CpE213 – Digital Systems Design
Winter Semester, 2002

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Office hours (tentative): Mon,Wed 10:00–11:00 AM
(Though I'm often available at other times)

Prerequisites: CmpE111, CS53 or CS74
Recommended: CmpE214 (taken simultaneously with CmpE213)

Textbook: *The 8051 Microcontroller,* I. S. MacKenzie, Prentice Hall, 1999
Recommended supplements:

- *C and the 8051*, Tom Schultz, Prentice Hall, 1998
- *80C51-Based 8-Bit Microcontrollers,* Databook for the 80C51, Philips Semiconductors, 1998. Available at:
    - http://www.umr.edu/~daryl/classes/ee213/notes.html
- *The C Programming Language,* B. Kernighan and D. Ritchie, Prentice Hall, 1988
- Other manuscripts/notes available electronically at
  http://www.umr.edu/~daryl/classes/classes.html and
  http://www.ece.umr.edu/~hjp/ee213.

Material covered: Probably the whole book... plus handouts.

Grading: *(Tentative)*

23%	Test 1
23%	Test 2
28%	Final Exam
12%	Project (tentative)
12%	Homework
2%	Evaluation (I can push your grade up or down by 1%)

Tests and Quizzes:

Tests will cover material from the lectures, text, and homework, with a slight emphasis on homework. Tests will generally be 45-60 minutes long and will primarily cover material presented since the last test. The final exam will be comprehensive, though a slight emphasis will be placed on material that might not have been covered on the previous test. I may occasionally give small, in-class, quizzes.

Approximate dates:

Test 1	2/18/02
Test 2	4/08/02
Final Exam	5/17/02 (Friday), 10:30–12:30

Course objectives: At the end of this course, you should be able to:

- **Interpret and design hardware and software for simple real-time digital systems which use the 8051 microcontroller.**

- Describe the fundamentals of microprocessor organization and operation. Show the transfer of information, from register to register or from register to memory, that occurs within the Wimp51 processor for each instruction within its instruction set. Modify the Wimp51 processor to perform new functions.

- Describe the basis for interaction between the 8051 microcontroller and external hardware. Interpret and design digital systems incorporating the 8051 and common peripherals (RAM, ROM, A/D converters, etc). Explain the operation of parts of the 8051, including digital I/O ports, register banks, special function registers, internal and external memory, timers, counters, and interrupts, and be able to apply this knowledge in simple programs.

- Define the operations performed by each assembly (ASM) language instruction for the 8051. Interpret and design ASM programs. Develop, simulate, and debug ASM programs for the 8051 using Keil software development tools.

- Define the operations performed by each C-language instruction for the 8051. Interpret and design C programs. Develop, simulate, and debug C programs for the 8051 using Keil development software.

- Describe the reasons for using tools such as functions, modules, libraries, and headers when developing microcontroller software. Develop mixed C/ASM software for long-term or multi-programmer use with these tools.

- Explain what occurs within the 8051 on an interrupt. Write programs using interrupts to: perform a task at regular intervals using counters; to communicate between processors serially; or to provide immediate service to external hardware. Describe and build a task scheduler. Describe the basis behind existing real-time operating systems (RTOS) and implement simple programs with these systems.

Homework:

- You are expected to read appropriate sections of the textbook before presentation in class
- Homework problems will be assigned in class
- As a rule of thumb, no late homework is accepted.
- Homework will consist of answering questions from the book, solving problems, writing programs, and, possibly, some laboratory work.
- While you are expected to complete all assigned problems, the grader may randomly pick only certain problems to grade. It is common in larger classes to compute your grade based on the accuracy of 1 or 2 problems and an evaluation of how hard you "tried" on the rest.
- Lowest homework grade is dropped
- Extra credit may occasionally be offered. You will not be penalized for not completing the extra credit, but if you have cause to be concerned about your grade I strongly encourage you to take advantage of this when available.
- I strongly encourage you to study with others, as this can be a powerful tool for learning. However, I insist that you must a) attempt to understand and solve each problem by yourself and b) thoroughly understand any solution you turn in. If you cannot adequately explain the basis for your solution at a later date, no credit will be given even if your solution is correct. Simply "copying" someone else's homework will be considered cheating and will not be accepted under any circumstances.

Partial Credit:

Problems are rarely graded as all-or-none. Emphasis is placed first on proper understanding of the concepts, then on proper application of those concepts, and lastly on "the right answer". You will not be severely penalized for minor, non-conceptual errors. On the other hand, a simple answer with no work or explanation may not be given full credit.

If you feel you deserve more credit on a problem than was given, you may submit a written request for additional credit, clearly stating why you deserve additional credit. Such requests may not be made until 24 hours after the exam was handed back and should be in the form of a memo like you would use when communicating between professionals on the job. No requests will be accepted after 30 days.

Attendance:

Attendance to lectures is generally not required, however, I will not be sympathetic to problems caused by skipping class without a documented excuse. Excessive absence (in particular, failure to attend a quiz or exam without an excuse) may cause you to be dropped from the course.

Cheating:

Don't do it. Department policy is to fail you in the course on the first offense and to expel you from school on the second.

Tentative Schedule

Lect.	Date	Topic
1	1/14	Syllabus, motivation
2	1/16	Digital-logic review, Addr decoding (some Ch 1)
3	1/18	Digital-logic review, Addr decoding (some Ch 1)
	1/21	Martin Luther King holiday
4	1/23	Digital-logic review, Addr decoding (some Ch 1)
5	1/25	Wimp51 - intro. to comp. org. (handout)
6	1/28	Wimp51 - intro. to comp. org.
7	1/30	Wimp51 - intro. to comp. org.
8	2/1	The 8051 - Hardware summary (Ch 2+)
9	2/4	The 8051 - Hardware summary (Ch 2+)
10	2/6	The 8051 - Hardware summary (Ch 2+)
11	2/8	The 8051 - Hardware summary (Ch 2+)
12	2/11	The 8051 - Hardware summary (Ch 2+)
13	2/13	The 8051 - Hardware summary (Ch 2+)
14	2/15	8051 Instruction set (Ch 3)
15	2/18	**Test I**
16	2/20	8051 Instruction set (Ch 3)
17	2/22	8051 Instruction set (Ch 3)
18	2/25	8051 Instruction set (Ch 3) *(last day to drop w/out WD)*
19	2/27	ASM programming (Ch 7)
20	3/1	ASM programming (Ch 7)
21	3/4	ASM programming (Ch 7)
22	3/6	Keil debugger (handout)
23	3/8	Review of C programming (handout)
24	3/11	Review of C programming (handout)
25	3/13	Review of C programming (handout)
	3/15	Spring Recess
26	3/18	C for the 8051 (handout)
27	3/20	C for the 8051 (handout)
28	3/22	Applications in C and ASM (handouts, Ch 10?)
	3/25	Spring break (no class)
	3/27	Spring break (no class)
	3/29	Spring break (no class)
29	3/29	Applications in C and ASM (handouts, Ch 10?)
30	4/1	Applications in C and ASM (handouts, Ch 10?)
31	4/3	Applications in C and ASM (handouts, Ch 10?)
32	4/5	Applications in C and ASM (handouts, Ch 10?)
33	4/8	**Test II**
34	4/10	Applications in C and ASM (handouts, Ch 10?)
35	4/12	Timers + Counters (Ch 4)
36	4/15	Timers + Counters (Ch 4), Projects Due
37	4/17	Serial Communication (Ch 5)
38	4/19	Serial Communication (Ch 5) *(last day to drop)*
39	4/22	Interrupts (Ch 6)
40	4/24	Interrupts (Ch 6)
41	4/26	Interrupts (Ch 6)
42	4/29	Mixing C and ASM (handout)
43	5/1	Design process (Ch 9)
44	5/3	Multi-tasking/real-time systems (handouts)
45	5/6	Multi-tasking/real-time systems (handouts)
46	5/8	Multi-tasking/real-time systems (handouts)
47	5/10	Catch-up and review. Evals and surveys
	5/17	**Final Exam** (at 10:30AM, Fri.)