**CDA 4205.001 Computer Architecture Syllabus**

**Instructor Name:** Yan Zhang

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**Office Hours:** Monday/Wednesday 10:00 am - 11:30 am or by appointment

**Class Meeting Days:** Tuesday/Thursday

**Class Meeting Time:** 11:00 pm - 12:15 pm

**Class Meeting Location:** SOC 152

**TA Information:**

Love Sah, [lsah@mail.usf.edu](mailto:lsah@mail.usf.edu), Office Hours: Tuesday, 2:30 pm - 4:30 pm @ ENB 329.

# University Course Description

Principles of the design of computer systems, processors, memories, and switches. Consideration of the register transfer representation of a computer, ALU's and their implementation, control units, memory and I/O, and the hardware support of operation systems.

# Prerequisites and Credits:

Prerequisites: CDA 3201/L Logic Design and Lab with a grade of C- or better

Credits: 3

# Course Objectives

* A student should grasp the basic concepts of computer architecture and organization, and understand the key skills of constructing cost-effective computer systems.
* A student should learn how to quantitatively evaluate different designs and organizations, and provide quantitative arguments in evaluating different designs.
* A student should be able to articulate design issues in the development of processor or other components that satisfy design requirements and objectives.
* In addition, a student should experience use of design tools to model various alternatives in computer design.
* A student should understand the basics of technical writing, and is able to construct a detailed tutorial paper on a selected topic related to computer engineering.

# Course Major Topics

* Instruction Set Architecture

Instruction set design, RISC design principles, MIPS instructions and formats, registers, arithmetic instructions, bit manipulation, load and store instructions, byte ordering, jump and conditional branch instructions, addressing modes, pseudo instructions.

* MIPS Assembly Language Programming

Assembly language tools, program template, directives, text, data, and stack segments, defining data, arrays, and strings, array indexing and traversal, translating expressions, if-else statements, loops, indirect jump and jump table, console input and output.

* Procedures and the Runtime Stack

Runtime stack and its applications, defining a procedure, procedure calls and return address, nested procedure calls, passing arguments in registers and on the stack, stack frames, value and reference parameters, saving and restoring registers, local variables on the stack.

* Interrupts

Software exceptions, syscall instruction, hardware interrupts, interrupt processing and handler, MIPS coprocessor 0.

* Integer Multiplication and Division

Integer multiplication, shift-add multiplication hardware, Shift-subtract division algorithm and hardware, MIPS integer multiply and divide instructions.

* Floating-point

Floating-point representation, IEEE 754 standard, FP addition and multiplication, rounding, MIPS floating-point coprocessor and instructions.

* CPU Performance

CPU performance equation, average CPI, Amdahl’s law.

* Single-Cycle Datapath and Control Design

Designing a single-cycle processor, register transfer, datapath components, register file design, multifunction ALU design, clocking methodology, control signals, implementing the control unit, estimating longest delay, multi-cycle instruction execution versus single-cycle performance.

* Pipelined Datapath and Control

Pipelining concepts, timing and performance, 5-stage MIPS pipeline, pipelined datapath and control, pipeline hazards, data hazards and forwarding, control hazards, branch prediction.

* Memory System Design

Memory hierarchy, SRAM, DRAM, pipelined and interleaved memory, cache memory and locality of reference, cache memory organization, write policy, write buffer, cache replacement, cache performance, two-level cache memory.

# Student Learning Outcomes

Towards the end of this course, students should be able to:

* Describe the instruction set architecture of a MIPS processor
* Analyze, write, and test MIPS assembly language programs
* Describe the organization/operation of integer & floating-point arithmetic units
* Design the datapath and control of a single-cycle CPU
* Design the datapath/control of a pipelined CPU and handle hazards
* Describe the organization/operation of memory and caches
* Analyze the performance of processors and caches

# Textbook:

Computer Organization and Design – The Hardware/Software Interface, David A. Patterson and John L. Hennessy, Morgan Kaufman, 5th Edition, ISBN 978-0-12-407726-3.

# Software Tools used in Assignments and Projects •

* **QtSPIM simulator**

QtSPIM is the latest version of Spim, which is a self-contained simulator that runs MIPS32 programs. Unlike all of the other version, it runs on Microsoft Windows, Mac OS X, and Linux—the same source code and the same user interface on all three platforms! *QtSpim* is the version of Spim that currently being actively maintaned.  A compiled, immediately installable version of *QtSpim* is available for Microsoft Windows, Mac OS X, and Linux can be downloaded from: <https://sourceforge.net/projects/spimsimulator/files/>.

* **Logisim simulator**

Logisim is an educational tool for designing and simulating digital logic circuits.

# Basis for Final Grade

* **Grading Rubric**
  + Homework assignments: 20%
  + Exam 1: 20%

Tentatively scheduled on Thursday **October 5, 2017.**

* + Exam 2: 25%

Tentatively scheduled on Thursday **November 16, 2017**.

* + Course Project: 15%

More detains in project assignment.

* + Comprehensive Final Exam: 20%

Scheduled on **Dec. 5th, 2017, 10:00 am – 12:00 pm** (in accordance with the USF final exam matrix)

* **Grading Scale**

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| --- | --- |
| Grading Scale (%) | Grade |
| 90 – 100 | A |
| 80-89 | B |
| 70-79 | C |
| 60-69 | D |
| 0-59 | F |

# Grade Dissemination

Graded tests and materials in this course will be returned individually only by request. You can access your scores at any time using "Grades" in Canvas.

# Course Policies: Grades

* **Late Work Policy:**
* The penalty for handing in an assignment late is a deduction equal to 20% of the assignment's maximum score per day (not just per weekday when the class is in session, this penalty is also assessed for off-day and holiday!), a weekend (Saturday through Sunday) counts as 2 (two) days for penalty-assessment purpose, a long-weekend (Friday through Monday) counts as 3 (three) days. The penalty is waived if you have an official university excuse as the reason for the lateness.
* Homework submissions 3 days later than the deadline will not be accepted.
* **Group Work Policy:**
* Everyone must take part in a group project.
* All members of a group will receive the same score; that is, the project is assessed and everyone receives this score.
* Everyone must take part in a group essay (see essay assignments below). The grading criteria are the same as the group project.
* Once formed, groups cannot be altered or switched, except for reasons of extended hospitalization.
* **Regrade Policies**
* Regrade requests must be submitted, in writing, to the instructor within seven calendar days of either: (1) the date the graded material is returned in class or (2) the date the grades are posted on Canvas, whichever occurs first.
* Regrade requests must be written on a separate sheet of paper and must be attached to your original submission.
* Regrade requests must specify the question(s) to be regraded. Regrade requests must include a brief description of why the question(s) should be regraded.
* The instructor reserves the right to regrade the entire submission.
* Graded material which has been modified in any way since it was returned to the student will not be regraded.
* **Final Examinations Policy**

All final exams are to be scheduled in accordance with the University’s final examination policy.

# Course Policies: Technology and Media

* **Canvas:**

This course will be offered via USF's learning management system (LMS), Canvas. If you need help learning how to perform various tasks related to this course or other courses being offered in Canvas, please view the following videos or consult the Canvas help guides. You may also contact USF's IT department at (813) 974-1222 or [help@usf.edu](mailto:help@usf.edu).

# Course Policies: Student Expectations

* **Homework Policies**
* All assignments are individual, and the final submission must be your own work.
* Homework submissions must be submitted electronically through Canvas and no hard copies will be accepted. Your handwriting must be legible, otherwise, loss of credits may be incurred and even not be graded with 0 for assignment.
* **Exam Policies**
* Exam 1 - 2 will be at the normal class meeting time.
* Requests for make-up examinations are not to be taken lightly. I will only make exceptions to this policy in case of excused absences. You must provide sufficient documentation to prove that your absence is excused.
* You must bring your University of South Florida identification card to each exam. The identification card will be verified during each exam.
* The dates provided for the exams are tentative. Changes to an exam date will be announced in-class at least one week prior to the exam.
* **Attendance Policies**
* Students are expected to attend all classes.
* You are responsible for all material presented during each lecture. Material presented during the lecture may not be in the textbook.
* Students who anticipate the necessity of being absent from class due to the observation of a major religious observance must provide notice of the date(s) to the instructor, in writing, by the second class meeting.
* **Disability Access**
* Students with disabilities are responsible for registering with Students with Disabilities Services (SDS) in order to receive academic accommodations. SDS encourages students to notify instructors of accommodation needs at least 5 business days prior to needing the accommodation. A letter from SDS must accompany this request.
* If you require extra time on exams due to your disability, you are required to make arrangements to take your exams with the SDS office. You will not receive extra time if you choose to take your exams with the course instructor.
* **Disruption to Academic Process:**

Disruptive students in the academic setting hinder the educational process. Disruption of the academic process is defined as the act, words, or general conduct of a student in a classroom or other academic environment which in the reasonable estimation of the instructor: (a) directs attention away from the academic matters at hand, such as noisy distractions, persistent, disrespectful or abusive interruption of lecture, exam, academic discussion, or general University operations, or (b) presents a danger to the health, safety, or well-being of self or other persons.

* **Academic Integrity of Students:**

Academic integrity is the foundation of the University of South Florida System’s commitment to the academic honesty and personal integrity of its university community. Academic integrity is grounded in certain fundamental values, which include honesty, respect, and fairness. Broadly defined, academic honesty is the completion of all academic endeavors and claims of scholarly knowledge as representative of one’s own efforts. The final decision on an academic integrity violation and related academic sanction at any USF System institution shall affect and be applied to the academic status of the student throughout the USF System, unless otherwise determined by the independently accredited institution.

* **Sexual Misconduct/Sexual Harassment Reporting:**

USF is committed to providing an environment free from sex discrimination, including sexual harassment and sexual violence ([USF System Policy 0-004](http://regulationspolicies.usf.edu/policies-and-procedures/pdfs/policy-0-004.pdf)). The USF Center for Victim Advocacy and Violence Prevention is a confidential resource where you can talk about incidents of sexual harassment and gender-based crimes including sexual assault, stalking, and domestic/relationship violence. This confidential resource can help you without having to report your situation to either the Office of Student Rights and Responsibilities (OSSR) or the Office of Diversity, Inclusion, and Equal Opportunity (DIEO), unless you request that they make a report. Please be aware that in compliance with Title IX and under the USF System Policy, educators must report incidents of sexual harassment and gender-based crimes including sexual assault, stalking, and domestic/relationship violence. If you disclose any of these situations in class, in papers, or to me personally, I am required to report it to OSSR or DIEO for investigation. Contact the USF Center for Victim Advocacy and Violence Prevention: (813) 974-5757.

* **Professionalism Policy:**

Per university policy and classroom etiquette; mobile phones, iPods, etc. **must be silenced** during all classroom and lab lectures. Those not heeding this rule will be asked to leave the classroom/lab immediately so as to not disrupt the learning environment. Please arrive on time for all class meetings. Students who habitually disturb the class by talking, arriving late, etc., and have been warned may suffer a reduction in their final class grade.

* **End of Semester Student Evaluations:**

All classes at USF make use of an online system for students to provide feedback to the University regarding the course. These surveys will be made available at the end of the semester, and the University will notify you by email when the response window opens. Your participation is highly encouraged and valued.

* **Campus Emergencies:**

In the event of an emergency, it may be necessary for USF to suspend normal operations. During this time, USF may opt to continue delivery of instruction through methods that include but are not limited to: Canvas, Elluminate, Skype, and email messaging and/or an alternate schedule. It’s the responsibility of the student to monitor the Canvas site for each class for course specific communication, and the main USF, college, and department websites, emails, and MoBull messages for important general information.

# Important Dates to Remember

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| --- | --- | --- |
| August 25 | Friday | Drop/Add ends, fee liability/tuition payment deadline |
| October 5 | Thursday | Exam 1 |
| October 28 | Saturday | Last day to withdraw without refund & no academic penalty |
| November 16 | Thursday | Exam 2 |
| December 5 | Tuesday | Final Exam |

# Tentative Schedule

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| --- | --- | --- |
| **Week #** | **Date** | **Contents** |
| **1** | Aug. 21 – Aug. 25 | Syllabus, Introduction, CPU Performance, |
| **2** | Aug. 28 – Sept. 1 | Instruction Set Architecture |
| **3** | Sept. 4 – Sept. 8 | MIPS Assembly Language Programming |
| **4** | Sept. 11 – Sept. 15 | Procedures and the Runtime Stack |
| **5** | Sept. 18 – Sept. 22 | Integer Multiplication and Division |
| **6** | Sept. 25 – Sept. 29 | Floating-point |
| **7** | **Oct. 2 – Oct. 6** | **Exam 1 (Chapter 1 – 3, Appendix A)** |
| **8** | Oct. 9 – Oct. 13 | Single-Cycle Datapath and Control Design |
| **9** | Oct. 16 – Oct. 20 | Pipelined Datapath and Control |
| **10** | Oct. 23 – Oct. 27 | Pipelined Datapath and Control II |
| **11** | Oct. 30 – Nov. 3 | Exceptions and Interrupts |
| **12** | Nov. 6 – Nov. 10 | Memory System Design |
| **13** | **Nov. 13 – Nov. 17** | **Exam 2 (Chapter 4 & 5)** |
| **14** | Nov. 20 – Nov. 24 | Reading Days and Thanksgiving Holidays |
| **15** | Nov. 27 – Dec. 1 | Parallel Processing |
| **16** | **Dec. 2 – Dec. 7** | **Final Exam : 10:00 am – 12:00 pm, Tuesday, Dec. 5** |

\* Note: The Schedule is subject to revision