CDA 3100 - Computer Organization I

Fall 2019, Department of Computer Science, Florida State University

Class time and location

Lectures:

Monday, Wednesday, and Friday, 11:15AM – 12:05PM, HCB 315 (HCB Classroom Building)

Recitation Sessions:

Section 1, Monday, 09:05AM – 09:55AM, LOV 301 (Love Building)
Section 2, Tuesday, 09:30AM – 10:20AM, HWC 3503 (Health and Wellness Center)
Section 3, Wednesday, 09:05AM – 09:55AM, LOV 301 (Love Building)
Section 4, Thursday, 09:30AM – 10:20AM, HCB 317 (HCB Classroom Building)
Special note: The classrooms for recitation sessions may change to MCH 202 during the semester when the room is restored.

Instructor

- Xiuwen Liu
- Email: xliu@fsu.edu (strongly preferred means of remote communication)
- Home page: http://www.cs.fsu.edu/~liux
- Office: 168 Love Building (LOV)   Phone: (850) 644-0050
- Office Hours: Monday and Wednesday from 08:10AM – 8:50AM and 10:30AM-11:00AM, and by appointments

Teaching Assistants

- Seyed Meysam Ghaffari Dehkordi (Grading of Homework Assignments 1 and 8; Recitation Sessions for Weeks 2, and 12, 13, and 15)
- Email: sg15w@my.fsu.edu
- Office: 338 Dittmer (inside 336 Dittmer) (Dittmer Chemistry Lab (DLC))
- Office hour: Friday 10:00AM – 11:00AM and by appointments

- Shaeke Salman (Grading of Homework Assignments 2, 3, 5, and 6; Recitation Sessions for Weeks 3-5 and 9-11)
- Email: ss17s@my.fsu.edu
- Office: TA Desk 19, 336 Dittmer (Dittmer Chemistry Lab (DLC))
- Office hours: Tuesday, 03:00PM – 05:00PM and by appointments

- Tonmoy Dey (Grading of Homework Assignments 4 and 7; Recitation Sessions for Weeks 6-8)
- Email: td18d@my.fsu.edu
- Office: 206 LOV (Love Building)
- Office hour: Thursday, 11:00AM – 12:00 Noon and by appointments

Course Home Page

http://www.cs.fsu.edu/~liux/courses/cda3100
This web site contains the up-to-date information related to this course such as news, announcements, assignments, lecture notes, and useful links to resources that are helpful to this class. Announcements

on this web page are OFFICIAL for this class. Besides the course home page, this class will also use Canvas for class communication and management.

Course Rationale

Arguably computer revolution is one of the most fundamental ones in the human history and it has changed and will be changing every aspect of the society and human life due to the following reasons:

- Separation of the software and hardware allows the same hardware to be used to solve different problems by only changing the software, leading to general purpose computing machines.
- Technology advances have led to over 250,000,000,000 improvements in relative performance / unit cost in half a century and no other industry has done so ever.
- The number of operations that can be performed per unit energy consumed by computers is many orders of magnitudes larger than any other physical systems, creating a unique cyber space, where many conventional concepts are completely redefined (e.g., cyber warfare), creating new challenges and new opportunities, especially for the computer science community.

During the evolution, numerous innovations have been created and are still being created, resulting in countless new research areas, companies, and job opportunities; computer architecture provides the foundation for such innovations. As the first course in a two-course sequence on computer organization, this course exposes fundamentals of the exciting computer systems, including building blocks of computer hardware (gates and memory elements), instruction set architectures (instruction sets and assembly language programming), and design of various components. By gaining much deeper understandings of computer systems, students will be able to lay a solid foundation to further their studies in computer organization, operating systems, compilers, high performance computing, cyber security, and other related areas. Furthermore, this class, along with other ones, prepares computer science major students for job opportunities and research areas otherwise not feasible.

Course Description

This is the first course (of a two-course sequence) in computer organization intended for computer science and closely related majors with previous C/C++ background. It introduces fundamental concepts in computer organization and digital logic design, including

- Computer arithmetic, including general number representation, two's complement, binary arithmetic (addition, subtraction, multiplication, and division, including overflow detection), and floating point representation (including the IEEE 754 floating point standard).
- MIPS instruction set, including different formats and addressing modes, encoding, and decoding.
- Introduction to instruction set design, including an overview of the Intel IA-32.
- Assembly programming using MIPS, including understanding of assembler.
- Digital logic design, including basic logic gates and their use in constructing combinational logic (decoders, multiplexors, an arithmetic logic unit, and programmable logic arrays), and sequential logic (such as flip-flops, latches, registers, and memory elements, and finite state machines).
- Processor design, including a single cycle implementation and introduction to multicycle implementation.
- Performance assessment and comparison; factors that affect performance and performance models.

Prerequisites

- Corequisites: COP3330 (Object Oriented Programming) and MAD2104 (Discrete Mathematics I).

- C/C++ Programming – Able to program proficiently using either C or C++ (note, however, skeleton codes for assignments will be given in C); this class uses C program examples for illustration and several assignments require implementations in C (C++ can be used also).
- Discrete Mathematics – Familiar with basic elements of digit logic.

Course Objectives

Upon successful completion of this course of study a student would:

- Know number representations; be able to compute the represented quantity (value) of a number in a specified representation system and be able to convert number representations between different representation systems.
- Know algorithms for binary arithmetic operations; be able to perform addition, subtraction, multiplication, and division using binary numbers.
- Know floating point number representations and IEEE 754 floating-point standard; be able to encode and decode floating point representations in IEEE 754 standard; be able to perform floating-point operations using IEEE 754 representations.
- Know the MIPS instruction set; be able to encode and decode MIPS instructions.
- Know MIPS assembly language; be able to read and write functions using the MIPS assembly language.
- Know MIPS calling conventions; be able to read and write programs consisting of multiple functions in MIPS assembly; be able to show the stack of recursive functions in MIPS assembly.
- Understand different types of instruction set architectures; be able to compare different instruction set architectures for a given (simple) function.
- Understand Intel calling convention and the overall Intel-32 instruction set architecture; be able to understand simple assembly programs in Intel-32 instructions.
- Know how to design combinational logic, including decoders, multiplexors, and simple arithmetic-logic units; be able to design decoders, multiplexors, and arithmetic-logic units using basic logic gates.
- Know carry-lookahead adders; be able to construct a carry-lookahead adder using basic logic elements.
- Know sequential logic elements including flip-flops, latches, and memory elements and know to apply them to construct large components; be able to construct the state diagram of sequential logic elements and be able to design flip-flops, latches, and memory elements using basic logic gates.
- Be able to use the Verilog programming language to describe simple circuits.
- Understand finite state machines; be able to draw state diagrams, implement next state functions, and design and implement finite state machines using basic logic elements.
- Know how to design a datapath and control unit for a processor using a single cycle implementation; be able to design and implement a simple processor using basic elements such as combinational logic, memory elements, and other components.
- Understand the limitations of single cycle implementations.
- Understand CPU performance and its related factors; be able to compare performance of two systems; be able to show how to improve CPU performance by analyzing the factors.

Textbook and Class Materials

Required textbook: "*Computer Organization and Design: The Hardware/Software Interface*," Fifth Edition, D. A. Patterson and J. L. Hennessy, Morgan Kaufmann (an imprint of Elsevier), 2014. This is the main textbook and chapters 1-3, part of chapter 4 (4.1 – 4.5), and appendices A and B will be covered.

In addition, appropriate articles from the literature will be distributed to supplement the textbook and the class notes.

Student Responsibilities

Attendance is required for this class. In case that it is necessary to skip a class, students are responsible to make up missed materials. Excused absences include documented illness, deaths in the family and other documented crises, call to active military duty or jury duty, religious holy days, and official University activities. These absences will be accommodated in a way that does not arbitrarily penalize students who have a valid excuse. Consideration will also be given to students whose dependent children experience serious illness. Participation of in-class discussions and activities is also required. All submitted assignments and projects must be done by the author. It is a violation of the Academic Honor Code (see below) to submit other's work and the instructor of this class takes the violations very seriously.

Assignments and Projects

Eight required homework assignments (see http://www.cs.fsu.edu/~liux/courses/cda3100/calendar.html for details) will be given along the lectures and they need to be turned in, where some of the assignments require C (or C++) programming and some require programming using MIPS assembly. There will be several in-class quizzes for feedback purposes ONLY. There will be a midterm (on October 18, 2019 (in class)) and an accumulative final exam (on December 10, 2019 from 5:30-7:30PM).

Grading Policy

Grades will be determined as follows:

Item Description	Percentage points	Item Description	Percentage points
Homework Assignments (Assignments 1-3, 5-8)	40 %	MIPS Programming Assignment (#4)	10 %
Midterm (In class, October 18, 2019)	20 %	Final exam (Accumulative; 5:30pm-7:30pm, Dec. 10, 2019)	30 %

Grading will be based on the weighted average as specified above and the following scale will be used (suppose the weighted average is S in 100 scale)

Score	Grade	Score	Grade	Score	Grade
$93 \leq S$	A	$80 \leq S < 83$	B-	$67 \leq S < 70$	D+
$90 \leq S < 93$	A-	$77 \leq S < 80$	C+	$63 \leq S < 67$	D
$87 \leq S < 90$	B+	$73 \leq S < 77$	C	$60 \leq S < 63$	D-
$83 \leq S < 87$	B	$70 \leq S < 73$	C-	$S < 60$	F

Late Penalties

Assignments are due at the beginning of the class on the due date unless specified otherwise. Assignments turned in late, but before or at the beginning of the next class will be penalized by 10 % and assignments will **NOT** be accepted after that. You must inform the instructor as soon as possible about excused absences so that arrangements can be made accordingly about submission of the affected assignments.

Submission and Return Policy

All exams/assignments will be returned as soon as possible after grading (typically in one week from the submission date).

Tentative Schedule

- See the weekly calendar http://www.cs.fsu.edu/~liux/courses/cda3100/calendar.html on the class web site for details.

Academic Honor Policy

The Florida State University Academic Honor Policy outlines the University's expectations for the integrity of students' academic work, the procedures for resolving alleged violations of those expectations, and the rights and responsibilities of students and faculty members throughout the process. Students are responsible for reading the Academic Honor Policy and for living up to their pledge to "... be honest and truthful and ... [to] strive for personal and institutional integrity at Florida State University." (Florida State University Academic Honor Policy, found at http://dof.fsu.edu/honorpolicy.htm)

Assignments/projects/exams are to be done individually, unless specified otherwise. It is a violation of the Academic Honor Code to take credit for the work done by other people. It is also a violation to assist another person in violating the Code (See the FSU Student Handbook for penalties for violations of the Honor Code). The judgment for the violation of the Academic Honor Code will be done by the instructor and a third party member (another faculty member in the Computer Science Department not involved in this course). Once the judgment is made, the case is closed and no arguments from the involved parties will be heard. Examples of cheating behaviors include:

- ❖ Discuss the solution for a homework question.
- ❖ Copy programs for programming assignments.
- ❖ Use and submit existing programs/reports on the World Wide Web as written assignments.
- ❖ Submit programs/reports/assignments done by a third party, including hired and contracted.
- ❖ Plagiarize sentences/paragraphs from others without giving the appropriate references. Plagiarism is a serious intellectual crime and the consequences can be very substantial.

Penalty for violating the Academic Honor Code: A 0 grade for the particular assignment/quiz/exam and a reduction of one letter grade in the final grade for all parties involved for each occurrence. A report will be sent to the department chairman for further administrative actions.

Accommodation for Disabilities

Students with disabilities needing academic accommodations should: 1) register with and provide documentation to the Student Disability Resource Center (SDRC), and 2) bring a letter to the instructor

indicating the need for accommodation and what type. This should be done within the first week of class. *This syllabus and other class materials are available in alternative format upon request.*

For more information about services available to FSU students with disabilities, contact the Assistant Dean of Students:

     Student Disability Resource Center
     97 Woodward Avenue, South
     108 Student Services Building
     Florida State University
     Tallahassee, FL 32306-4167
     (850) 644-9566 (voice)
     (850) 644-8504 (TDD)
     sdrc@admin.fsu.edu
     http://www.disabilitycenter.fsu.edu/

Syllabus Change Policy

Except for changes that substantially affect implementation of the evaluation (grading) statement, this syllabus is a guide for the course and is subject to change with advance notice.

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