

COM S 321 Introduction to Computer Architecture and Machine-Level Programming
Spring 2018

Lectures: MWF 11 – 11:50 A.M., Rm 1352 Gilman Hall

Instructor: Prof. G. M. Prabhu

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Office Hours: To be posted later

TAs and office hours: To be posted later

Prerequisites: Com S 228, CprE 281, Engl 250

Course work: Students are expected to regularly attend lectures and take their own notes.

Graded course work will consist of homeworks, in-class activities, and three exams (2 mid-terms and one final). The tentative weights for these are:

Homeworks: 25%

In-class Activities: 5%

Mid-term Exam 1: 20%

Mid-term Exam 2: 25%

Final Exam: 25%

Office hour policy: I have an open office hour policy if you are not able to see me during my office hours. Please feel free to knock on my door to check if I am in or send me an e-mail requesting an appointment. As far as possible, we will distribute office hours so that a TA is available every day of the week. Questions about the homework and concepts covered in class will be answered only in office hours and not via e-mail. E-mail will be used only for homework clarifications or postponements of due dates.

General approach: Concepts in computer architecture and machine-level programming will be explained as much as possible through solutions to problems in lectures, through in-class activities, and homework. It is a good idea for you to regularly attend lectures. There is no required textbook. Please bring a calculator to class everyday. If you miss a lecture and want the notes, please send me an email and I will give you a close approximation to what was covered in the lecture.

Cell phone policy: Cell phones should be kept on silent during lecture and in airplane mode during exams. Failure to adhere to this policy may result in a grade penalty (after a couple of warnings). If you forget to bring a calculator you may use the calculator app on your phone.

Late Homeworks: In general, homeworks should be turned in on time. A 25% grade penalty will be assigned for homeworks that are turned in up to 24 hours late (weekend

and university holidays are not counted in the 24 hours). Homeworks turned in beyond 24 hours will not receive any points.

In-class Activities: For in-class activities you have to be in class. There will be no make-ups for in-class activities. In-class activities are group efforts meant to help you learn concepts covered in class. When they are turned in, you should write only the names of students who were present in class and in your group. Writing in the name of a student who was not present in class for an activity will be considered as academic dishonesty (see policy below on how that is enforced).

Academic Honesty: Homework assignments are individual efforts, not group efforts. You are expected to complete your work on your own. You may discuss ideas about the homework problems with other students, the TAs, and the instructor, but when you turn in your homework solutions you are expected to do them on your own without help from anyone else. You should not copy verbatim any solutions that are posted on the internet. When in doubt, contact the TAs or the instructor for clarification.

If you turn in the work of another student, both the person presenting the work as their own and the student tendering the information would be guilty of *academic dishonesty*. See the University's Academic Dishonesty Policy on a homework or exam, a report will be turned in to the Dean of Students with a recommended penalty depending on the severity of the academic misconduct.

Students with Disabilities: Iowa State University complies with the American with Disabilities Act and Section 504 of the Rehabilitation Act. Any student who may require an accommodation under such provisions should contact me as soon as possible and no later than the end of the first week of class or as soon as you become aware. You will need to provide documentation of your disability to the Disability Resources (DR) office, located on the main floor of the Student Services Building, Room 1076, 515-294-7220. Please request that a Disability Resources staff send a SAAR form verifying your disability and specifying the accommodation you will need.

Harassment and Discrimination: Iowa State University strives to maintain our campus as a place of work and study for faculty, staff, and students that is free of all forms of prohibited discrimination and harassment based upon race, ethnicity, sex (including sexual assault), pregnancy, color, religion, national origin, physical or mental disability, age, marital status, sexual orientation, gender identity, genetic information, or status as a U.S. veteran. Any student who has concerns about such behavior should contact his/her instructor, Student Assistance at 515-294-1020 or email dso-sas@iastate.edu, or the Office of Equal Opportunity and Compliance at 515-294-7612.

Religious Accommodation: If an academic or work requirement conflicts with your religious practices and/or observances, you may request reasonable accommodations. Your request must be in writing, and your instructor or supervisor will review the request. You or your instructor may also seek assistance from the Dean of Students Office or the Office of Equal Opportunity and Compliance.

Course Objectives: To understand aspects of computer architecture and program performance. To adopt an evolutionary approach to learning by presenting fundamental concepts first in the context of an easy-to-understand instruction set such as MIPS, and building more complex ideas from the simpler ones.

Learning outcomes: Students will develop the ability to form their own mental model of the underlying concepts by regularly attending class and taking their own notes. Students will develop the ability to understand computer performance, computer design, and tradeoffs between cost and performance as well as between hardware and software. Students will formulate and solve problems, understand the requirements of systems, communicate effectively, and learn to think creatively and critically, both independently and with others.

ABET Outcomes: B, C, J

<http://www.cs.iastate.edu/files/page/files/Undergraduate-Student-Outcomes-revised.pdf>

Topical Outline

1. **Introduction:** Computer abstractions and technology
2. **Measuring and evaluating performance:** Metrics of performance; Amdahl's Law; Cost/benefit tradeoffs; Instruction count, CPI, Clock cycle time; Comparing and summarizing performance
3. **Instruction set architecture of MIPS:** Signed and unsigned numbers; Representing instructions - the MIPS instruction set; Instructions for decision making; Supporting procedures - stack pointer; Arithmetic and Logical operations
4. **Processor Datapath and control:** Building a datapath; A single-cycle implementation; How control is supposed to work; A multicycle implementation and control
5. **Memory Hierarchy design:** A framework for memory hierarchies; The basics of caches; Placement, replacement, and memory interaction policies; Measuring and improving cache performance; FIFO, LRU, MRU, write back and write through policies
6. **Enhancing performance with pipelining:** Overview of pipelining; A pipelined datapath; Data hazards and forwarding; Data hazards and stalls; Branch hazards. Introduction to parallel and distributed computing.
7. **Exceptions and exception handling:** Interrupts and exceptions Hardware/software interface; Interrupt handlers