CS 281 Systems Architecture Syllabus

Spring 2017-18

Course Description

This course covers internal function and organization of digital computers, including instruction set design, machine and assembly language, computer arithmetic, ALU design, central processor organization and implementation.

Course Objective and Goals

1. To obtain an understanding of how a computer is organized and how it works. To develop a model of how a program executes on a computer.
2. To be able to understand an assembly language program. There will be some assignments involving assembly language programming; however, the objective is to understand the instruction set of a machine and how a program executes on a computer, rather than to be able to write full length assembly language programs.
3. To understand how a computer can be implemented (down to the gate level). In the lab associated with the course, students will implement a subset of the MIPS architecture using the hardware definition language VHDL.

Prerequisites (all Min Grade: D)

(ECE 200 or CS 270) and (CS 172 or CS 176 or SE 103)

Instructor

Constantine Katsinis (katsinis@drexel.edu)
Office Hours: Monday 3-5 pm in UC 114

Meeting Time

281 A Monday 1800-2050
281 B Tuesday 1830-2120

Teaching Assistants

		Office Hours		
Mariana Quinde Garcia	mq55@drexel.edu	Tu	10:00 AM	12:00 PM
		We	12:00 PM	2:00 PM
Denisa Qori	dq38@drexel.edu	Th	12:00 PM	2:00 PM
		Fr	2:00 PM	4:00 PM

What Students Should Know Prior to this Course

1. Should be familiar with Boolean expressions, truth tables, normal forms.
2. Should be able to design a simple logic circuit.
3. Should be familiar with basic components of combinational logic: encoders, decoders, and multiplexors.
4. Should be familiar with elements of sequential logic: latches, flip flops, registers, memory.
5. Should be able to understand and design a finite state machine.
6. Should have solid programming experience.
7. Must be comfortable with the basic programming constructs in C/C++.
8. Must be comfortable with recursion and pointers.
9. Knowledge and the ability to use data structures such as arrays and lists.

What Students will be able to do upon Successfully Completing this Course Statement of Expected Learning

1. Understand what a compiler, interpreter, assembler, linker and loader does.
2. Understand the components and format of a machine instruction set.
3. Write a simple assembly language program.
4. Understand how an assembly language program executes on a computer.
5. Understand how a computer represents numbers and performs arithmetic.
6. Build a simple ALU.
7. Understand the datapath and control of a simple computer.
8. Implement a simple instruction set: create an appropriate datapath and describe the control using microcode or a finite state machine.
9. Describe and simulate a processor using a hardware definition language.

Textbook

1. David A. Patterson and John L. Hennessy. Computer Organization and Design: The Hardware/Software Interface - FIFTH EDITION. Morgan Kaufman/Elsevier: 9780124077263
2. Recommended: Randel Bryant and David O'Hallaron. Computer Systems: A Programmer's Perspective. Prentice Hall: 013034074X

Topics

1. Computer Abstractions (Chapter 1)
2. Review of Digital Circuits and Logic Design (Appendix B)
3. History of Computers (Chapter 1)
4. Instructions: Language of the Machine (Chapter 2)
5. Assembly Language Programming (Chapter 2 and Appendix A)
6. Assemblers, Linkers, and the SPIM Simulator (Appendix A)
7. Computer Arithmetic (Chapter 3)
8. The Processor: Datapath and Control (Chapter 4 and Appendix D)
9. VHDL and hardware simulation (VHDL/FPGA Text)

Grading and Policies

1. Written Assignments 20% (five at 4% each)
2. Programming Assignments 8% (two at 4% each)
3. Labs (five) 20% (five at 4% each)
4. Midterm Exam 20%
5. Final Exam 25%
6. Project 7%

Final grades

- A range (A+, A, A-) is a course average [90, 100)
- B range is a course average [80, 90)
- C range is a course average [70, 80)
- D and F range is a course average [0, 70)

The university's Academic Honesty policy is in effect for this course. Please read Drexel University Student Handbook found at http://www.drexel.edu/Studentlife/. On the first incident, students who share their work (even with best intentions) or otherwise violate the course or university academic honesty policy may receive a grade of F for the course (the students may not withdraw in this case). The students may be reported to the department, college, and/or University Judicial (Honesty) Board. Both the giver and the receiver will receive these penalties.

Submitting Assignments

Assignments will be submitted through BBLearn according to the directions given on the assignment page, no later than the due date and time listed on each assignment and/or the assignment page. Grade breakdowns, rubrics, and/or point valuations will be provided on each assignment as it is assigned, as appropriate. Grades will be reported via BBLearn.

Tentative Course Schedule

Wk	Class Day		Homework Due next Monday Lab Due Friday after next Monday

1	04/02
	04/03
		Topics
		1. Compilers and Assemblers
		2. The MIPS Instruction Set
		
		Readings
		• COD 1
		• COD 2 (Sections 1 to 6)
		• COD App A
		  • Sections A1-A6 and A9
		  • Section A10 used for reference
		
		Presentation
		• MIPS-InstructionSet
			Homework **Due 04/09, 6 pm**
			• W1A Ch 2 Problems
			
			No Lab

2	04/09 04/10	Topics 1. Branching and Procedures 2. Recursive Functions, Arrays and Strings 3. Arrays, Pointers, and Linked Lists Readings • COD 2 (Sections 1 to 10) Presentation • MIPS-InstructionSet • Review W1A	Homework **Due 04/16, 6 pm** • W1B Ch 2 Problems Lab **Due 04/20, 6 pm** • L1 MIPS Intro
3	04/16 04/17	Topics 1. Arrays, Pointers, and Linked Lists 2. Assemblers, Linkers and Loaders Readings • COD 2 (Sections 1 to 14) Presentation • MIPS-InstructionSet • Review W1B • Review mips-gcc • Review Project	Homework **Due 04/23, 6 pm** • G1 Min_max Lab **Due 04/27, 6 pm** • L2 Arrays

4	04/23
	04/24
		Topics
		1. Review of Digital Circuits
		2. Introduction to VHDL
		3. Introduction to Computer Arithmetic
		4. Design of the ALU
		
		Readings
		• COD 3 (Sections 1,2)
		• COD App B
		  • Carefully read Sections 1,2,3,5,7,8,9
		  • Review the other sections as needed
		
		Presentation
		• LogicDesign
		• Intro-to-VHDL
		• Arithmetic (1 and 2)
		• MIPS-ALU
		• Review G1
			Homework **Due 04/30, 6 pm**
			• G2 Stack Analysis
			
			No Lab

5	04/30 05/01	**Midterm Exam** (Two hours, closed-book)	No Homework Lab **Due 05/11, 6 pm** • L3 VHDL Intro Project • Start working on the project
6	05/07 05/08	Topics 1. Alternative Instruction Sets 2. Design of the ALU 3. A Simple Implementation of MIPS Readings • COD App B • COD 4 (Sections 1 to 4) Presentation • Review G2 • Alternative Instruction Sets • MIPS-ALU • Simple Implementation of MIPS	No Homework Lab **Due 05/18, 6 pm** • L4 1-bit ALU
7	05/14 05/15	Topics 1. A Simple Implementation of MIPS Readings • COD 4 (Sections 1 to 4) Presentation • Simple Implementation of MIPS	Homework **Due 05/21, 6 pm** • W2 Ch 4 Problems No Lab EVAL

8	05/21 05/22	Topics 1. Pipelined Implementation of MIPS Readings • COD 4 (Sections 1 to 9) Presentation • Pipelined Implementation of MIPS • Review W2	Homework **Due 05/28, 6 pm** • W3 Multicycle No Lab
9	05/28 05/29	Topics 1. Pipelined Implementation of MIPS Readings • COD 4 (Sections 1 to 9) Presentation • Pipelined Implementation of MIPS • Review W3	Homework Lab **Due 06/08, 6 pm** • L5 32-bit ALU Project **Due 06/01, 6 pm**
10	06/04 06/05	Topics 1. Integer Multiplication and Division 2. Floating Point Arithmetic Readings • COD 3 (Sections 3 to 5) Presentation	Homework **Due 06/11, 6 pm** • W4 Ch 3 Problems No Lab
11	06/11 06/12	Final Exam	

Holidays
Please note the following holidays. If we have class normally scheduled on these days, we will not meet.
- 05/28/2018

Office of Disability Resources

Students requesting accommodations due to a disability at Drexel University need to present a current Accommodation Verification Letter (AVL) to faculty before accommodations can be made. AVL's are issued by the Office of Disability Resources (ODR). For additional information, visit the ODR website at http://www.drexel.edu/oed/disabilityResources, or contact the Office for more information: 215-895-1401 (V), or disability@drexel.edu.

University Policies
In addition to the course policies listed on this syllabus, course assignments or course website, the following University policies are in effect:
- Academic Honesty:
  - http://www.drexel.edu/provost/policies/academic_dishonesty.asp
- Student Life Honesty Policy from Judicial Affairs:
  - http://www.drexel.edu/studentlife/judicial/honesty.html
- Students with Disability Statement:
  - http://www.drexel.edu/ods/student_reg.html
- Course Drop Policy:
  - http://www.drexel.edu/provost/policies/course_drop.asp
- The instructor may, at his/her/their discretion, change any part of the course during the term, including assignments, grade breakdowns, due-dates, and the schedule. Such changes will be communicated to students via the course web site Announcements page in BBLearn. This page should be checked regularly and frequently for such changes and announcements. Other announcements, although rare, may include class cancellations and other urgent announcements.
- Drexel Student Learning Priorities:
  - http://www.drexel.edu/provost/dcae/SymposiumLearningPriorities.PDF