CSEE W3827 - Fundamentals of Computer Systems

(Call # 75949)

Course Information

Professor Dan Rubenstein Fall 2007

Contact Information				
who	**office**	**phone**	**e-mail**	**office hours**
Prof. Dan Rubenstein	CEPSR 816	(212) 854-0050	danr@cs.columbia.edu	Tu,Th 2pm-3pm or by appt
TA Abhilash Itharaju	122A Mudd	(917) 330-0050	ai2160@columbia.edu	M,W 11am-12pm

Course URL: http://www.cs.columbia.edu/∼danr/3827.

Also see Courseworks (https://courseworks.columbia.edu/) for additional handouts, etc.

Course meeting time / location: 2:40pm - 3:55 pm on M,W in Mudd 535

Pre-Requisites

An introductory programming course (e.g., COMS 1004 or 1007)

Description

This course explains, from a logic perspective, how computers work, i.e., how 0's and 1's are manipulated to do all the advanced calculations, computations, and services that computers can perform.

The first major topic is digital logic, which concerns the design of circuits to implement logic functions using standard components such as AND-gates, OR-gates, and inverters. The circuits might be used to control the flow of data within a computer, or the processing of the data (e.g., arithmetic operations), or to control the overall action of a computer. We will cover how to specify logic functions precisely, to manipulate formal expressions, and to implement them efficiently. We will then cover the design of basic building blocks, including the control, of modern digital computers. Both combinational and sequential circuits will be covered.

The second part of the course involves the structure and software interface of digital computers. Focusing our attention on modern RISC architecture. We will discuss the functional blocks such as the arithmetic unit, register files, and memory. Single-cycle and multiple-cycle implementations will be presented, followed by the concept of pipelining. We will cover the basics of caches and virtual memory. Machine and assembly language programming is a feature of the course. Main memory systems, currently DRAM, will be discussed as well as the operation of magnetic disk drives. Some aspects of I/O will also be introduced.

Note: This course is a joint EE/CS course.

Grading

Your grade consists of:

25% **Homework:** Unless otherwise specified, homework will be due one week after it is assigned and should be turned in by beginning of class. At that time, a physical copy of the assignment must be received *(CVN students have an additional 24 hours to send in their homework)*. If you will not attend class on that day, you should slide the homework under my office door (CEPSR 816) by **2:30 pm** on the day it is due. Before class but after 2:30, I will collect the homeworks from my office. On-campus students: E-mailed/faxed 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% **Midterm:** October 15 in-class, closed book, no calculators. You must let Professor Rubenstein know a month in advance (i.e., by next week) if you cannot take the midterm on that date. Otherwise, only medical emergencies (with doctor's note) are acceptable reasons for scheduling an alternate date. This applies to both in-class and CVN students (CVN students have the entire day to take the exam, but it must be on Oct 15).

40% **Final:** TBD by registrar, closed book, no calculators.

Exams: I try to test your understanding of a concept, and not just straightforward regurgitation of formulae, i.e., **why** certain rules, laws, and techniques hold and are used. Hence, I 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. I usually take a problem covered in class and put a small "twist" on it, so that blind application of the method won't work, but if you have the kind of understanding I am looking for (e.g., the kind that the inventor of the method had), you will know how to adapt the method.

A note on effort: Your grade will mainly be a reflection of how you perform on the midterm and final. Homework grades don't have much of an effect, as long as homework is turned in (i.e., most students typically get most of the problems right). **You should do the homework so that you learn the material.** If you find yourself copying or getting solutions from someone else without putting in the effort of solving them yourself, you'll probably find yourself doing poorly on the exams. You won't get much sympathy from me if you come crying to me at the end of the term that you did well on the homework yet poorly on the midterm and final.

If you are a bad test-taker, there is hope! Show me (i.e., in office hours and class) that you understand what is going on, and I take that into account when assigning the final grade.

How much I care about helping students is directly proportional to how much you seem to care about the class (i.e., via attendance, homework, coming to office hours). I have nothing personal against students who think the class is a waste of their time or think they have better things to do with their time. I also have lots to do besides teaching, and will only make the extra effort for those students who earn it by putting in the extra effort themselves (active in class, active at office hours).

Reading / Texts

Two texts are **required**:

- *Fundamentals of Digital Logic with VHDL Design, 2nd ed*, Stephen Brown and Zvonko Vranesic, McGraw-Hill, ISBN #0-07-249938-9
- *Computer Organization and Design, The Hardware/Software Interface*, David A. Patterson and John L. Hennessy, Morgan Kaufmann, ISBN #1-55860-604-1

Computing Accounts

Not required for the course.

Cheating

In short: don't do it. Be warned now - I take cheating very seriously. If you are caught cheating on the midterm or final, you will fail the class and I will likely take additional action which can result in your suspension or expulsion from Columbia. It's not worth putting yourself in this position.

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.

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 Abhilash first *before* doing something you (and I) might consider unethical. Both I and Abhilash 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.

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...

Things to know about Professor Rubenstein

- I write on the board (i.e., I rarely use slides, I don't provide handouts, etc.) so if you want to know what is going on in class, come to class, or get a friend to take notes. Strangely enough, if you're paying attention, I believe you learn alot more when taking notes yourself. For some reason, when you just read off of notes, your brain tricks itself into thinking it's seen everything when it hasn't. Also, if you have good pre-packaged notes, what do you need me for?
- For this course, we will follow the books fairly closely, but not exactly - many parts of the books will not be included. It's what's covered in class and not what's in the book that you are expected to know.
- I respond to e-mail in batches. I get between 50-100 e-mails a day that require a response. I read everything as it comes in (Unless traveling, I check e-mail several times during the day, before I go to bed, when I wake up, etc.) but if an e-mail takes more than a minute to craft a response, I usually wait to answer it. Roughly once or twice a week, I do a sweep of my inbox and respond to e-mails in a batch. So if you have questions on the homework and cannot come to office hours, my advice is to not wait until the last minute if you want me to answer questions via e-mail.
- Some Outside Thoughts (from Columbia Underground Listing of Professor Ability (CULPA) at www.culpa.info)

  For ELEN E4710: Intro to Networking Theory (from someone who isn't my biggest fan):

  > "My worst academic experience. Pay 200% attention during lectures if you are taking his class since nothing he teaches in lectures will be found in the textbooks. Never buy the textbook he assigned since I have never used it once. Professor Rubenstein seems to be a very smart person and he gets annoyed with questions. Don't take his class if you have problems getting up. He always has 9:00am classes, hws are due at the beginning of the class and LATE assignments are never accepted, even if you arrive 30 seconds after the lecture has started. Homeworks are very very difficult, so are exams.

you are doing really well if you get above 70% in HWs. Midterms and final scores usually averaged around $\sim$ 40%.

Workload: Around 7 - 8 assignments. Due dates usually get postponed since he never finishes the materials on time."

Alot of this was true for 4710: I didn't follow a book at all (I didn't think any book was at the right math level) but expect to be closer to the book here. I don't agree that I don't like questions. I'm much tougher in the networking course than this course, but I do believe in tough exams (to really push you on what you know) and curving the grades accordingly (i.e., a 40 on an exam doesn't mean you fail).

- I'm willing to put time into helping those students who truly put effort into the class. I judge this by them coming to office hours and showing me where they get stuck on a problem, clarifying something they didn't understand in office hours, answering relevant questions in class, and/or showing me in class that they're truly thinking about the material (i.e., asking an insightful question).
- I find it a waste of time to put effort into students who don't put effort into the class. Some of you will disappear after a few lectures, copy your homework, and then get crushed on the midterm (and probably on the final later on as well). Don't come to me if all you want is sympathy, or to explain to me that you understand the material and don't know what happened. You can come to me if you want to get back on track, but my suggestion will be: do your homework, come to class, come to office hours, i.e., put in effort.