Jin-Soo Kim
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Systems Software &
Architecture Lab.

Seoul National University

Fall 2023

4190.307:
Operating Systems

Course Information

- Schedule
  - 14:00 – 15:15 (Tuesday & Thursday)
  - Lecture room: Engineering Bldg. #301-203
  - 3 credits
  - Official language: Korean

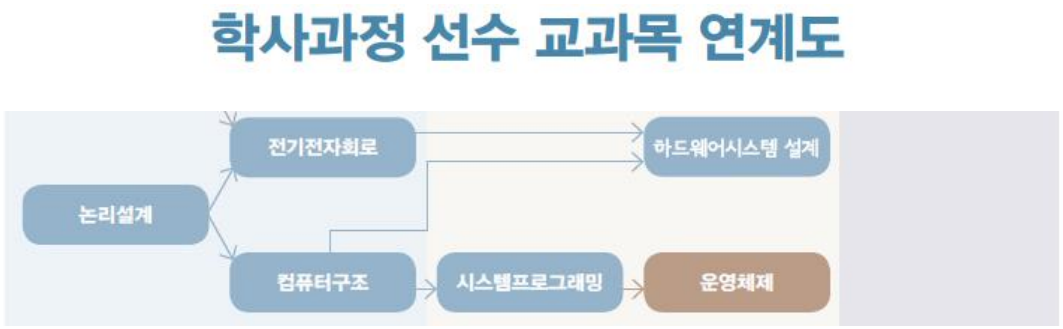
- TA: Injae Kang, Heejae Kim (snucsl.ta [at] gmail.com)
- SNU eTL system for exam/project scores (and attendance)
- http://csl.snu.ac.kr/courses/4190.307/2023-2 for announcements and lecture slides
- http://sys.snu.ac.kr for project submissions and automatic grading

About Me

- Jin-Soo Kim (김진수)
  - Professor @ CSE Dept.
  - Systems Software & Architecture Laboratory
  - Operating systems, storage systems, parallel and distributed computing, embedded systems, …
- E-mail: jinsoo.kim@snu.ac.kr
- Tel: 02-880-7302
- Office: Engineering Bldg. #301-504
- Office hours: Tuesday & Thursday (appointments by email)
- http://csl.snu.ac.kr

Prerequisites

- Courses
  - Computer Architecture (4190.308) – Must!
  - System Programming (M1522.000800) – Must!



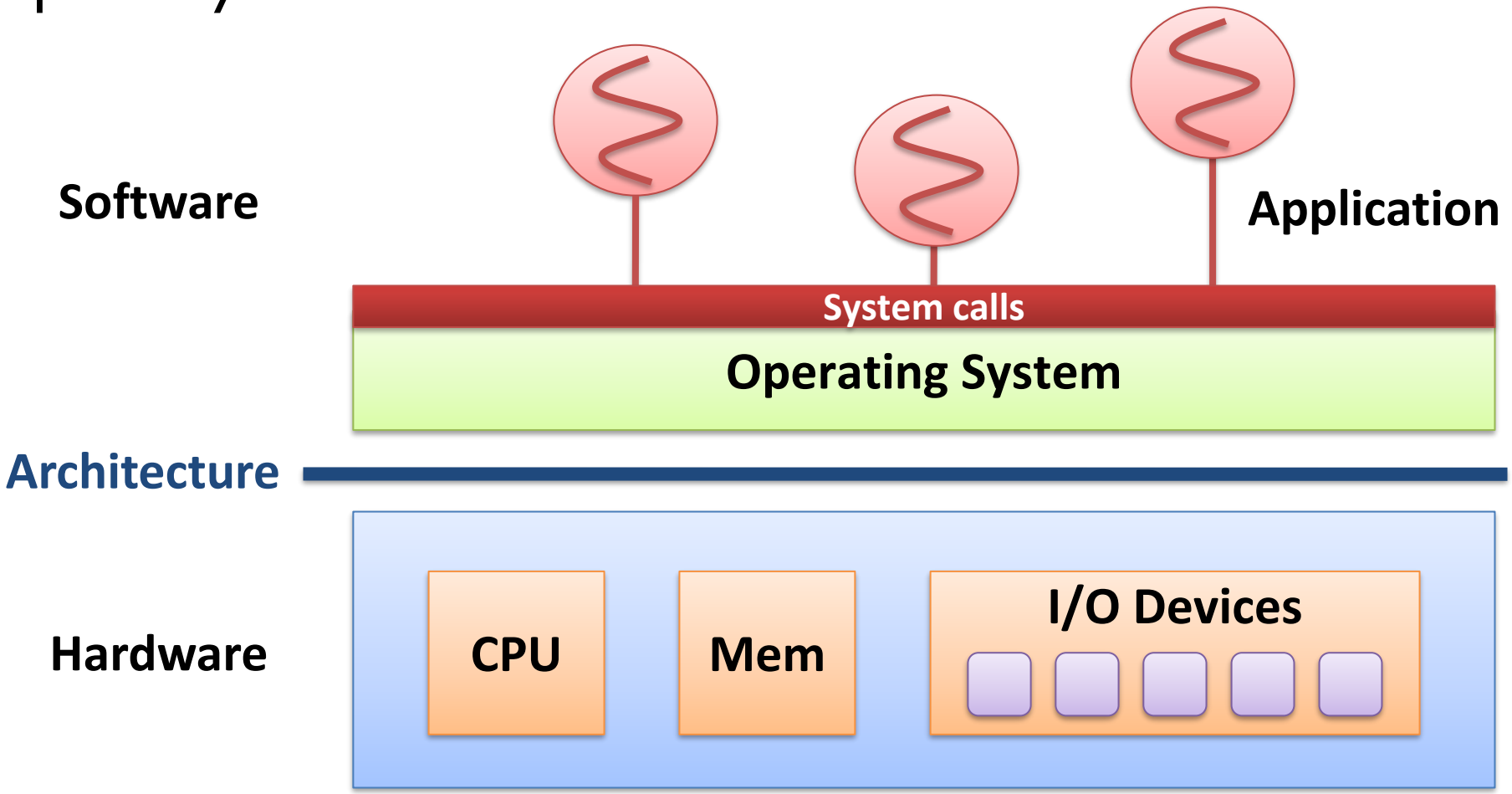
https://cse.snu.ac.kr/undergraduate/course-dependency-graph

- Skills
  - Fluent C programming
  - Familiarity with Linux commands and build environment (e.g., gcc, gdb, make, …)
  - Reading a large, complex program
  - RISC-V architecture & assembly programming

- Accessible Linux (Ubuntu 20.04.4 LTS or similar) or MacOS machine

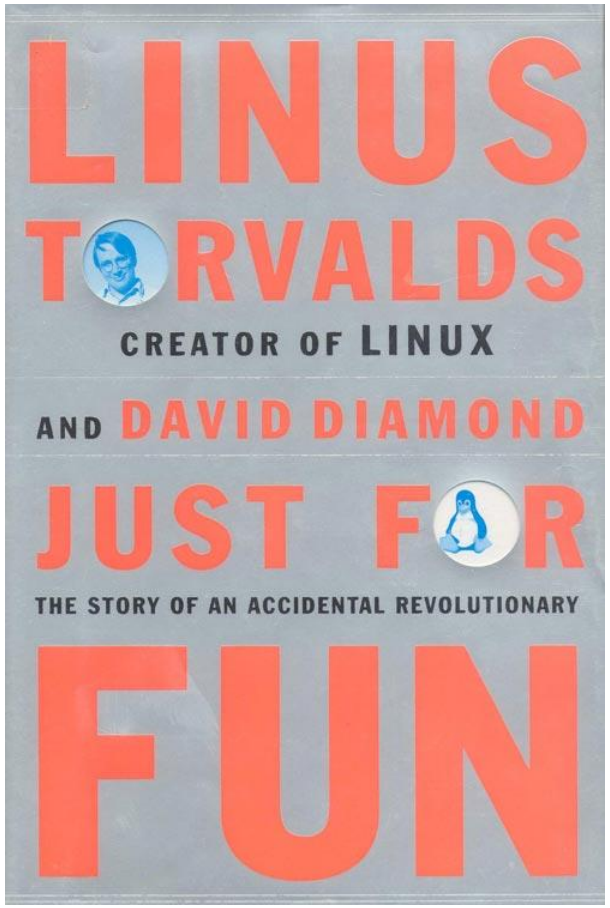
What is an OS?

- Computer systems internals



Why do we learn OS?

- To graduate (for some of you)
- To understand computer systems better
- To make a better OS or system
  - Functionality
  - Performance/cost
  - Reliability
  - Energy efficiency
- To make a new hardware up and running
- To design OS-aware hardware
- Just for fun!

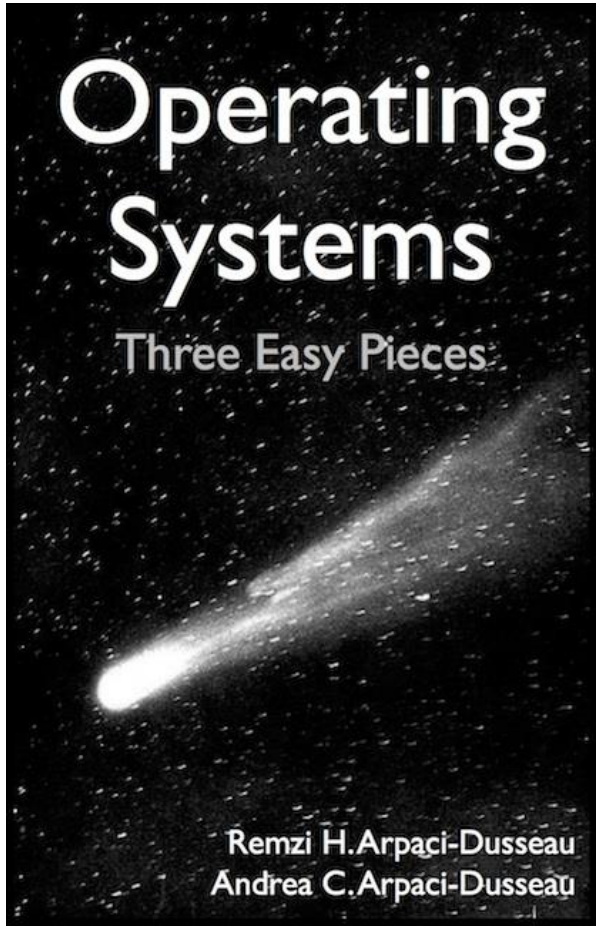


Textbook

- Operating Systems: Three Easy Pieces
  - Remzi H. Arpaci-Dusseau and Andrea C. Arpaci-Dusseau
  - Arpaci-Dusseau Books
  - August 2018 (Version 1.00)
  - Available (with several options) at http://ostep.org

  - Korean version (based on Version 0.91) is also available at https://github.com/remzi-arpacidusseau/ostep-translations/, but I highly recommend you read the original English version

  - Read Remzi's great article at http://from-a-to-remzi.blogspot.com/2014/01/the-case-for-free-online-books-fobs.html

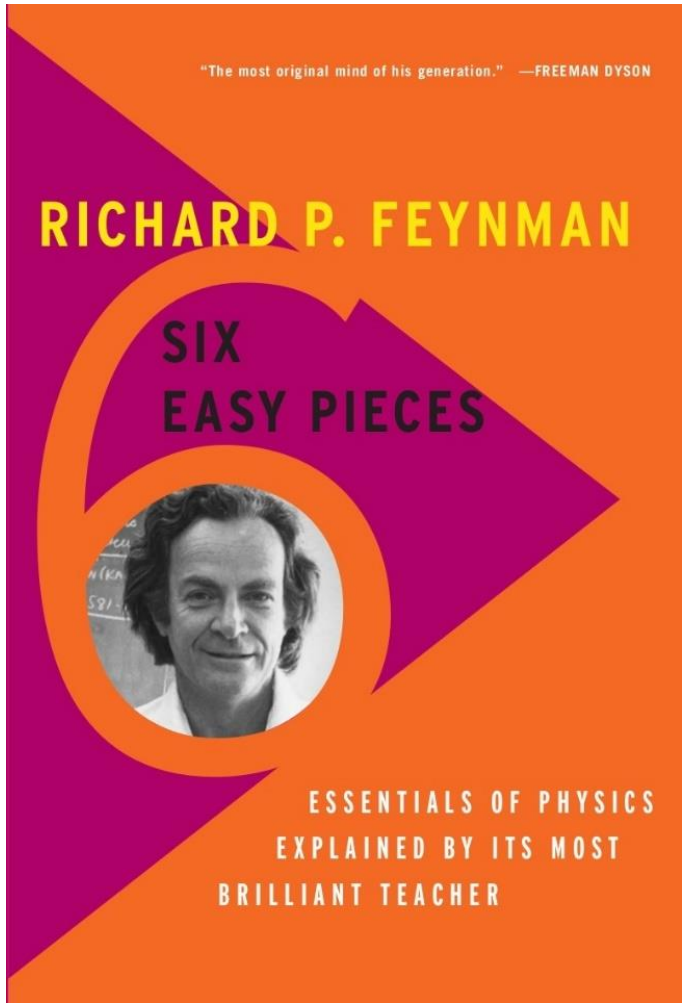


Why Three Pieces?

"… as *Operating Systems are about half as hard as Physics.*"

Chap. 1

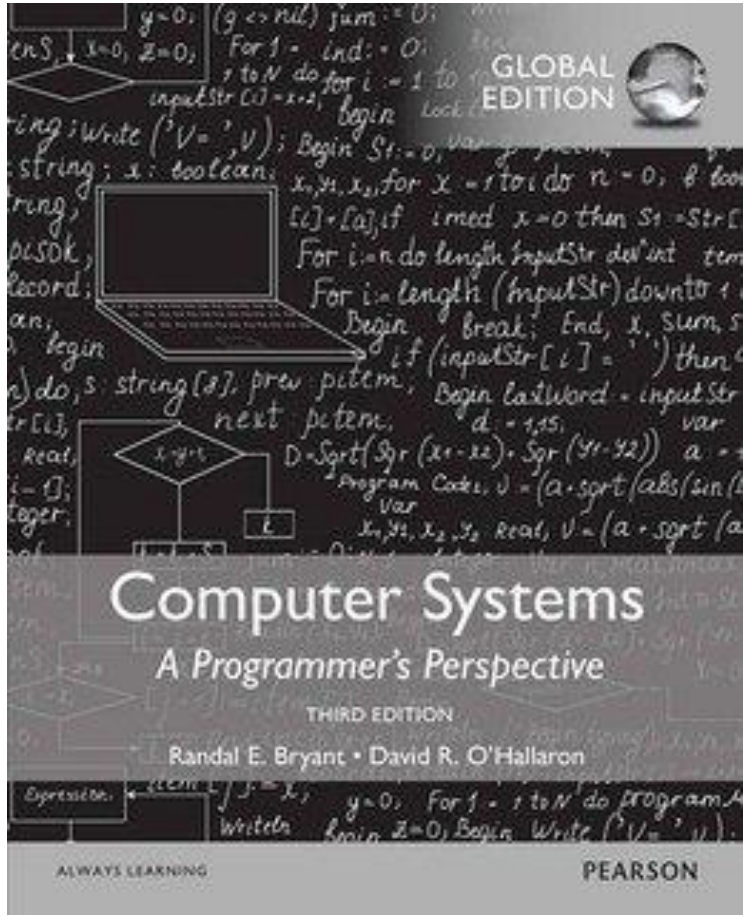
A Dialogue on the Book



Reference: CSAPP

- Computer Systems: A Programmer's Perspective
  - Randel E. Bryant and David R. O'Hallaron
  - Third Edition
  - Pearson
  - March 2015

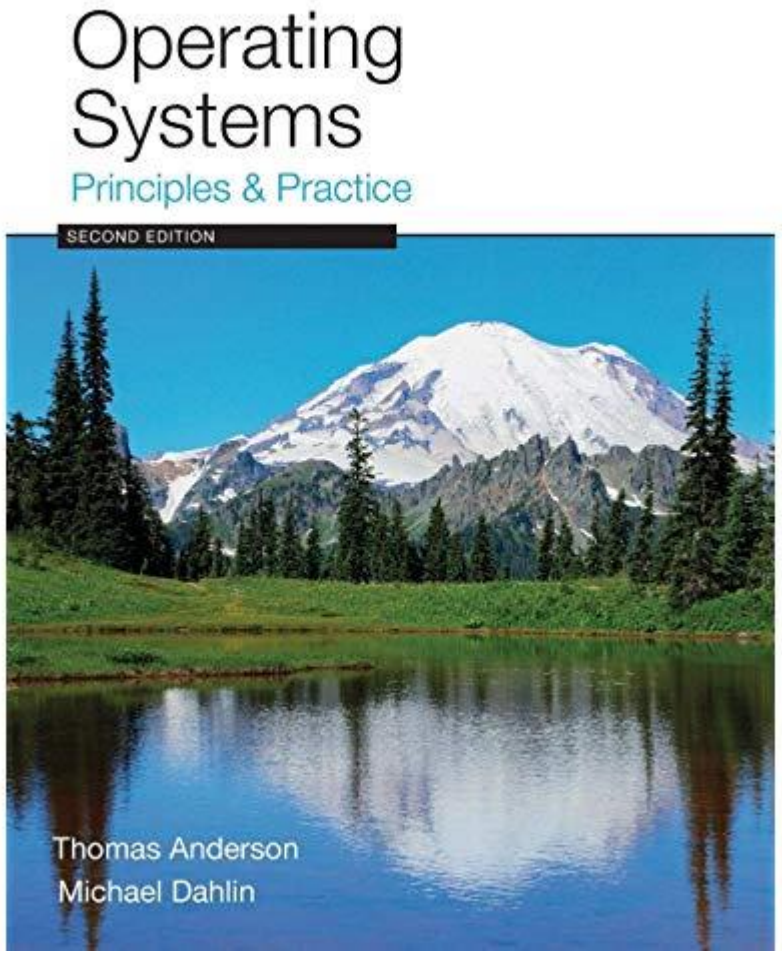
  - http://csapp.cs.cmu.edu



Reference: OSPP

- Operating Systems: Principles and Practice
  - Thomas Anderson and Michael Dahlin
  - Second Edition
  - Recursive Books
  - August 2014

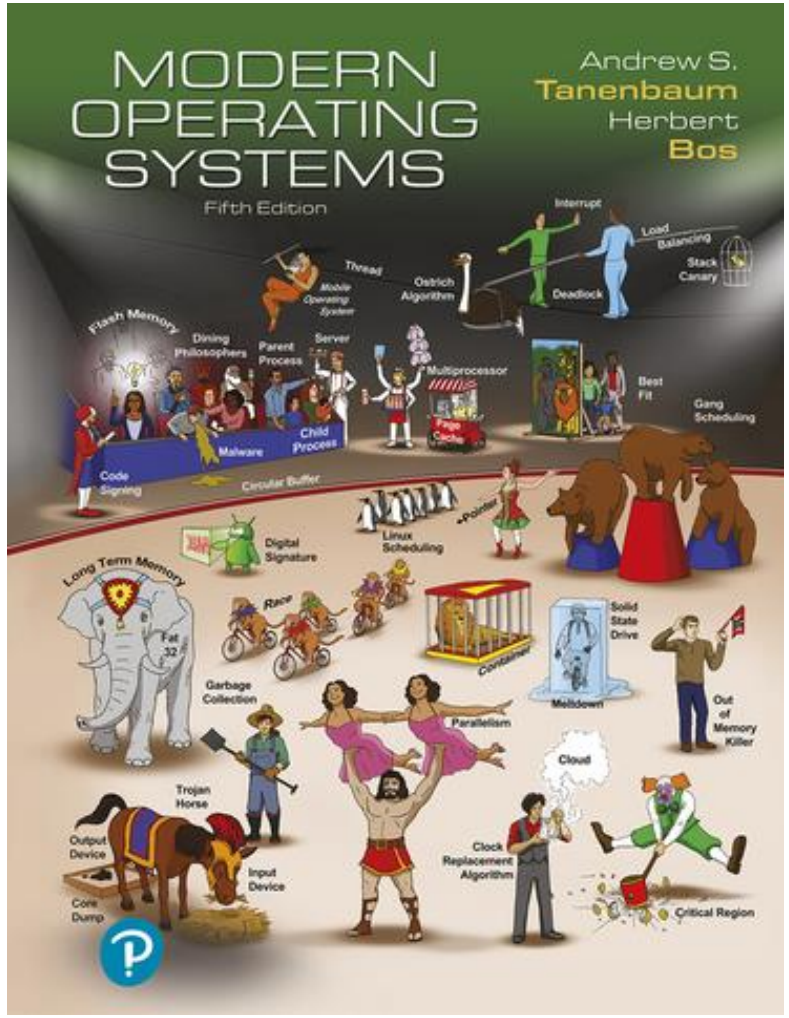
- http://ospp.cs.washington.edu/



Reference: MOS

- Modern Operating Systems
  - Andrew S. Tanenbaum and Herbert Bos
  - Fifth Edition
  - Pearson
  - October 2022

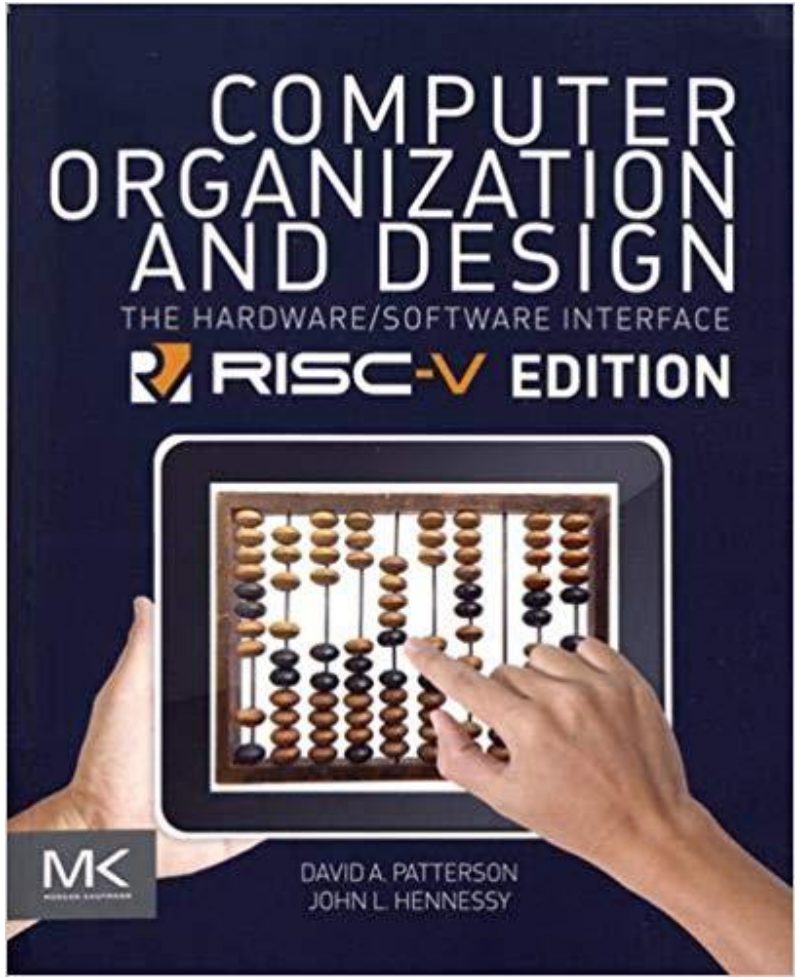
- https://www.pearson.com/en-us/subject-catalog/p/modern-operating-systems/P200000003295



Reference: RISC-V (1)

- Computer Organization and Design: The Hardware/Software Interface (RISC-V Edition)

  - David A. Patterson and John L. Hennessy (Turing Award Recipients in 2017)
  - Second Edition
  - Morgan Kaufmann, 2017
  - http://booksite.elsevier.com/9780128122754/

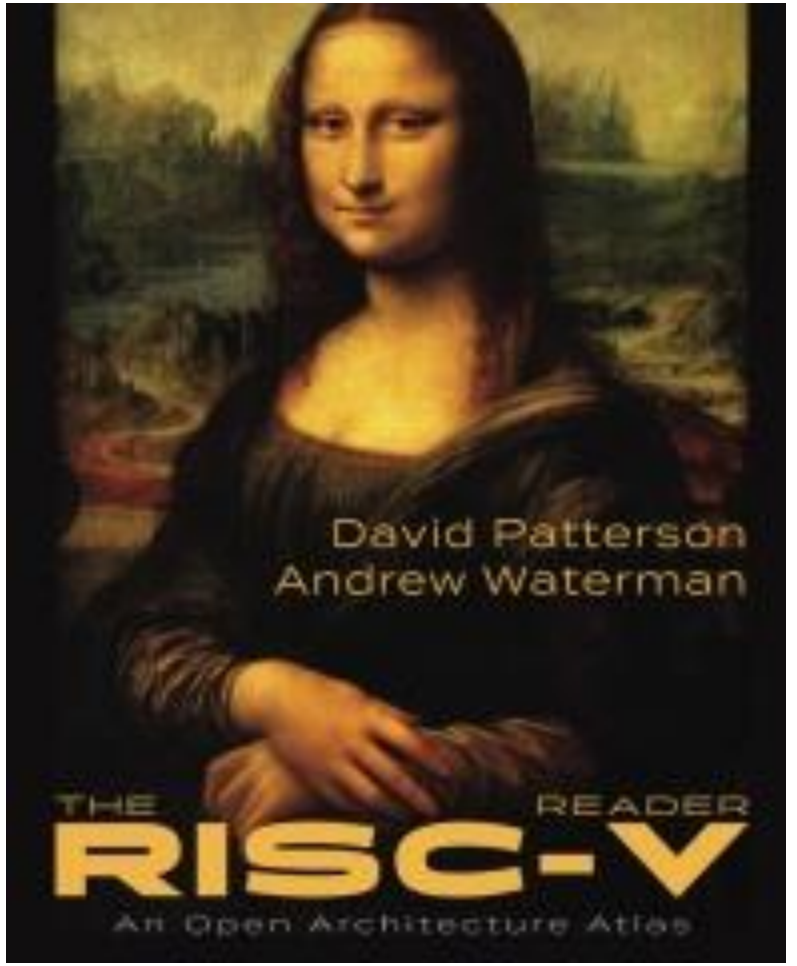


Reference: RISC-V (2)

- The RISC-V Reader:
  An Open Architecture Atlas

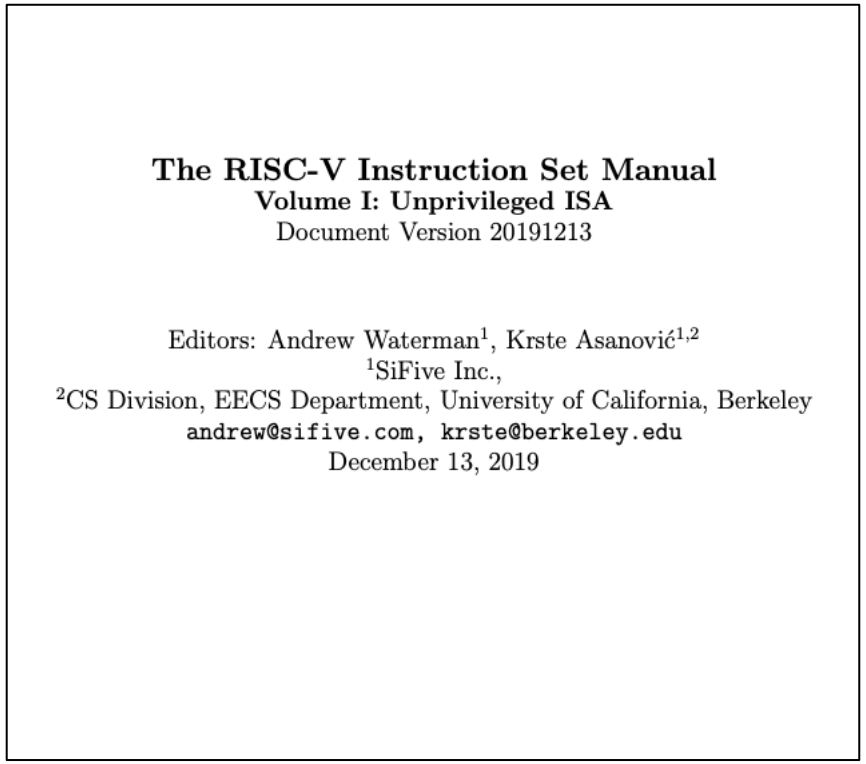
  - David A. Patterson and Andrew Waterman
  - Strawberry Canyon, 2017
  - http://riscvbook.com/

  - The free Korean (pdf) version is available



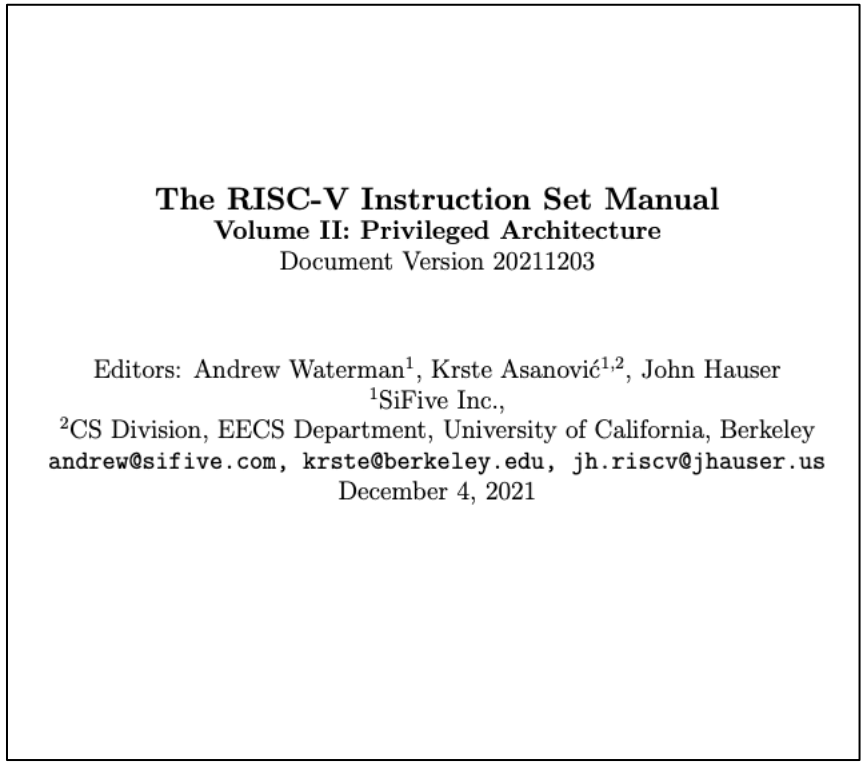
Reference: RISC-V (3)

- https://riscv.org/technical/specifications/
  - Volume I: Unprivileged ISA (v20191213)
  - Volume II: Privileged Architecture (v20211203)



The RISC-V Instruction Set Manual
Volume I: Unprivileged ISA
Document Version 20191213

Editors: Andrew Waterman[1], Krste Asanović[1,2]
[1]SiFive Inc.,
[2]CS Division, EECS Department, University of California, Berkeley
andrew@sifive.com, krste@berkeley.edu
December 13, 2019



The RISC-V Instruction Set Manual
Volume II: Privileged Architecture
Document Version 20211203

Editors: Andrew Waterman[1], Krste Asanović[1,2], John Hauser
[1]SiFive Inc.,
[2]CS Division, EECS Department, University of California, Berkeley
andrew@sifive.com, krste@berkeley.edu, jh.riscv@jhauser.us
December 4, 2021

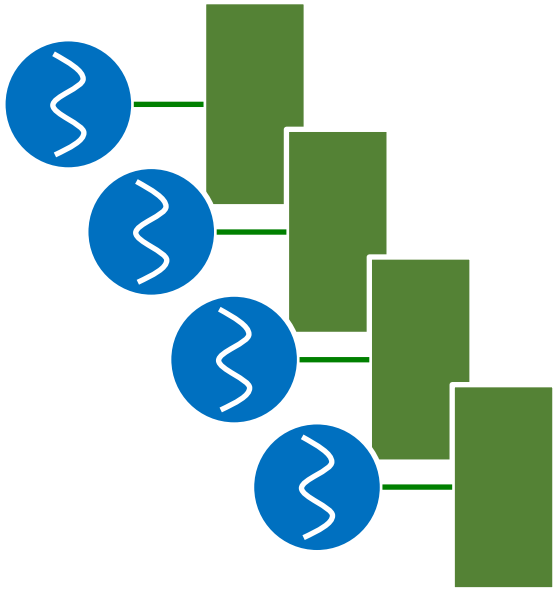
Course Plan

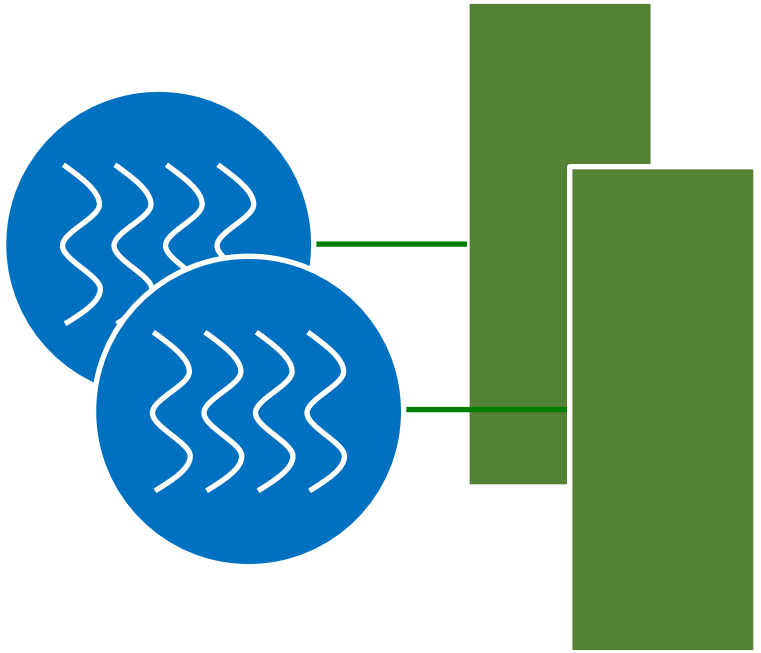
- Lectures
  - General operating system concepts
  - Case study: Linux, xv6

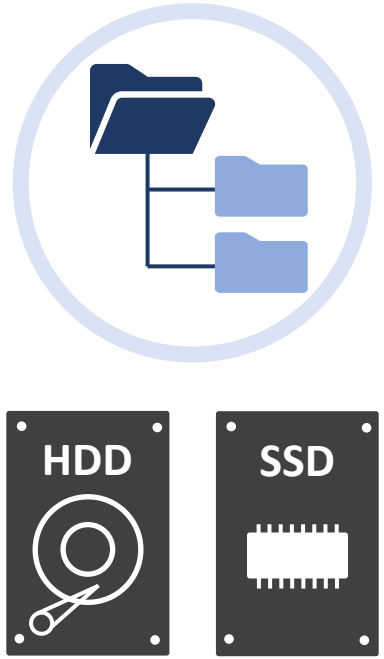
- Hands-on projects
  - Using xv6 instructional OS
  - Based on RISC-V architecture

Lectures: Topics

- Virtualization
  - Process
  - CPU scheduling
  - Virtual memory
- Concurrency
  - Threads
  - Synchronization
- Persistence
  - Storage
  - File systems







Projects: xv6

- A teaching OS developed by MIT
  - Port of the Sixth Edition Unix (v6) in ANSI C
  - Originally runs on multi-core x86 systems
  - We will use the version that runs on multi-core 64-bit RISC-V systems
- Why xv6?
  - Code inherited from a real, historical OS!
  - Includes working user-level programs and libraries
  - Small: *only* 6K LOCs (vs. 27+ million LOCs for Linux)
  - Easier to install on modern Linux / MacOS systems using QEMU
  - Easier to extend
  - Easier to understand modern OSes such as Linux

Projects Plan

- We are preparing 5 ~ 6 project assignments
  - The relative weight of each project can vary, typically increasing monotonically
  - Just for your reference: In 2020, there were 6 projects, and their weights were 1%, 2%, 6%, 9%, 12%, 20% for PA1 – PA6, respectively
- These will be individual projects
- You can use up to 3 *slip* days
- Lab sessions
  - A separate class with a TA
  - Project announcement and Q & A
  - Hints & helps
  - Code review, oral tests, …

Grading Policy (subject to change)

- Exams: 60% (Midterm 25%, Final 35%)
- Projects: 40%

- University policy requires students to attend at least 2/3 of the scheduled classes. Otherwise, you'll fail this course.
- We are using the electronic attendance system

- If you miss one of the exams, you'll fail this course

- The course drop request will NOT be accepted if you haven't taken the "System Programming" course or equivalent

Cheating Policy

- What is cheating?
  - Copying another student's solution (or one from the Internet) and submitting it as your own
  - Allowing another student to copy your solution (including publicly posting your solution on Github, etc.)
- What is NOT cheating?
  - Helping others use systems or tools
  - Helping others with high-level design issues
  - Helping others debug their code
- Penalty for cheating
  - Severe penalty on the grade (F) and report to dept. committee
  - Ask helps to your TA or instructor if you experience any difficulty!

Lecture Schedule

September

Su	Mo	Tu	We	Th	Fr	Sa
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30

October

Su	Mo	Tu	We	Th	Fr	Sa	
1	2	3	4	5	6	7	
8	9	10	11	12	13	14	
15	16	17	18	19	20	21	
22	23	24	25	26	27	28	*midterm*
29	30	31					

November

Su	Mo	Tu	We	Th	Fr	Sa
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30		

December

Su	Mo	Tu	We	Th	Fr	Sa	
					1	2	
3	4	5	6	7	8	9	
10	11	12	13	14	15	16	*final*
17	18	19	20	21	22	23	
24	25	26	27	28	29	30	
31							

Summary

- Understanding OS is essential for a broad spectrum of computer systems research & development
  - Embedded systems
  - Cloud computing
  - Distributed systems
  - Security, …
- It has been one of the toughest courses! Use your time wisely
- Please make sure if you're ready to take this course
- Happy hacking!