California State University Dominguez Hills

Computer Science Department

Course Syllabus

CSC 531 Computer Architecture, 3 units, Spring 2020

Course Information Thursdays, 7:00pm-9:45pm, NSM D129

Faculty Information Dr. Bin Tang
Associate Professor of Computer Science

office NSM E-117
office hour Mondays 5:30pm-7pm and Thursdays 5:30pm-7pm, or by appointment

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Course Information This course provides comprehensive study of computer architectures to maximize performance and energy efficiency of a computer while staying within cost, power, and availability constraint. The main focus is on the quantitative analysis and cost-performance tradeoffs in instruction-set, pipeline, and memory design. Specific topics covered include: quantitative performance measures, instruction set design, parallelism (mainly pipeline and instruction-level), and memory organization. Related topics such as data centers and cloud computing will also be covered.

Prerequisites CSC 311 Data Structures and CSC 331 Computer Organization. Specifically, students should have mastery of Boolean algebra, logic equations, binary numbers (including negatives), fixed-point binary arithmetic, hexadecimal notation, powers-of-2, logarithms, exponential numbers. Student should also have familiarity with: logic gates & diagrams, processor organization & operation, memory devices & hierarchies, and processes.

Course content and instructional method This course consists of lectures, examinations, homework assignments and programming projects, and a term project. We will have four to five homework and two to three programming projects. They will all be done individually. For the programming projects, we will use QtSpim (http://spimsimulator.sourceforge.net/), a simulator that runs assembly language programs written for processors that implement the MIPS32 architecture. It runs on it runs on Microsoft Windows, Mac OS X, and Linux. In QtSpim website, you can also find many useful resources and documents to get started. We will discuss those materials in class when time comes.

Course Objectives and Student Outcomes

The course is to provide the knowledge needed to

- Understand organized approaches to determine the capabilities and performance of computing systems
- Understand the fundamentals of different instruction set architectures and their relationship to the CPU design
- Understand and effectively utilize modern advanced computer systems, and the operations of modern CPUs including pipelining and memory systems
- Understand different systems architectures and scalable computer systems

By the end of this course, students should be able to

- Identify trade-offs in design, implementation, and performance issues in computer systems
- Design and emulate a single cycle or pipelined CPU using QtSpim simulator
- Keep up with state-of-the-art industry practice and academia research, by writing reports and making presentations about their computer architecture projects

Required Textbooks

Computer Architecture: A Quantitative Approach, Six Edition, Morgan-Kaufmann 2019

By John L. Hennessy and David A. Patterson, ISBN-13: 978-0-12-811905-1

CSUDH's Affordable Learning Initiatives give students free online access of the book.

Course Calendar

WEEK	*DATE*	*READING*	*TOPICS*
1	1/23	Appendix A	Instruction Set Architecture (ISA)
2	1/30	Appendix A	Instruction Set Architecture (ISA)
3	2/6	Chapter 1	Fundamentals of Quantitative Design & Analysis

4	2/13	Chapter 1	Fundamentals of Quantitative Design & Analysis
5	2/21	Appendix B	Review of Memory Hierarchy Design
6	2/20	Appendix B	Review of Memory Hierarchy Design
7	3/5		**Midterm**
8	3/12	Chapter 2	Memory Hierarchy Design
9	3/19	Chapter 2	Memory Hierarchy Design
10	3/26	Appendix C	Pipelining
11	4/2		**Spring Break**
12	4/9	Chapter 3	Instruction-Level Parallelism and Its Exploitation
13	4/16	Chapter 3	Instruction-Level Parallelism and Its Exploitation
14	4/23	Chapter 3	Instruction-Level Parallelism and Its Exploitation
15	4/30		**No class due to instructor conference travel**
16	5/7		Term Project Presentation

Examinations **Midterm Examination is scheduled on 3/5 Thursday, in class. It covers the Chapters 1 and Appendix A and B. Final Examination is scheduled on 5/14 Thursday, 7:45pm-9:45pm. It covers Chapter 2 and 3 and Appendix C.**

No class on 4/2 Thursday due to spring break, no class on 4/30 due to instructor conference travel

Term Project Machine learning/deep learning has become one of the hottest areas in computer science these days. Please do a research on the topic combining machine learning/deep learning and computer architecture and try to identify a research problem and understand it from a technical point of view such as the problem, the solution, and other necessary perspective. A final report of 8 pages, double-column, IEEE format is expected.

Here are some computer architecture related conferences. IEEE International Conference on Networking, Architecture and Storage (IEEE NAS) and IEEE Symposium on High Performance Computer Architecture (IEEE HPCA). Students should browse the conference proceedings of NSDI 2018, 2019, and 2020 and find a paper of interest. A final presentation is required. To start, read:

A New Golden Age in Computer Architecture: Empowering the Machine-Learning Revolution,

A Domain-Specific Architecture for Deep Neural Networks,

, and watch youtube of John Hennessy and David Patterson 2017 ACM A.M. Turing Award Lecture.

Course grade factors
20% Homework Assignments
10% Programming Projects
30% Midterm Exam
30% Final Exam
10% Term Project (presentation and term paper)

AMERICANS WITH DISABILITIES ACT

CSUDH adheres to all applicable federal, state, and local laws, regulations, and guidelines with respect to providing reasonable accommodations for students with temporary and permanent disabilities. If you have a disability that may adversely affect your work in this class, I encourage you to register with Disabled Student Services (DSS) and to talk with me about how I can best help you. All disclosures of disabilities will be kept strictly confidential. NOTE: no accommodation can be made until you register with the DSS. For information call (310) 243-3660 or to use the Telecommunications Device for the Deaf, call (310) 243-2028 or goto: http://www4.csudh.edu/dss/

COMPUTER INFORMATION LITERACY EXPECTATIONS

It is expected that students will:

1. *Use Microsoft Word for word processing unless otherwise approved by the instructor,*
2. *Be familiar with using email as a communication tool and check your official campus email account at least every other day;*
3. *Be able to access websites and online course materials which may require Flash and other plug-ins;*
4. *Use the library databases to find articles, journals, books, databases and other materials;*
5. *Be able to create an effective PowerPoint presentation;*
6. *Be able to record audio (ideally video) to share with the instructor via the web; and*
7. *Have regular access to a computer and internet access for the term of this course.*

ACADEMIC INTEGRITY Academic integrity is of central importance in this and every other course at CSUDH. You are obliged to consult the appropriate sections of the University Catalog and obey all rules and regulations

imposed by the University relevant to its lawful missions, processes, and functions. ***All work turned in by a student for a grade must be the students' own work.*** Plagiarism and cheating (e.g. stealing or copying the work of others and turning it in as your own) will not be tolerated, and will be dealt with according to University policy. The consequences for being caught plagiarizing or cheating range from a minimum of a zero grade for the work you plagiarized or cheated on, to being dropped from the course.

Consequences for violations of academic integrity in this class will automatically receive an "F" in the course and may be in jeopardy of expulsion from the university.

Academic dishonesty includes:

Cheating – Intentionally using or attempting to use unauthorized materials, information, or study aids in any academic exercise.

- Students completing any examination should assume that external assistance (e.g., books, notes, calculators, and conversations with others) is prohibited unless specifically authorized by the instructor.
- Students may not allow others to conduct research or prepare work for them without advance authorization from the instructor.
- Substantial portions of the same academic work may not be submitted for credit in more than one course without authorization.

Fabrication – Intentional falsification or invention of any information or citation in an academic exercise.

Facilitating academic dishonesty – Intentionally or knowingly helping or attempting to help another commit an act of academic dishonesty.

Plagiarism – Intentionally or knowingly representing the words, ideas, or work of another as one's own in any academic exercise."
Further details may be found in the Undergraduate Academic Integrity Policy. Wherever the current university policy is different from the policies in this syllabus, the university policy takes precedence.

BEHAVIORAL STANDARDS

Behavior that persistently or grossly interferes with classroom activities is considered disruptive behavior and may be subject to disciplinary action. Such behavior inhibits other students' ability to learn and an instructor's ability to teach. The instructor may require a student responsible for disruptive behavior to leave class pending discussion and resolution of the problem and may also report a disruptive student to the Student Affairs Office (WH A-410, 310-243-3784) for disciplinary action.

Bibliography

Computer Organization and Design, Fourth Edition: The Hardware/Software Interface – David A. Patterson, John L. Hennessy.

Reservation of Rights

The instructor reserves the right to change this syllabus, at his sole discretion, at any time, and without prior notice. In the event of a conflict between this syllabus and the university catalog, the university catalog shall have precedence.