

# **EE557 – Computer Systems Architecture**

**Fall 2013**

**Instructor: Murali Annavaram**

**Office hours: 2-4pm Monday; other times: by appointment.**

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## **Syllabus**

### **1. Overview**

The main objective of EE557 is computer architecture exploration at a more abstract level than in previous courses on architecture (such as EE457). Because architectures are described at a block diagram level a large number of machines, memory structures, and interconnections will be taught. In ee457, we learned how to design a simple five-stage pipeline in great details, down to the circuit level. This pipeline corresponds to architectures designed at the beginning of the 1990's. In ee557, we assume that these implementation details are known. We will learn about processors and systems as they are designed for servers and laptops today, which include out of order processors, complex memory hierarchy, chip multiprocessors, IO and interconnects. The focus of the course is not on research but on knowing the design details of existing machines. Time permitting towards the end of the class we will discuss some research issues. These research issues are the topics of EE653, EE657, EE659 and EE677.

Students enrolled in this class will learn the structure of current processors and computer systems and will be ready to work on advanced development and research in the area of computer architecture. Moreover they will gain practical experience in using modern architectural design tools, such as architecture simulators, area/complexity estimators and power/energy estimators, to design processors at the architectural level.

Besides attending two lectures and one discussion session per week students will complete five homework and two simulation projects and multiple in-class quiz exams.

### **2. Textbooks**

- **Class slides presented in class. Purchase from the USC bookstore. REQUIRED.**
- **Dubois, Annavaram & Strenstrom. Parallel Compute Organization & Design. (Required)**
- Shen and Lipasti: "Modern Processor Design: Fundamentals of Superscalar Processors." 2013 Recommended.

### **3. Prerequisite**

- EE101: Digital Logic Design
- EE357: Assembly Code Programming and Basic Machine Structure
- EE457: Computer System Organization

### **4. Meeting times**

**Tue/Thu 12:30-1:50PM in OHE132. Attendance for all classes is required. There is one discussion session per week that is lead by the TA.**

**Discussion: Fri: 1-1:50PM in OHE 132.**

Office hours: 2:00-4:00PM, Monday. Room: EEB 232. Phone: (213) 740-3299. Just email me any time if you want to meet with me regarding this course material.

## 5. Attendance and Discussion session:

EE-557 has two lectures of 80 minutes each and a 50 minutes discussion session per week, over 15 weeks. The discussion session is an opportunity to discuss the material covered in class, the homework and the exams with the TA. At times class material may be expanded upon during the discussion session.

**All material/information given out during regular class times and discussion sessions is part of the course.** If you have to miss a class or a discussion session, make sure that you catch up by asking a friend to brief you up. Also stay informed of homework deadlines, changes of deadlines, potential problems with homework questions etc. by visiting the EE557 DEN site regularly.

## 6. TA

Gunjae Koo, Office Hours: Wed: 10AM - 12Noon. Room EEB 230. Please email [gunjae.koo@gmail.com](mailto:gunjae.koo@gmail.com) if you like to setup a different time slot to meet the TA.

Lizhong Chen, Office Hours: Friday: 2PM-4PM. Room TBD. Please email [lizhongc@usc.edu](mailto:lizhongc@usc.edu) if you like to setup a different time slot to meet the TA.

TAs will help with homeworks and simulation infrastructure.

Per department policies, complaints about homework and project grading issues should be addressed to the TA who will then interact with the graders to solve them.

## 7. Course Work

**Homework:** There will be six homework assignments; five will be graded. These are assigned electronically through the DEN site. Homework assignments are due two weeks from assignment date, before 5pm PST. We will use paperless homework submission, grading and return. Homework solutions are submitted electronically on the DEN blackboard. Homework must be in PDF or WORD DOC (scan it if you want). In order to minimize errors use the following file naming convention for the submitted work LASTNAME\_HW#\_TOTALPAGES.DOC/PDF. Homework will be graded electronically and returned through the DEN blackboard. **Late homework will not be accepted. No exceptions to this policy either for DEN or IN-CLASS students.**

**Simulation assignments:** There will be two simulation assignments. These assignments do require familiarity with using a simulator under Unix and require some programming. The submission and grading of projects follow the same procedure as for homework.

**Quizzes:** There will be up to 5 pop quizzes during the semester administered at random times. Each pop quiz is worth point. The quiz will be very short and will last no more than 5 minutes. It will ask one brief question about the material just taught in the class or in the previous class. It can happen at the beginning, the middle or the end of the class.

Midterm: TBA —ROOM TBA

Final: TBA—ROOM TBA

Please understand that there will be NO make-up exam, except in cases of personal medical emergency certified by a physician. All other requests will be denied.

## **8. Grading Policy**

Homework: 25%; Simulation projects: 25%; Midterm 20%; Final: 25%, Quiz: 5%. For DEN registered students quiz grade will be substituted with a sixth homework.

There will be no possibility to earn extra credit in this class. The final grade will be computed as announced. So please, do the best you can on each component of the class you are graded on. All grading related disputes should be brought to TA's attention within one week from the day you receive your grade. Beyond one week no grading disputes will be entertained.

I will be happy to award A to every student in the class if all do superbly well in the class. Otherwise, if the total score  $\geq 95\%$  guaranteed A. If the total score  $\geq 85\%$  guaranteed B.

## **9. Academic Integrity Issues**

While active collaboration within a group may be needed sometimes, there should be a clear separation of work between the group members. If you plan to integrate some existing code fragments into your simulation infrastructure check with the TA or me first. Make sure that you give credit to the source whenever you integrate an existing body of work (code, papers, presentations etc.)

To understand these issues more clearly please consult <http://www.usc.edu/student-affairs/SJACS/acadresources.html>.

## **10. Disability Accommodation**

Any student requesting academic accommodations based on a disability is required to register with Disability Services and Programs (DSP) each semester. A letter of verification for approved accommodations can be obtained from DSP. Please be sure the letter is delivered to me (or to TA) as early in the semester as possible. DSP is located in STU 301 and is open 8:30 a.m.-5:00 p.m., Monday through Friday. The phone number for DSP is (213) 740-0776.

## 10.1. TENTATIVE Course Schedule

Lecture	Date	Notes	Students: Things to do
Lect 1	8/27	Administration/Introduction	
Lect 2	8/29	Instruction set	
Lect 3	9/3	Static Pipelines	
Lect 4	9/5	Dynamic Pipelines-Tomasulo	HWK1
Lect 5	9/10	Branch prediction	
Lect 6	9/12	Speculative execution	
Lect 7	9/17	Speculative execution	
Lect 8	9/19	Register renaming/Speculative scheduling	HWK2; HWK1 is DUE
Lect 9	9/24	VLIW	
Lect 10	9/26	Vector	
Lect 11	10/1	Memory hierarchies/Caches	PROJECT1
Lect 12	10/3	Caches	HWK3; HWK2 is DUE
Lect 13	10/8	Virtual memory	
Lect 14	10/10	Virtual memory	
Lect 15	10/15	Multiprocessors Introduction	
Lect 16	10/17	Interconnections	HWK4; HWK3 is DUE
Lect 17	10/22	Multiprocessor Applications	PROJECT1 DUE; PROJECT2
Lect 18	10/24	Multiprocessor Programming	
	10/29	MID TERM	
Lect 19	10/31	Synchronization	
Lect 20	11/5	Coherence	HWK5; HWK4 is DUE
Lect 21	11/7	Coherence	

Lect 22	11/12	Consistency	
Lect 23	11/14	Consistency	HWK6
Lect 24	11/19	Core Multithreading	
Lect 25	11/21	CMPs	
Lect 26	11/26	CMPs	HWK5 is DUE
Lect 27	12/3	Technology Issues	
Lect 28	12/5	Technology Issues/Course Wrap Up	PROJECT2 is DUE
	12/12	Final Exam DATE & TIME MAY CHANGE!!!	