UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN
CS 433: Computer System Organization
Course Information for Fall 2018

Instructor: Sarita Adve (SC 4104, sadve@illinois.edu, 217-333-8461).

Teaching Assistant: Radha Venkatagiri (SC 4111 desk 7, venktgr2@illinois.edu).

Administrative Assistant: Jennifer Dixson (SC 4301, jbdixson@illinois.edu, 217-300-1205).

Office Hours: Sarita Adve: 12:30 to 1:00pm on Thursdays and by appointment (send email to make an appointment) in SC 4104. Radha Venkatagiri: 1:00 to 2:00pm on Mondays and 3:00 to 4:00pm on Wednesdays in SC 4111 (desk 7).

Web site and discussion: The course home page is at http://courses.engr.illinois.edu/cs433/. Most handouts, including this handout, lecture notes, homeworks, and solution sets will be available here (see below). Please review the safety information posted on the web site. For announcements related to the class, we will use piazza: https://piazza.com/illinois/fall2018/cs433. This will be the primary medium for communication between the course staff and the students. It is your responsibility to check this site regularly.

Class meeting place/time: 1105 Siebel Center, Tuesday/Thursday 11:00am to 12:15pm (Illinois time).

Pre-requisites: CS 233 or equivalent. Specifically, you should be familiar with Chapters 1-6 of *Computer Organization and Design: The Hardware Software Interface* by Patterson and Hennessy, 5th edition. See the detailed section below elaborating on specific requirements from CS 233.

Credit: 3 credits for undergraduate students. Graduate students should take the course for 4 credits. *All* graduate students will be required to do a mini-project (described below), possibly additional work on the assignments, and possibly additional problems on the exam.

Course Material: John L. Hennessy and David Patterson, *Computer Architecture: A Quantitative Approach*, Elsevier, **sixth edition**. The text will be supplemented with some additional material that will be provided in the lectures.

Lecture notes and handouts: Most lecture notes and handouts will be available from the course home page listed above the day before they are used in class. It is your responsibility to print them out and bring them to class.

Assignments: There will be several written assignments. The assignments will usually be due at the beginning of class on the due date. An automatic extension of 10 minutes (i.e., until 11:10 a.m. Illinois time) is given without any further request. **No further extensions for late submissions will be given in general.** For exceptional reasons, an agreement to submit an assignment late may be reached with Professor Adve. Except for unforeseen medical emergencies, the agreement must be made within 48 hours after the assignment is handed out to the class. *In all cases, you must get an email confirmation of the agreement.*

Exams: There will be one midterm and a final exam. The midterm will be on October 15th (Monday) from 7pm to 9pm in 0216 SC. It will include material covered until and including the last class before the midterm. The date for the final will be announced by the campus office in October. The final will include material covered after the midterm and until the last lecture. **Requests for a conflict midterm should be emailed to the TA and Professor Adve by September 18th. Requests for a conflict final should be emailed to the TA and Professor Adve by November 13th. Except for medical emergencies, no further requests will be granted after that time. Please indicate clearly the reason for your request. Note that a job interview is not an appropriate reason – you should schedule those around your academic schedule.**

Mini-projects: *For graduate students:* Graduate students will work in small groups to research how the concepts presented in class are applied in a real system and present the results to the class (towards the end of the semester), based on provided guidelines. More information will be announced shortly. All students in the group are required to participate in the research and presentation.

For undergraduate students: All undergraduates are required to attend the mini-project presentations in class. The slides prepared by the graduate students will be made available to all students. Brief questions from these slides will appear on the exams.

Grading: For undergraduates: assignments: 25%, midterm: 37%, final: 38%.

For graduates: assignments: 20%, mini-projects: 14%, midterm: 33%, final: 33%.

You will be graded on an absolute scale. For undergraduates, the minimum score for a grade is as follows: A+: 90%, A: 83%, A-: 78%, B+: 73%, B: 65%, B-: 58%, C+: 53%, C: 48%, C-: 43%, D: 35%, F: 0%.

For graduates, the minimum score for guaranteeing a grade is as follows: A+: 95%, A: 88%, A-: 83%, B+: 78%, B: 70%, B-: 63%, C+: 58%, C: 53%, C-: 48%, D: 35%, F: 0%.

No D- and D+ grades will be allotted. Under exceptional circumstances, the minimum scores on some grades may be reduced, but they will not be increased.

Regrade requests: If you think you have been unfairly graded on a homework or exam, you should petition the TA or Professor Adve in writing **within a week of distribution of the graded work.** After a week, no regrade requests will be entertained.

Honor code – policies on assignments and exams: You may work with one partner for each assignment (different partners for different assignments are encouraged). You may discuss the problem and solution at length with your partner, but each partner must finally write up her or his own solution independently (on your own, with no more input from your partner) and submit an individual assignment. Write the name of your partner clearly on the submitted work to let us know who you worked with. The partner will not get any credit for your submission. Both partners must actively participate in the development of all the solutions. You may seek clarifications on the assignment *problems* from other students in the class as well, but you may not discuss the *solutions* with anyone other than your partner.

Exams are to be done individually. No books, notes, electronic devices, handouts, etc. may be used during the exam.

Unless made available by the course staff, assignments, exams, and solution sets from previous offerings of the course or from other universities may not be used for this course. If you use such material, it is likely you will find the solutions to the problems in the assignments and the exams – we spend much time formulating the best possible set of problems and it is not possible to invent all new assignments for each course offering. Your use of such solutions will entirely defeat the goal of helping you learn the material and violate our honor code principles.

I call the above policies the honor code because I would like to largely rely on your honor to enforce them – you are the only one to lose when you cheat. I consider both giving and receiving help beyond that allowed by the honor code policies to be forms of cheating, and take a violation of the honor code very seriously. **My default is to give anyone found violating the above policies a zero on the entire section of the course where the policy is violated (where a section is *all* homeworks, the midterm, or the final); further, after the student's scores are adjusted as above, the resulting grade will be reduced by a whole letter grade to determine the final grade. For example, if a student cheats on one homework problem, a zero score will be assigned on *all* homeworks. If this adjustment results in a total course score that would normally give a B- grade, then the final grade will be a C-. All cheating cases will be handled through the College of Engineering reporting system and will become part of the students' permanent academic record. So please read these policies very carefully.**

Details on CS 233 pre-requisite: We assume that the student is familiar with Chapters 1 to 5 and parts of Chapter 6 of *Computer Organization and Design: The Hardware / Software Interface* by Patterson and Hennessy, 5th edition, with specific emphasis on the following topics.

- Instruction Sets
    - Familiarity with at least one RISC instruction set (MIPS/SPARC/Alpha/ARM/RISC V...)
    - Addressing modes
    - Arithmetic instructions
    - Control instructions - jump, conditional branch
    - Procedure calls and returns
- Basics of Computer Arithmetic
- Basic Understanding for Assessing Performance
- Basic pipelined implementation
    - Structural, data, and control hazards
- Memory hierarchies – Caches and Virtual Memory
    - Concept of locality
    - Concepts of miss vs. hit, miss and hit ratios, block or line, page, page fault, address translation, purpose of a translation lookaside buffer (TLB)
    - On a miss, where to place a block (associativity), which block to replace (LRU, random, etc. replacement policy), how to find a block (page index, tags, etc.), what to do on a write (writethrough vs. writeback)
- Basics of I/O – disks and buses
- Basic familiarity with shared-memory and snooping based cache coherence and the SIMD model of computation

Topics for this course

- Introduction – review of fundamental performance issues, power and reliability, cost vs. price, basic pipeline structure
- Instruction level parallelism – hardware and software techniques (e.g., dynamic scheduling, superscalar, static and dynamic branch prediction, VLIW, loop unrolling).
- Memory hierarchy – advanced concepts in caches, main memory, and virtual memory.
- Multiprocessors/multicore – overview of different models, cache coherence with shared-memory systems/multicore (snoopy and directory solutions), synchronization, memory consistency models.
- Data parallel architectures (e.g., SIMD, vectors, GPUs)
- Domain-specific architectures – *depending on available time*
- Storage systems, I/O – *depending on available time*
- Recent advances in architecture and future challenges – *depending on available time*