EE E3910 - Elements of Digital Systems
Course Information

Course Call #: 22554
Professor Dan Rubenstein — Spring 2004

Course Resources

Contact Information		
	Dan Rubenstein (Instructor)	Bong-Jun Ko (TA)
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Office Hours	M,W 4-5pm or by appt.	T,Th 3-4pm

Course URL: http://www.cs.columbia.edu/~danr/3910

Course meeting time / location: 9:35 am - 10:50 am on T,Th in 834 Mudd

Pre-Requisites

None

Description

Topics: Theory of digital systems. Digital coding of information. Study of combinational and sequential system design. Finite-state machines. Microcode. Computer arithmetic. Microprocessors.

The purpose of this course is to introduce you to logic design, digital system design, and computer design. What you will learn here will give you a fundamental understanding of how computers work. We will be dealing mostly with binary operations: 1's and 0's and how these two values are applied to produce any computation that is doable on a computer.

Grading

Your grade consists of:

20% **Homework:** Unless otherwise specified, homework will be due one week after it is assigned and **should be turned in at the beginning of class**. At that time, you must turn in a physical copy of the assignment. E-mailed homework and late assignments **will not** be accepted unless approved in advance. Approval will only be given under extreme circumstances. You are expected to produce your work in a timely manner.

You may discuss and work on questions with other students in the class. However, you should write your solutions on your own. In other words, if I were to later ask you to re-derive one of your homework solutions or to solve a similar problem when you were without your friends, you should be able to do so or have a clear understanding of how to approach the problem. This can only be learned by doing, so you should do your homework.

35% **Mid-term:** 3/9 in-class, closed book, closed note, no calculators.

45% **Final:** Date TBD

Extra Credit **Class / office-hour participation:** If you ace your tests and homeworks, you will get an A+, even if you do not participate in class or come to office hours. However, if you don't ace your tests and homeworks, but you can demonstrate to me that you have learned the material in another fashion (mainly via office-hour discussion in which you work through additional problems), you can improve by up to one letter grade (e.g., C to a B). To reiterate, it is possible to improve your grade by demonstrating an understanding of the material **during the course of the term** (i.e., not just when you get your midterm back)..

A note on exams: I am more interested in your gaining an understanding of and developing an intuition for **why** certain rules, laws, and techniques hold and are used. I am less interested in your ability to memorize these rules, laws and techniques and blindly apply them without intuition as to why they work. Thus, I will try to design the midterm and final questions to test your understanding of the concepts, not your memorization skills. I realize that some memorization will undoubtedly be required, but hopefully the memorized concepts will be those that can be re-derived via your intuition.

Reading / Texts

You should do the assigned reading **before** class.

- **Required:** M. Morris Mano and Charles R. Kime, *Logic and Computer Design Fundamentals (3rd edition)*, Prentice Hall, 2003. ISBN 0-13-124711-5.
- **Additional (optional):** Norman Balabanian and Bradley Carlson, *Digital Logic Design Principles*, John Wiley & Sons, 2001. ISBN 0-471-29351-2.
- **Additional (optional):** John F. Wakerly, Digital Design, *Principles & Practices (3rd edition)*, Prentice Hall, 2001. ISBN 0-13-089896-1.

Computing Accounts

The course does not require computing facilities or computing accounts.

Cheating

In short: don't do it. You must use common sense about when to collaborate / use notes / calculators, etc. If you are unsure of a policy, you should ask me or the TA first *before* doing something you (and I) might consider unethical. Both I and Bong-Jun have and will be putting a lot of time into teaching you this course. Our goal is to teach you the material. Grades on homeworks, midterms, and finals are not only a means to evaluate you, but also a means to force you to learn the course material. Thus, when you cheat, you not only deceive me and Bong-Jun, you also hurt the school's reputation by producing unknowledgeable graduates. In the long run, you hurt yourself, because you wasted your time. If a grade is that important to you then you should be putting in the extra effort, i.e., reading the book, coming to office hours, etc.

If you do your own work but facilitate someone else's cheating, you run a risk of getting in trouble as well. This is because you run the risk of having me determine who copied from whom. If you feel that someone is pressuring you to help them in a way that makes you uncomfortable, come talk to me / send me e-mail. You should feel free (and actually I would encourage you) to

- Discuss homework problems / give hints / work together through a part of a problem that you are stuck on
- Study for the midterm / final together

Student Feedback

I'm always looking for ways to improve the course. If you have any comments or criticism about the course, or find any mistakes or misleading facts / comments in the lecture, please feel free to contact me. This includes comments on the material being covered, teaching style, pace of the class, workload, etc. I will try and accommodate, but I can't make any promises...

Syllabus and Schedule

Schedule subject to change...

Date	#	Topics/chapters covered	Reading (before class)	Assigned	Due
1/20	1	Course information; introduction; non-decimal number systems; decimal and alphanumerical codes; binary logic and gates	1, 2.1		
1/22	2	Boolean algebra	2.2	HW #1	
1/27	3	Standard forms	2.3		
1/29	4	Map simplification	2.4	HW #2	HW #1
2/3	5	Map manipulation	2.5		
2/5	6	Multiple Level Circuit Optimization	2.6		HW #2
2/10	7	NAND, NOR, XOR, 3-State Buffers, Gates	2.7-2.9	HW #3	
2/12	8	Combinatorial Logic Design, PLAs, PALs	3.1-3.6		
2/17	9	Decoders, Encoders, Multiplexers	4.1-4.5	HW #4	HW #3
2/19	10	Binary adder-subtractors; multipliers	4.6, 5.1-5.6		
2/24	11	Intro to sequential circuits, latches	6.1-6.2	HW #5	HW #4
2/26	12	Flip-flops: master-slave; edge-triggered; characteristic tables; sequential circuit analysis	6.3-6.4		
3/2	13	Sequential circuit design; design using D and JK flip-flops	6.5-6.6		HW #5
3/4	14	Registers; Register Transfers and Transfer Operations	7.1-7.3		
3/9	15	**MIDTERM EXAM**			
3/11	16	**Prof Rubenstein out of town: NO CLASS**			
3/16	17	**Spring Break: NO CLASS**			
3/18	18	**Spring Break: NO CLASS**			
3/23	19	Microoperations	7.5	HW #6	
3/25	20	Counters	7.6		
3/30	21	Register Cell Design, Multiplexer and bus- and serial-based transfer	7.7-7.9		HW #6 ,
4/1	22	Control Unit, Algorithmic State Machines	8.1-8.3	HW #7	
4/6	23	Hardwired Control	8.4		
4/8	24	Memory; RAM, SRAM	9.1-9.4	HW #8	HW #7
4/13	24	DRAM	9.5-9.7		
4/15	25	DataPaths, ALU	10.1-10.3	HW #9	HW #8
4/20	26	Shifter, Datapath Rep, Control Word, Computer Arch	10.4-10.7		
4/22	27	Single cycle hardwired control; multiple cycle microprogrammed control;	10.8-10.9		HW #9
4/27	28	Instruction set architecture	11.1-11.4		
4/29	29	Review			
TBD	**FINAL EXAM**	Location TBD			