, digital electronic devices, programmable logic circuits, electromechanical and automated systems, affect the design, maintenance, and operation of electrical systems.
7. Students will illustrate an ability to think critically and identify, evaluate and solve complex technical and non-technical problems; demonstrate creativity in designing problem solutions; and conduct and interpret experimental data and outcomes.
8. Students will recognize actions and acts of professionalism that allows them to become informed and participating citizens cognizant of ethics, civic duty, and social responsibility.
9. Students will recognize the need to be lifelong learners.

K258/9 Course Outcomes

1. Mastery of Electrical Technology concepts as defined in the course syllabus
2. Knowledge of concepts of the hardware and software of microcontroller-based systems
3. Demonstrate an ability to build and test microcontroller-based systems
4. Demonstrate an ability to analyze and solve problems relating to microcontroller-based systems
5. Demonstrate senior level oral and written communication skills
6. Demonstrate an appreciation for lifelong learning
7. Demonstrate proper professional and ethical behavior

8. Demonstrate a commitment to quality, timeliness and continuous improvement

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Week	Date	Title
L1	1/20/11	Introduction (Walkthrough)
L2	1/27/11	Seven-Segment Display: Hardware
L3	2/10/11	Seven-Segment Display: Test Program
L4	2/17/11	“Oddsum” Program: Hardware Version
L5	2/24/11	“Oddsum” Program: Debugger Version
L6	3/3/11	DMM #1: Single-Range Frequency Counter
L7	3/10/11	DMM #2: Autoranging Frequency Counter
L8	3/24/11	External Memory Interfacing
L9	3/31/11	↓
L10	4/7/11	DMM #3: Single-Slope A/D DC Voltmeter
L11	4/14/11	↓
L12	4/21/11	DMM #4: Interrupt-Driven A/D Control
L13	4/28/11	Serial I/O Part I
L14	5/5/11	Serial I/O Part II
L15	5/12/11	Makeup/Catch-up

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