ECE/CS 752: Advanced Computer Architecture I

Fall Semester 2019, MWF 11:00-12:15 EH 3032 (MWF)

Instructor: Prof. Mikko Lipasti, mikko@engr.wisc.edu, EH3621

https://canvas.wisc.edu/courses/160410

Course Description

This course will teach you the fundamental principles of operation of modern, high-performance processors and systems. We assume knowledge of pipelined processors with cache memories, as studied in depth in ECE 552, and continue with advanced techniques for extracting greater levels of instruction-level parallelism and memory-level parallelism. The former exploits opportunities for parallel execution of instructions from an inherently serial instruction stream, while the latter attempts to overlap increasing memory access latency with other useful work. We will study the memory hierarchy as well as virtual memory, and will also cover processor chips that with multiple cores, where concurrency is extracted from multiple sequential threads of execution.

Prerequisites: ECE 552 (or equivalent) and CS 537 (not strictly enforced).

Course Textbook

Recommended: John Paul Shen and Mikko H. Lipasti, *Modern Processor Design: Fundamentals of Superscalar Processors*, First Edition, hard cover or paper back, available online or in e-book form(Note: not the paperback beta edition)

Recommended: Mark Hill, Norm Jouppi, and Guri Sohi. *Readings in Computer Architecture.* Morgan Kauffman, 1999. Available from the bookstore or www.amazon.com

These will be supplemented with additional readings as specified in the reading list posted to the class web page.

Lectures

It is very important that you attend lecture faithfully. Much of the material will be covered only in lecture, as the textbook and readings are by definition out of date. Also, we will have several unannounced in-class quizzes. Lecture slots may be overscheduled; we are likely to meet more often than necessary in the first half of the semester to free up time in the second half for project work. Some review lectures will only be presented online.

Homework

There will be several assignments. Some assignments will require the review of material that is touched upon, but not covered in depth in class, and may require C/unix programming skills. Homework will be assigned but not always collected or graded; it's purpose is to help you learn the material and prepare for the midterm exams.

Project

The default course project is to do some original research in a group of three to four students. Some alternatives for original research are: you could examine a modest extension to a paper studied in class or simply revalidate the data in some paper by writing your own simulator. Projects will include a written report. Project work will be presented orally to the rest of the class at the end of the semester.

Quizzes, Paper Reviews, and Examinations

There will be two midterms; the second midterm is scheduled in the final exam timeslot. There will be several unannounced in-class quizzes throughout the semester. A paper review schedule will be published on the website. The lowest quiz score will be dropped to accommodate absences.

Grading

Quizzes, HW and Paper Reviews	20%	Project	30%
Midterm 1	25%	Midterm 2	25%

Communications Channels

I strongly encourage you to meet with me during my office hours, or call me or send e-mail. Introducing yourself to me, expressing concerns, offering suggestions, and seeking advice are among the welcome topics. Please monitor the web site for this course which contains course information, lecture notes, pointers to project resources, and the latest announcements.

Office Hours

Prof. Lipasti: EH3621, TBA, or by appointment

Tentative Course Outline

Week	Dates	Assignments/ Comments	Topics	Readings
0	9/4, 9/6	HW0 out	Introduction Technology challenges	Ch. 1
1	9/9,9/11,9/13		Pipelining Review (online) Superscalar Organization	Ch. 2 Ch. 4
2	9/16,9/18,9/20	HW1 out	Instruction Flow Cache Memory Review (online)	Ch. 5, Ch. 9 Ch. 3.1-3.4.3
3	~~9/23~~,9/25,~~9/27~~	No lecture Monday or Friday	Register Data Flow	Ch. 5
4	9/30,10/2,10/4		Memory Data Flow	Ch. 5
5	10/7,10/9,~~10/11~~	No lecture Friday	Advanced Register Data Flow	Ch. 10
6	10/14,10/16,10/18	HW2 out	Case Studies	Papers, Ch. 6-8
7	10/21,~~10/23~~,10/25	No lecture Wednesday	Case Studies Midterm 1 review	Papers, Ch. 6-8
8	10/28,10/30,11/1	Midterm1 Mon Oct. 28	Advanced Memory Hierarchy	Ch. 3, papers
9	11/4,11/6,11/8	HW 3 out Project proposals due 11/4	Multiple threads Case studies	Ch. 11, papers Papers
10	11/11,11/13,11/15		Advanced Topics	Papers
11	11/18,11/20,11/22	Project progress report due 11/22	Lecture canceled, project work	
12	11/25,11/27,11/29		Lecture canceled, project work	
13	12/2,12/4,12/6		Lecture canceled, project work	
14	12/9,12/11	Final project reports due 12/11	Project talks Course Evaluation Midterm 2 Review	
15	12/16	Midterm 2	10:05am-12:05pm	