CSC3510-Spring-2024

This document serves as both the course's syllabus and its main web page.

Listing of Day by Day Material and Video Links

About the Professor

Professor Perry Kivolowitz has retired from full time teaching after 19 years (ten at UW-Madison and nine at Carthage College). They continues to teach two highly specialized courses at Carthage: CSC4730 - Operating Systems and CSC3510 - Computer Organization.

In addition to their years in academia, Professor Kivolowitz enjoyed a more than 40 year career as an entrepreneur and inventor mostly in the field of digital visual effects for motion pictures and television. They have been awarded with two Emmy Awards and an Academy Award for their inventions.

The digressions they will make constitute significant value. Professor Kivolowitz has had a passion for Computer Science for 50 years, long enough to posses **lived** experience from the late dawn / early adolescence of computing.

So pay attention and let Grandpa rant.

Course Overview and Introduction

This course is entitled Computer Organization. This classically suggests we'll start with *and* and *or* logic gates and build our way up to a simple computer. This is fine if you are going to be an EE. Electrical engineering is not the focus of this Computer Science program. Software excellence is.

This course presents Computer Organization from the perspective of an astute and sagacious software developer. More deeply, this course is about software excellence. By stressing assembly language, the harshest and most unforgiving of languages, you'll learn patience, diligence, perseverance and **discipline**.

It's one thing to develop software while sipping a Venti Iced Caramel Macchiato made with Blonde Espresso Upside Down 1/2 Vanilla Syrup 1/2 Dark Caramel Syrup Topped with Salted Caramel in beautiful Stratos, Elysium or Zalem.

It's another thing to code on Crematoria, LV-426 or Ceti Alpha V. By understanding the intimate interplay between hardware and software in an unforgiving environment, you are more likely to outshine your post-Carthage competition.

This is a Required Course

You cannot complete the CS program at Carthage College without achieving a grade of C- or better. This is a very low bar. In my view it should require a B or better. Do you want the coder of the avionics software of the plane your family

is riding in to be written by a C- coder? How about Paw Paw's pacemaker? You want a C- student writing that code?

Course Objectives and Outcomes

As stated above, this course presents Computer Organization from the perspective of the *astute* and *sagacious* software developer.

As a result of taking this course you will be:

- proficient and knowledgeable of the ARM V8 64-bit ISA (Instruction Set Architecture).
- knowledgeable of the ramifications of choices that you make in higher level languages on the performance of the resulting system.
- knowledgeable of number formats and operations.
- knowledgeable of bit oriented operations.
- able to discern the effect of CPU specifications upon performance with understanding of the parts of a CPU.
- able to discern the effect of computer specifications upon performance with understanding of components like buses, memory and storage devices.

Meetings and Office Hours

All meetings and office hours are virtual. These are held here:

Zoom Link

Class Meetings:

Days	Times
TR	2:20 PM to 4:00 PM

Office Hours:

Day	Times
M	~~11 AM to 12 PM~~ 12 PM to 1 PM
T	~~11 AM to 12 PM~~ 12 PM to 1 PM
BBQ	7 PM to 9 PM
F	12 PM to 1 PM

The Day "BBQ" coincides with whatever day the BBQ is to be held on.

Office hours may be recorded if the content is deemed by me to be of general use to the class.

Meetings / Questions outside of office hours

Due to abuse of the instructor's time during Spring 2023, help shall be largely limited to the above hours. Make sure you ask your questions during class or during posted office hours.

Meetings / Questions prior to project due dates

With some exceptions, to be decided by me, help on projects will not be available within 24 hours of a project's due date. This prohibition is imposed to encourage good working habits including but not limited to starting work early / working steadily. This is not intended punitively.

Help will always be available during office hours that coincide with the weekly BBQ.

Texts

Primary: My Assembly Language Book This book is free and a work in progress.

Ancillary (These are listed in order of usability / importance):

0. Cheat Sheet highlighted sections include a superset of what we will cover in class with little exception.
1. ARM V8-A Reference Manual
2. ARM V8-A ISA
3. Load Linked Store Condition
4. ARM Scalable Vector Extension

Readings

There are no assigned readings in this class. Grandpa's not spoon feeding you by telling you what to read and when. I *will* often make suggestions. Take these suggestions seriously. Not assigning reading is intended to mimic real life as a software developer. Nobody holds your hand. Preparing you for your post-Carthage life is appropriate for this level of course.

You expected to have consulted the texts before approaching me with questions. If I should answer something to the effect that the answer is in the book, you are expected to explain to me what you read and articulate what you found unclear. This step is take to encourage good working habits on your part and is not punitive.

Recordings

- Another "first" assembly program

- 2/1/2024
- 2/6/2024
- 2/8/2024
- 2/13/2024
- 2/15/2024
- 2/20/2024
- 2/22/2024
- 2/27/2024
- 2/29/2024
- 3/14/2024
- 3/19/2024
- 3/21/2024
- 3/26/2024

Topics Covered

Daily Content Covered Here

The following are the topics which we can expect to be covered. This list may be incomplete and specific items on the list may be omitted subject to class pace.

- ARM V8 ISA
  - – Basic Instructions
  - ☒ Addressing Modes
  - ☒ Integer Math Instructions
  - ☒ Floating Point Math Instructions
  - ☐ Conditional Instructions
  - ☒ Branch Instructions
  - ☒ Branch With Link
  - ☐ Synchronization Instructions

☒ Registers Including Some Special Registers

- Implementation of Control Structures
  - ☒ if, if / else, if / else if
  - ☒ while, for, do / until

- ☐ switch

☒ `struct`

☒ arrays

☐ What is the "this" pointer?

☒ Function Calls and Argument Passing

☐ Recursion in Assembly language.

☐ Variadic Functions

☒ System Calls

☐ Cache Memory Systems

☒ Rotating Disc Systems and Maybe, SSDs

☒ RAID Architectures

☐ Bus Systems

☒ Binary, Octal and Hexadecimal

☒ Integers, Two's Complement Arithmetic

☒ IEEE 754 Floating Point Numbers

- Bitwise Operations
  - in ARM V8
  - in C and C++
  - Bit Bashing

☒ Dialogs and Discourses on Debugging

Environment

Our programming environment is a Linux ARM distribution. It is required on both Windows and Macintosh (even if you have an ARM-based Macintosh or a rare ARM-based Windows machine).

The installation guide is found here.

Note, if you are on an ARM Windows machine, let me know. I'd like to know how and where you got it. I have the Microsoft ARM Development machine, myself. I like it but you will have to use WSL as the API we are using is Linux.

Attendance

Attendance will be taken at nearly every class. The only exceptions will be when I am so excited to get down to business, that I forget to take it.

You get 6 free absences. After that each absence will remove 2 (two) percent from your aggregate score at the end of the term.

All absences are treated equally. That is, there are no "excused" absences.

The number of free absences equates to three weeks of missed class time so it is unlikely you'll exceed this and incur a penalty.

Should a *long-term* absence due to uncontrollable circumstances become necessary, please speak to me as soon as possible.

Arriving Late

Anyone arriving after attendance has been completed will be counted as absent. Generally, attendance will end between ten to fifteen minutes after the official start of class. Do not depend upon this estimate because it will vary from class period to class period.

Leaving Early

No, your coach cannot force you to leave class early to make practice. This comes directly from the current Athletic Director.

If you are friends with persons arriving at practice before 4 PM, they do not have late afternoon classes or are choosing to put their extra-curricular sports ahead of the **REST OF THEIR LIVES**.

Warmups

There are two warmup exercises that are graded and are included in your final score.

The first is an essay. It is already assigned and is due 2/1/2024 at 11:59 PM.

The second is to be completed after you install the environment we will be using. The exercise is simply to modify some source code which is supplied to you, build it, run it, take a screen shot of it. Submit the screen shot. This is already assigned as is due on 2/8/2024.

Essay

You will be required to write an essay as part of class. It is found here.

Build Code

See the install guide and then the warmup specification.

Projects

Below is a listing of some number of projects.

The *Weight* column provides a weighting of the project within the Project Grading Component. It suggests my anticipation of the *relative* difficulty of each project compared to the others.

Projects contribute 82 percent of your final grade.

#	Project	Weight	Partner
1	Read a Byte, Write a Byte	60	No
2	Sorted Singly Linked List	80	No
3	Tail	80	Yes
4	Cosine Using Taylor Series	70	No
5	NEON Intrinsics	70	No
6	memcpy	80	Yes

Project Partners

Choose whom you like to partner with for those projects which are partner projects. A project is a partner project if it says so above.

Please get over partnering with losers. You know, that friend of yours who has been riding your skills, knowledge and work effort all through college.

Let the losers lose.

Better they learn this lesson now then get fired later or worse: injure or kill someone because of their incompetence.

Partners get the same grade. If your partner ducks up, it's a **you** problem. See above.

Project Requirements

- Requirements are spelled out in each specification.
- Any deviation from the specification likely results in penalties.
- Generating even a single warning during building your code will result in a 10 percent penalty.
- Commenting is required. Failure to adequately comment is a mandatory 5 percent penalty.

Project Grace Days

All projects get one grace day, no questions asked.

No Late work apart from grace days

Late work (factoring in one free grace day) will not be accepted.

To state this differently, if an assignment is due on day n, you have until the end of day $n + 1$ to turn it in. After that, it will not be accepted.

I award partial credit for substantial but incomplete work. This is unlike the real world where incomplete work earns termination of your employment. Hand in what you have... it's better than a zero.

Grading Components

Gradable Component	Weight	Notes
Attendance	10	
Warmups	3	
Essay	5	
Projects	82	

There is very little likelihood a curve will be applied in computing your final grade.

Accommodations

There are no exams in this course and projects already include a grace day. Therefore, no significant accommodations ought to be necessary but present your papers to me at the start of the semester anyway. We'll discuss what should be done.

Health and Counseling Center

The Health and Counseling Center (HCC) addresses student physical, mental, and emotional well-being. All services, provided by experienced professionals, are free and confidential to currently enrolled, full-time undergraduate students. Students must call or visit the HCC to schedule an appointment. Health services are available by walk-in or appointment from 8:30am - 3:30pm. Counseling walk-in sessions are available Monday through Friday from 11:30am to 1:00pm, last appointment begins around 12:30pm, first-come first-seen. TWC, first floor(behind mailboxes)| 262-551-5710 | Website | Mon-Fri 8:30am to 1pm and 2pm to 4:00pm.

Learning Accessibility Services

Carthage College strives to make all learning experiences as accessible as possible. If you anticipate or experience academic barriers due to your disability (including mental health, learning disorders, and chronic medical conditions),

please let me know immediately so we can discuss options privately. To establish reasonable accommodations, you must register with Warren Wolchuk in Learning Accessibility Services wwolchuk@carthage.edu.

Academic Honesty

All work will be examined for originality. Should I find evidence of copied work, all parties shall receive a grade of zero. If any individuals are found to have copied a second time, the individuals will be reported to the Provost's office for discipline and will receive a zero for the assignment. Should an individual be associated with a third instance, in addition to a second trip to the Provost, the individual shall receive an F in the course.

The decision of the instructor is final.

General statement about "help"

Apart from lecture, I will not "just give you the answer." Rather, you must demonstrate that you have exhausted the means available to you to learn on your own. This is not punitive. This will be a requirement for your future. You'll get in the habit now. This may be a lasting and meaningful "gift" to you from me.

Jishnu Mukerjee, Senior Systems Architect at Hewlett-Packard

Jishnu Mukerji

When I was an undergraduate, Jishnu Mukerjee was the graduate student who was in charge our department's PDP-11/60. It ran an early version of Unix, V6 to be exact.

A representative image of a PDP 11/60 with two RK05 (2.5 megabyte) hard disk drives and an LA120 console. My CS Department received an RK05 disk pack from Ken Thompson in the mail with a hand written note on it. "Here's you Unix distribution. Love, Ken". The Department also had a DecTape

The first time I had a question, I asked Jishnu and he answered it.

The second time I had a question, I asked Jishnu and he answered it.

The third time I had a question, I asked Jishnu and he handed me a print out of the entire OS. He said, "All your answers are in here."

It was the greatest gift he could possibly give and I am thankful to him to this day.