15-740/18-740 Computer Architecture
Fall 2010 Syllabus

1 Course Contacts & Logistics

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Office Hours: Wed 2:30-3:30 PM (or by appointment)

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Course Administrative Assistant: Bara Ammoura, bammoura@ece.cmu.edu, HH-D200
Timings: Mondays, Wednesdays, Fridays - 4:30-6:20 PM
Class: Wean Hall 5409

Two out of three days a week will be lectures and the remaining day will be devoted to discussions.

2 Course Overview

Computer architecture is the science and art of designing, selecting and interconnecting hardware components and co-designing the hardware/software interface to create a computer that meets functional, performance, energy consumption, cost, and other specific goals. This course qualitatively and quantitatively examines fundamental computer design trade-offs, with the goal of developing an understanding that will enable students to perform cutting-edge research in computer architecture. We will learn, for example, how uniprocessors execute many instructions concurrently, how state-of-the-art memory systems deliver data into the processor and why they are so complex, and how/why multiple processors are interconnected to execute portions of a program or multiple programs in parallel, as done in modern multi-core processors. Examining trade-offs requires that you already know how to correctly design a computer, as is taught in the important prerequisite 18-447.

Prerequisites - 18-447 or equivalent

3   What This Course is About?

This course has two major goals:

1. to familiarize computer architecture majors and those interested in computer system design with both the state-of-the-art and trends/research in processor, memory, and platform architectures in today's and future systems.

2. to provide the necessary background and experience to advance the state-of-the-art in computer architecture by performing cutting-edge research.

This course teaches students how to design a computer system well and better than past approaches. It is *not an introduction* to computer system design.

4   Textbooks & Reading/Research Material

Arguably, there is no perfect textbook for computer architecture. I encourage you to do your own research, consult multiple sources, question assumptions and statements, and talk with me and TAs whenever you have questions. Lectures will serve as the main source of information and they will provide the required references to textbooks or other reading material (such as research articles). A good source of information on all covered topics is the research articles that introduced or built upon the covered topic. These articles are usually published in top conferences (such as ISCA, MICRO, ASPLOS, HPCA) or journals (such as IEEE or ACM Transactions). I strongly encourage you to dig out the original source of the covered topics as well as the research that builds upon it. This will help you become a successful and well-read researcher in computer architecture/systems. When in doubt, ask questions.

The following textbooks could be useful as supplements to lectures:

1. **Computer Architecture: A Quantitative Approach, Fourth Edition** by Hennessy and Patterson, Morgan Kaufmann/Elsevier
2. **Computer Architecture and Implementation** by Harvey Cragon, Cambridge University Press
3. **Computer Organization** by Hamacher, Vranesic, Zaky, McGraw-Hill
4. **Structured Computer Organization** by Andrew Tanenbaum, Prentice Hall
5. **High Performance Computer Architecture** by Harold Stone, Prentice Hall (dated but good reference)
6. **Readings in Computer Architecture** by Hill, Jouppi, Sohi, Morgan Kaufmann

The following websites contain links to original articles as well as articles that refer to them:

1. Google and Google Scholar
2. ACM Digital Library
3. IEEE Explore
4. Microprocessor Report (The CMU E & S Library has a subscription)

Other reading material will be distributed in class and/or will be available on the website electronically.

5   Assignments & Grading

The course will be graded on a curve scale. The tentative breakdown of grades is given below:

10%	Homeworks, Reviews, Quizzes
35%	Research Project (detailed breakdown to follow in project handouts)
20%	Midterm Exam 1
35%	Midterm Exam 2
5%	The teaching team's evaluation of your performance

6   Homeworks & Reviews

The primary purpose of the homeworks is to help you master the material and prepare for both the projects and exams. We encourage you to work together with your classmates to help you understand the basic concepts. However, you are required to do your own homework.

7   Research Projects & Late Policy

This course is a hands-on research oriented course. You (in groups of two) are expected to propose, conduct, and experimentally evaluate a 2-3-month long research project whose goal is to advance the state-of-the-art and/or current understanding in computer architecture or a related subject. The topic of the project is flexible, but it must be approved by me. You will have to find a project partner and conduct research in groups of two. This is your chance to explore in depth a computer architecture topic that interests you and perhaps even publish your innovation in a top computer architecture conference. I strongly encourage you to start thinking about your project topic as early as possible and interacting with me and the teaching assistants to crystallize it over time.

A total of five late days will be allowed for the assignments and project proposal/reports. Once you use up all your late days, your submissions will be graded based on the instructor's discretion. **No late submission will be allowed for the project final report**.

8   Academic Honesty

We would like to promote a collaborative environment where people feel free to openly discuss and ask questions. However, when assignments are submitted, the work must be the author's own and any aid received from other people must be documented in the assignment. Simply put, cheating is submitting work that is not your own; material handed in for grading must be the product of individual effort; anything else constitutes cheating. Cheating in any form or shape will result in a failing grade for the course. No exceptions will be made. Students are referred to the University Policy about Cheating and Plagiarism [1].

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[1] http://www.cmu.edu/policies/documents/Cheating.html

9 Compile Time **Course Schedule** (Subject to change at Run Time)

Date	Tentative Topic	Homework	Project
08/23	Announcements	HW0 Assigned	
08/25-09/03	**CSD Immigration Course (No Class)**		Topics Out
09/06	**Labor Day (No Class)**		
09/(08-10)	Introduction, Principles and Trade-offs	HW0 Due	
09/13	Pipelining	HW1 Assigned	
09/(15-17)	Memory Subsystem I (Caching)		
09/20	Memory Subsystem II (Prefetching)		
09/(22-24)	Memory Subsystem III (Virtual Memory)	HW1 Due	
09/27	Multi-Core Issues in Memory Subsystem		Proposal Due
09/29-10/01	Main Memory	HW2 Assigned	
10/04	Main Memory		
10/(06-08)	Out-of-order Execution I	HW2 Due	
10/11	**Midterm Exam I**		
10/13	Out-of-order Execution II		Milestone 1 Due
10/15	**Mid-semester Break (No Class)**		
10/18	Superscalar Processing I	HW3 Assigned	
10/(20-22)	Superscalar Processing II		
10/25	Control Flow I	HW3 Due	
10/(27-29)	Control Flow II		
11/01	Memory Dataflow	HW4 Assigned	Milestone 2 Due
11/(03-05)	Alternative Approaches to Concurrency I		
11/08	Alternative Approaches to Concurrency II	HW4 Due	
11/(10-12)	Vector Processing		
11/15	Multithreading	HW5 Assigned	
11/(17-19)	Multiprocessing, Multi-Core		Milestone 3 Due
11/22	**Midterm Exam II**	HW5 Due	
11/(24-26)	**Thanksgiving (No Class)**		
11/29	Project Presentations I		
12/(01-03)	Project Presentations II		
12/(04-08)	MICRO Conference		
12/(06-10)	Project Poster Session		
12/12			Final Report Due