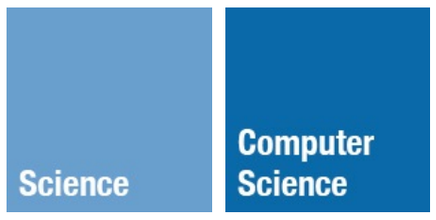
Introduction



CS 351: Systems Programming
Michael Lee <lee@iit.edu>

IIT College of Science
ILLINOIS INSTITUTE OF TECHNOLOGY

Michael Lee

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- http://moss.cs.iit.edu
- Office hours: Tue/Thu 11AM-1PM
  - By appointment only! (Zoom/In-person)

Agenda

- Syllabus & Administrivia
- Course overview (“Systems Programming”)

Science

Computer Science

§Syllabus

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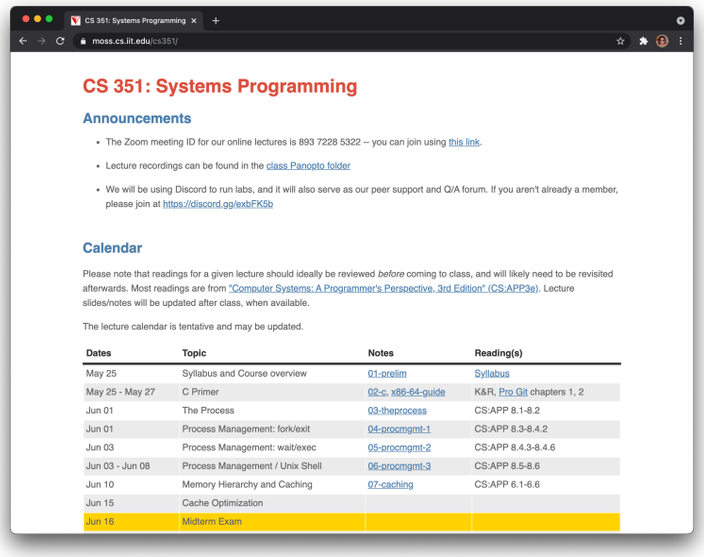
Prerequisites

- "substantial" programming experience
- data structures: concepts & implementation
- basic run-time analysis (big O)
- knowledge of (any) assembly language
- computer organization essentials

- computer organization essentials:
  - data representation (binary, two's comp, f.p. inaccuracy, etc.)
  - von Neumann model
    - CPU, memory, I/O
  - stack usage / conventions

Online resources

1. Course website
   moss.cs.iit.edu/cs351

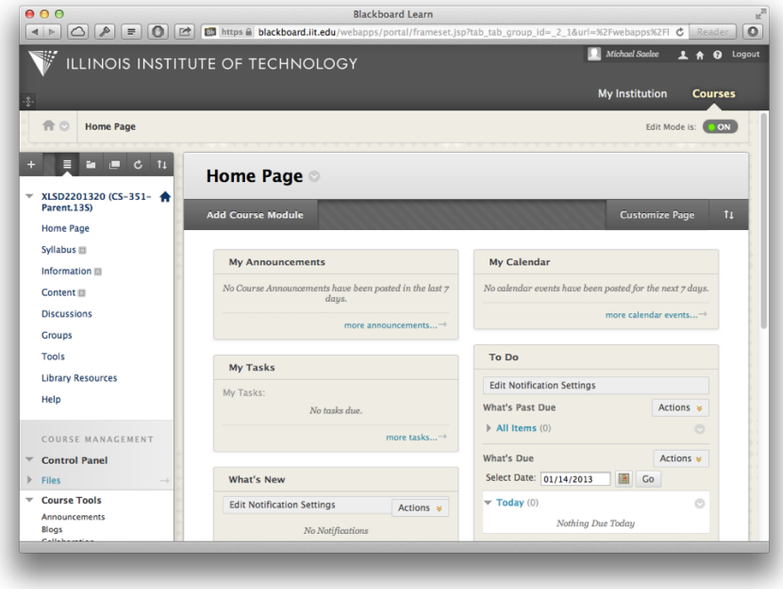


- static information
  - lecture calendar, assignment writeups, slides, screencasts, links, etc.

Online resources

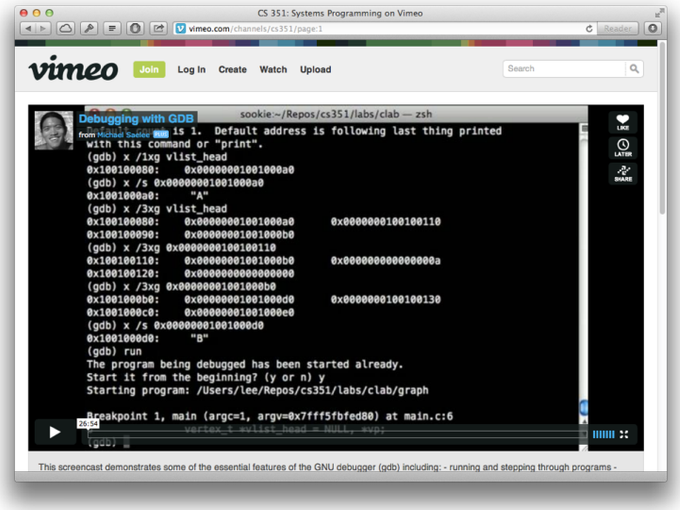
2.Blackboard

- grade spreadsheet
- online exams



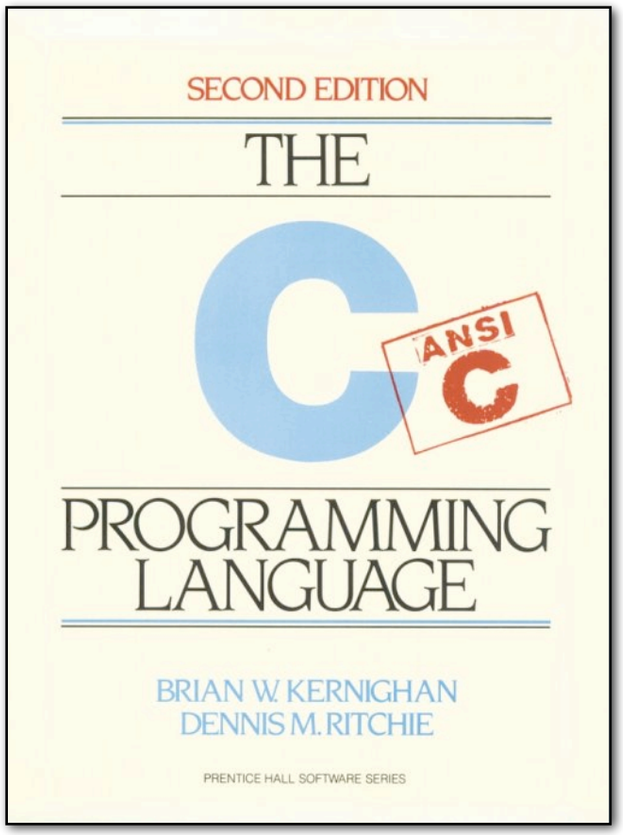
Online resources

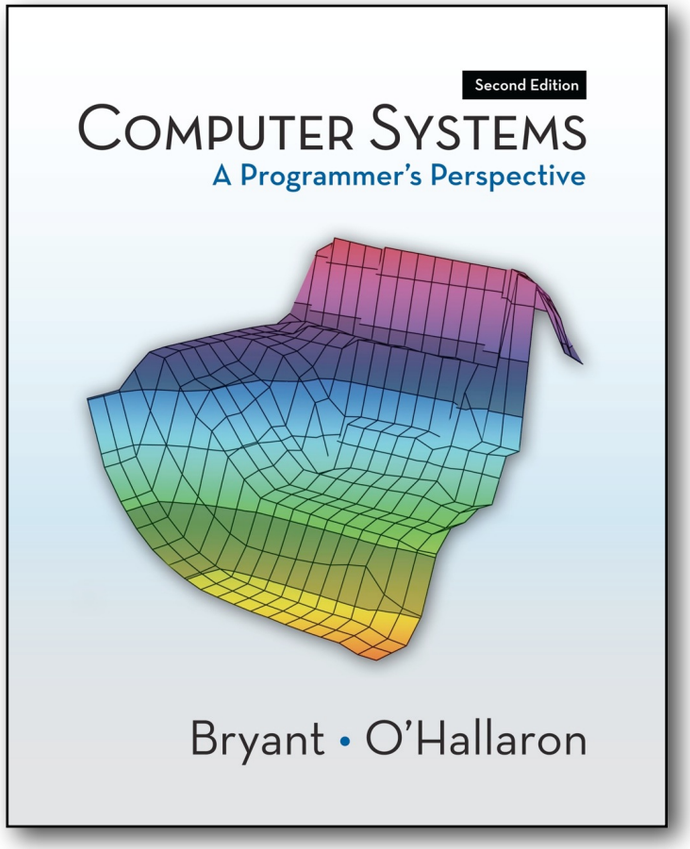
3. Vimeo channel: screencasts

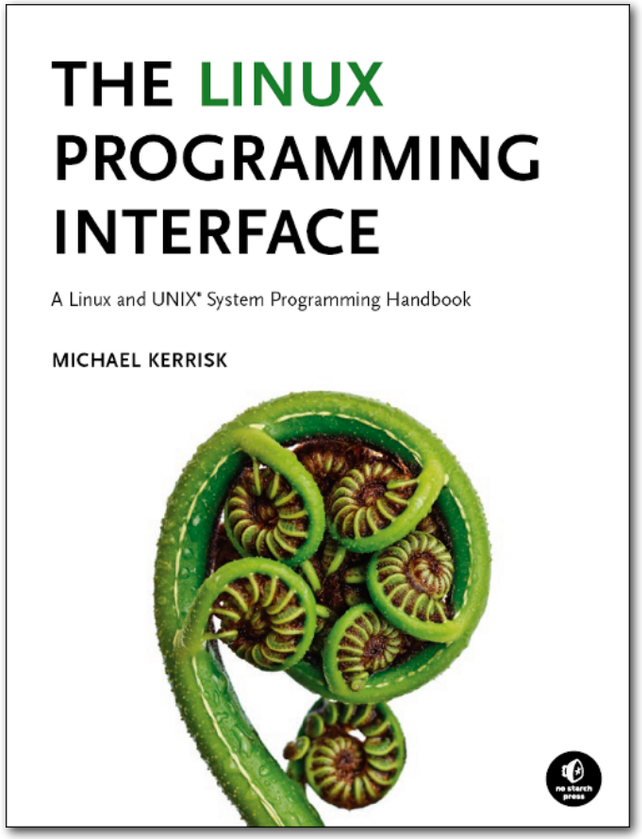


- vimeo.com/channels/cs351
- walkthroughs & tutorials (check before starting labs!)

Textbooks


SECOND EDITION
THE
C
ANSI
C
PROGRAMMING
LANGUAGE
BRIAN W. KERNIGHAN
DENNIS M. RITCHIE
PRENTICE HALL SOFTWARE SERIES


Second Edition
COMPUTER SYSTEMS
A Programmer's Perspective
Bryant • O'Hallaron


THE LINUX
PROGRAMMING
INTERFACE
A Linux and UNIX® System Programming Handbook
MICHAEL KERRISK
no starch press

Grading

- 50% Labs
- 25% Midterm exam
- 25% Final exam

Grade Scale

```
char letter_grade(float score) {
    if (score >= 90.0)      return 'A';
    else if (score >= 80.0) return 'B';
    else if (score >= 70.0) return 'C';
    else if (score >= 60.0) return 'D';
    else return 'E';
}
```

Labs

- 5-7 fairly substantial machine problems
- real-world application of concepts covered in lecture & textbook
- late policy: elastic over summer
  - hard due date for everything: June 24

Exams

- Midterm exam on June 10
- Final exam is nominally cumulative
- Scores may be linearly scaled so that median/mean (whichever lower) is 70%

§Course Overview

“Systems Programming”

system |ˈsistəm|

noun

1 a set of connected things or parts forming a complex whole

(*New Oxford American Dictionary*)

“Systems Programming”

- Programming the *operating system*
- What does *that* mean?

OS vs. OS *kernel*

- OS kernel ≈ smallest subset of OS code needed to bootstrap system and provide basic services to user programs
- "smallest" is debatable

How to “program” it?

- Require some API
  - Application Programming Interface
    - A collection of (documented) functions
      - e.g., get/put/del for a hashtable

OS API

- a.k.a. “system call” interface
  - OS as a very low-level library
- common purpose: provide services to user level programs
  - *def:* program in execution = ***process***

The Process

- A program in execution
- Code + Data { global, local, dynamic }

  + OS kernel data
- OS hides complexity of machine from processes by creating *abstractions*

“Abstraction”

http://xkcd.com/

Primary Abstractions

- Logical control flow
- Exceptional (extra-process) control flow
- Logical address space
- “I/O” (via uniform APIs)
- Interprocess Communication

In the old days …

- … every program had to include its own implementation of all the above!
- Now, OS simplifies life for all of us.
  - Only need to know how to *use* them, not how they're *implemented*.

But!

- In this class we dig a bit deeper
- What facilities are encapsulated by syscalls?
- What limitations/restrictions do they have?
- Why are they designed the way they are?
- How do they work behind the scenes?

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But why should I care?

- *efficiency*: know how to use tools optimally; reuse existing features and design/layer new ones appropriately

- *robustness*: avoid bugs/failures & know how to diagnose and fix them

the real reason: it's fun to take things apart!

goal: turn you into a **hacker**

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(or: make you a **better** hacker)

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hacker |ˈhakər|

noun

1 A person who enjoys exploring the details of programmable systems and how to stretch their capabilities, as opposed to most users, who prefer to learn only the minimum necessary.

The Jargon File, version 4.4.7

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Our tools (& approach)

- C & Linux
  - C: low-level language
  - GNU Linux: open source kernel & tools
    - GNU gdb & gcc; debugger & compiler

Fourier

- All labs must be tested and submitted on the class Linux server: fourier.cs.iit.edu
  - You will receive an e-mail with account info
  - If off-campus, must connect via IIT VPN
  - Log in via SSH client

Git & GitHub

- All labs are distributed using Git via GitHub
  - Distributed VCS + platform
- Typical workflow: (1) accept invitation and get a private copy of the assignment repo, (2) clone repo on fourier, (3) work on assignment, (4) submit via commit & push