Introduction to Computer Systems

Syllabus

Web Page

http://pdinda.org/ics

See the web page for more information.
We will not use Canvas except possibly for grade reporting.

Instructor

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Teaching assistants

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Location and Time

Lecture: Tuesdays and Thursdays, 2-3:20pm, Tech M345
Recitation: Fridays, 3-5pm, Frances Searle 2407 (6/12 in Tech L440)

Prerequisites

Required   EECS 211 or equivalent
Required   Experience with C or C++

EECS 213 is a **required core course** in the Computer Science curriculum in both McCormick and Weinberg. It is also a required course for CS minors in both schools. 213 can also be taken for credit within the Computer Engineering curriculum. 300-level systems courses have 213 as a prerequisite.

Textbook

Randal E. Bryant and David R. O'Hallaron*, Computer Systems: A Programmer's Perspective, **Second Edition***,* Prentice Hall, 2010, (ISBN-10: 0136108040 ISBN-13: 978-0136108047) (Required - Textbook)
- Details on http://csapp.cs.cmu.edu
- Make sure you have the second edition of the book.

Brian W. Kernighan and Dennis M. Ritchie, *The C Programming Language, Second Edition*, Prentice Hall, 1988 (ISBN 0-131-10370-9) (Recommended)
- This remains the definitive book on C by its creators

Richard Stevens and Stephen Rago, *Advanced Programming in the Unix Environment*, *Third Edition*, Addison-Wesley, 2013 (ISBN-10: 0321637739 | ISBN-13: 978-0321637734) (Recommended)
- This describes how to think like a Unix systems programmer
- The older editions, even the first edition, are very good

Objectives, framework, philosophy, and caveats

This course has four purposes. First, you will learn about the hierarchy of abstractions and implementations that comprise a modern computer system. This will provide a conceptual framework that you can then flesh out with courses such as compilers, operating systems, networks, and others. The second purpose is to demystify the machine and the tools that we use to program it. This includes telling you the little details that students usually have to learn by osmosis. In combination, these two purposes will give you the background to understand many different computer systems. The third purpose is to bring you up to speed in doing systems programming in a low-level language in the Unix environment. The final purpose is to prepare you for upper-level courses in systems.

This is a learn-by-doing kind of class. You will write pieces of code, compile them, debug them, disassemble them, measure their performance, optimize them, etc.

The specific computer architecture we will focus on in this class is the Intel/AMD x86 architecture, which is used in virtually all cloud, cluster, server, desktop, and laptop/notebook computers today.[1] The specific operating system we will use is

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[1] For the most part, the lecture and programming assignments in this class look at x86 processors in 32 bit mode.   We will try to touch on x86 in 64 bit mode as well. You will also have a chance to look at the

Linux, which is used in most cloud and server environments, and is also the foundation of the Android platform. The specific programming toolchain we will use is GCC (and GDB), which is the core toolchain on pretty much all platforms, except Windows.

This course is ideally taken after 211 early in your academic career.

Discussion and Getting Help

In addition to lecture and office hours, the TAs will also hold an optional recitation section once a week.   We will use an online discussion group on Piazza as well.   There are no discussions on Canvas.

Resources

You will have Linux accounts on the Wilkinson and Tlab machines, and it should be possible to do a lot of your work on them, or other 64 bit Linux machines. However, you will also have access to a considerably more powerful server machine that can support many users simultaneously, and we expect most students will use that.   We will test your labs on that machine.

Labs

My current plan is to have four programming labs. Their goal is to make you apply the concepts you've learned and to gain familiarity with Unix tools that can help you apply them. Labs should be done in groups of two.

It is possible we may eliminate or change one programming lab later in the quarter. This largely depends on whether I feel we will be able to do the desired lab in a scalable way given limits on TA time and resources.

Homework

This course **usually** has four graded homework assignments. Unfortunately, due to a lack of appropriate support for the class, they have been eliminated this year. I strongly encourage you to do the exercises in the book in preparing for exams.

Exams

There will be a midterm exam and a final exam. The final exam will not be cumulative.

Grading

60 %   Programming labs (15% per lab)
20 %   Midterm (covers first half of the course)
20 %   Final (covers second half of the course)

Xeon Phi.   We may also look briefly at the ARM architecture used in iPhones/iPads and many Android devices. If this doesn't make sense to you yet, don't worry about it.

Peter ultimately assigns all grades. If you have a problem with a grade, you are welcome to bring it up with either Peter or the TAs, but only Peter is empowered to change grades.

Late Policy

For each calendar day after the due date for a homework or a lab, 10% is lost. After 1 day, the maximum score is 90%, after 2 days, 80%, etc, for a maximum of 10 days.

Cheating

Since cheaters are mostly hurting themselves, we do not have the time or energy to hunt them down. We much prefer that you act collegially and help each other to learn the material and to solve development problems than to have you live in fear of our wrath and not talk to each other. Nonetheless, if we detect blatant cheating, we will deal with the cheaters as per Northwestern guidelines.

Schedule

Lecture	Date	Topics	Readings	Homework/Labs
1	3/31 T	Mechanics, Introduction, overview of abstractions	Chapter 1	Data lab out
2	4/2 Th	Physics, transistors, photolithography, Moore's Law, bits, bytes, logic, cores, and multicores	2, 2.1, handout	
Last day for late registration: Friday, 4/3				
3	4/7 T	Integers and integer math	2.2-2.3	
4	4/9 Th	Floating point	2.4-2.5	
5	4/14 T	The Machine Model – instruction set architecture, microarchitecture, and basic instructions	3, 3.1-3.5, 5.7	
6	4/16 Th	Control flow	3.6	Data lab in Bomb lab out
7	4/21 T	Procedures	3.7	
8	4/23 Th	Data	3.8-3.12	
9	4/28 T	64 bit x86 and perhaps some ARM	3.13-3.15, possible ARM materials	
Midterm Exam: TBD, but around this time – will be in the evening, 1.5 hours, covering lectures 1-9				
10	4/30 Th	Memory and cache	6, 6.1-6.4	
11	5/5 T	Cache performance	6.5-6.7	Bomb lab in,

				Buffer lab out
12	5/7 Th	Linking	Chapter 7	
Last day for class drops: Friday, 5/8				
13	5/12 T	Exceptional control flow	8,8.1-8.4	
14	5/14 Th	Exceptional control flow	8.5-8.8	
15	5/19 T	Virtual memory Memory system	9, 9.1-9.8	Buffer lab in, Fourth lab out (probably),
16	5/21 Th	Memory allocation	9.9-9.12	
17	5/26 T	*Slack Day / Catchup / TBD*		
18	5/28 Th	Input and Output	Chapter 10	
19	6/2 T	Network programming	Chapter 11 Handout	
20	6/4 Th	Concurrency, Distributed Systems and Wrap-up	Chapter 12 handouts	Fourth lab in (probably)
Finals week – Exam is Friday, June 12, 9 AM				

Note that in the latter part of the course, we will cover Chapters 10-12 at a very high level. I want you to read these chapters, but I will not cover them in their entirety in class.

We will skip Chapter 4 (Processor Architecture), 5 (Performance Optimization), and others. Chapter 4 is worth reading if you're interested in how a simple processor with an Intel-like instruction set is implemented. Chapter 5 is all about understanding how to make programs run faster.