ITSC 3181 Introduction to Computer Architecture, Spring 2023 Section 004, 005, and 006

https://passlab.github.io/ITSC3181

Department of Computer Science

Yonghong Yan

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Course Information 1/2

- **Website: https://passlab.github.io/ITSC3181/**
- **Course Schedule and Materials:** https://passlab.github.io/ITSC3181/schedule.html
- **Class Meeting Time and Classroom:**
  - Lecture class: 11:30 AM - 12:45 PM, Tuesday and Thursday
    - Classroom: Woodward Hall 106, Zoom for recording: from https://uncc.zoom.us/j/6698366594?pwd=MVBmOURvRGU1azRwY0lnejVwa2tjUT09. Meeting ID: 669 836 6594, Passcode: 3181. More detailed Zoom info for the lecture
- Labs: Woodward Hall 140
  - Section 004: 8:00 am - 11:00 am Wednesday Woodward Hall 140, Instructor:
  - Section 005: 11:15 am - 2:15 pm Wednesday Woodward Hall 140, Instructor:
  - Section 006: 02:30 pm - 5:15 pm Wednesday Woodward Hall 140, Instructor:
- Check University Academic Calendar for other important dates and deadlines.

Course Information 2/2

- **Instructor: Yonghong Yan, yyan7@uncc.edu**
  - Office: 210G Woodward Hall, Phone: 704-687-8546
  - Office Hours: 10:30 AM - 11:15 AM Tuesday and Thursday, WW 210G, https://uncc.zoom.us/j/6698366594?pwd=MVBmOURvRGU1azRwY0lnejVwa2tjUT09. Meeting ID: 669 836 6594, Passcode: 3181.
  - Or by appointment if the above time does not work for you, send me email.
- **Teaching Assistant and Office Hours**
  - Patrick Flynn (pflynn5@uncc.edu)
  - Zachary Ellixson (zellixso@uncc.edu)
  - More to come
  - Office hours: TBD
- **Announcement, grade and assignment submission:**
  - **https://uncc.instructure.com/courses/193482**
    Website or Canvas syllabus for more details

Learning Outcomes

1. Explain the principles, components, progression and performance/power challenges of computer architecture and its design.
2. Convert numerical data in computers between different representations including binary, hexadecimal, decimal, and other alternative formats.
3. Illustrate how an instruction is represented at the machine level and symbolic assembler level and how it is executed in a classical von Neumann machine.
4. Map major high-level language patterns into assembly/machine language notations.
5. Describe the design of basic building blocks of a computer: arithmetic-logic unit, registers, central processing unit, and memory.
6. Illustrate instruction level parallelism and hazards, and how they are managed in typical processor pipelines.
7. Illustrate the idea of memory hierarchy (cache, virtual memory) and how it can be exploited in programming for reducing memory access latency.

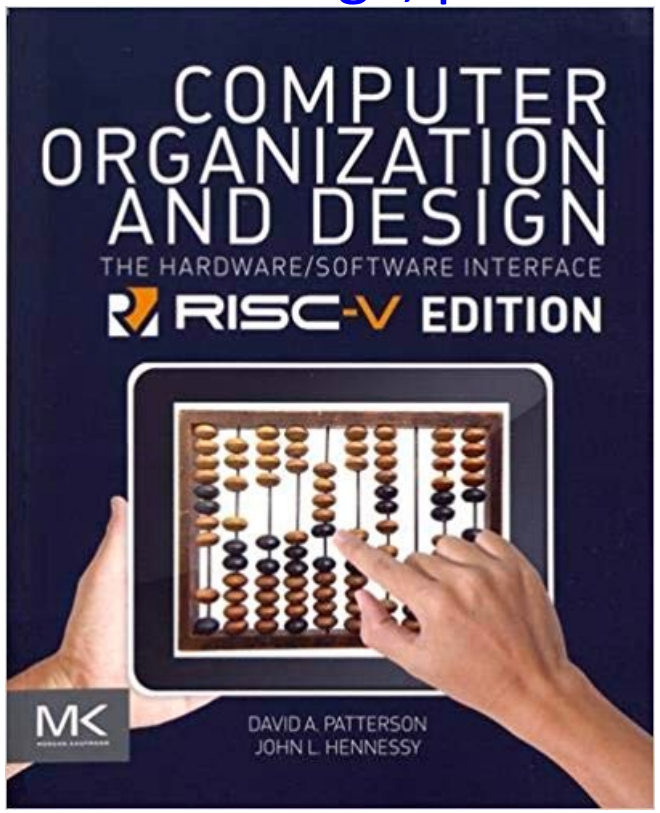
Make you a computer/software engineer and an expert, know how program works underneath, and how to make it run faster.

Other Important Outcomes

- Manage your schedule and stick to the study plan
- How to break down complex problems into smaller ones and step-by-step solutions
- Use Examples to explain CA ideas and problems

Required Textbook (COD)

- Computer Organization and Design RISC-V Edition: The Hardware/Software Interface, 2017
  - John L. Hennessy and David A. Patterson
  - Course lectures will follow textbook
  - Read 20 pages/week in average, preview and review



Authors of the Textbook

- **John L. Hennessy and David A. Patterson**

Pioneers of Modern Computer Architecture Receive ACM A.M. Turing Award

Hennessy and Patterson's Foundational Contributions to Today's Microprocessors Helped Usher in Mobile and IoT Revolutions

NEW YORK, NY, March 21, 2018 – ACM, the Association for Computing Machinery, today named John L. Hennessy, former President of Stanford University, and David A. Patterson, retired Professor
s of the 2017 ACM A.M. Turing Award for pioneering a
nd evaluation of computer architectures with enduring
and Patterson created a systematic and quantitative
educed instruction set computer (RISC) microprocessors.
ciples that generations of architects have used for many
f the more than 16 billion microprocessors produced
early all smartphones, tablets, and the billions of
Things (IoT).

https://www.acm.org/media-center/2018/march/turing-award-2017

Hennessy & Patterson: A New Golden Age for Computer Architecture

By Staff

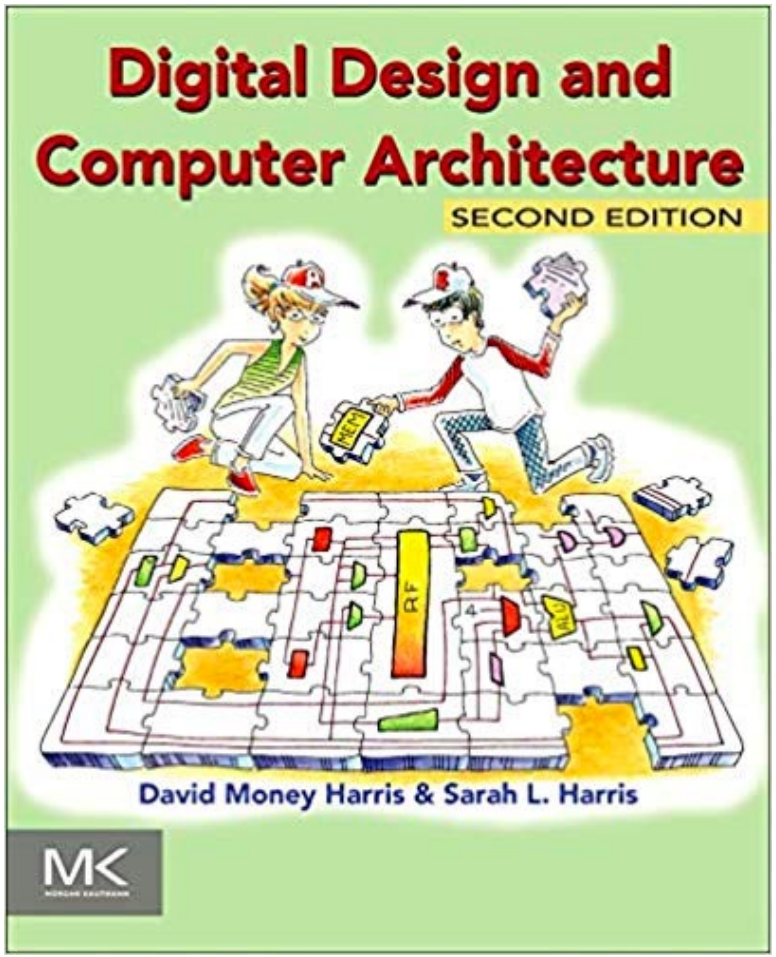
April 17, 2018

On Monday June 4, 2018, 2017 A.M. Turing Award Winners John L. Hennessy and David A. Patterson will deliver the Turing Lecture at the 45th International Symposium on Computer Architecture (ISCA) in Los Angeles.

- Video: https://www.acm.org/hennessy-patterson-turing-lecture
- Short summary
  - https://www.hpcwire.com/2018/04/17/hennessy-patterson-a-new-golden-age-for-computer-architecture/

Reference Textbook (DDCA)

- Digital Design and Computer Architecture: 2nd Edition, by Sarah Harris and David Harris



Course Content, Work Load and Grading

Letter	Percentage
A	90-100
B+	86-90
B	80-86
C+	76-80
C	70-76
D+	66-70
D	60-66
F	0-60

- Main content
  - Chapter 1,2,4,5, Appendix A, and C programming basics
- ~5 homework, 11-13 labs, and three tests and one final, all individual
  - About one homework per chapter and one test per two chapters
  - Tests and finals are open books and notes of this class only and inclusive
- Grade distribution
  - Homework and labs: 40%
  - Three tests: 34%
  - Final: 26%

- Assignment due 11:59PM on the due date. **NO submission will not be accepted after canvas closes.**

Class Schedule

- Chapter 1: Computer Abstractions and Technology
- C Programming and generating executables from source code
  - C Programming basics; Compilation, Assembly and Linking
  - Memory and number systems
- Chapter 2: Instructions: Language of the Computer
- Test 1 (02/14, Tuesday during the class)
- Appendix A: Basics of Logic Design
- Test 2 (03/09 Thursday during the class)
- Chapter 4: The Processor
- Test 3 (04/06 Thursday during the class)
- Chapter 5: Large and Fast: Exploiting Memory Hierarchy
- 12/06 Last Lecture Class, 12/07 Lab lab
- Final Exam: 05/09 Tuesday 11:00 - 1:30PM

More detailed schedule: https://passlab.github.io/ITSC3181/#schedule

Study Topics for Each Lecture

- https://passlab.github.io/ITSC3181/studytopics.html
  - Book chapter and lecture to read
  - Questions and topics to answer and review
  - Exercises to practice and other materials
  - **The first 3-4 topics are the most important ones**

For each lecture, the first 3-4 topics are the most important ones.

Chapter 1,Computer Abstraction and Technology

Lecture 01, Chapter 1.1 - 1.5

1. Explain what is Moore's Law, how it has been impacting the computer industry and how it has been used for predicting computer performance starting from 1970s. Another question that can be answered by Moore's Law is: Why do computer industry and technology advance so fast? For example, it is common that a new generation of computer, CPU, smartphones are produced in every two years.
2. How the idea of abstraction is exploited in computer hardware/software? E.g. in the layers of high-level language, ISA and ABI, and hardware implementation, low-level details are hidden from the higher level.
3. Understand how a program (application software) written in high-level programming languages is being executed by the hardware. First, compilers translate programs written in high-level programming languages into machine instructions (assembly code). From the assembly codes, assemblers translate symbolic notation of the instructions to the binary. Operating system launches the program of the binary format onto the hardware to execute. The hardware execute the program instruction by instruction.

Environment and Tools for Development and Lab Work

- Web-based and Java-based standalone tools
  - **C Online Compiler IDE and Editor and a Linux terminal from https://repl.it/languages/c**
    - Use this site to edit your C program, compiler and execute it to see its results.
  - **Compiler Explorer from https://godbolt.org/**
    - Use this site to see the assembly output of a C program compiled by different compiler on different computer architectures/ISAs.
  - **A University educational cluster named Centaurus (https://oneit.charlotte.edu/urc/educational-clusters) available as hpc-student.uncc.edu.**
  - **RARS -- RISC-V Assembler and Runtime Simulator from https://github.com/TheThirdOne/rars**
    - A standalone Java software that you need for writing RISC-V assembly program and execute the program using simulation.
  - **Digital for digital logic design and experiment from https://github.com/hneemann/Digital**
    - A Java software that you need for the digital logic design and simulation.
- Virtual machine or real machine are not required, but you are welcome to use
  - Details: https://passlab.github.io/ITSC3181/resources/devenv.html

Time Management

- You have total 40 hours/week quality time for study (full time)
  - If you take 5 courses ➔ budget ~8 hours per week for each course

- 8 Hours
  - 2.5 hours to attend lecture
  - ~1 hour for study
    - Preview/review lecture materials
    - Reading textbooks
    - Study regularly, e.g. in two or three days a week
    - Check the study topics of the course for each lecture
      - https://passlab.github.io/ITSC3181/studytopics.html
  - ~4.5 hours of lab and homework
  - You may spend more or less time on homework than study
    - It depends on each person, contents and habits

  - Quality time and concentration are important
  - Do not stuck in one topic or one problem too long
    - Ask me or others
    - Move on to another topic/problem and come back later

Academic Integrity

- **Examination work and assignment are expected to be the sole effort of the student submitting the work. Students are expected to follow the UNC Charlotte Code of Student Academic Integrity for all class activities, assignments and tests. This includes following all of the instructions given by the course instructor, TAs, and other test proctors. Here is a link to the code: http://legal.uncc.edu/policies/up-407**
- **Prohibited behaviors include plagiarism, cheating, falsification, and complicity. All cases of potential academic misconduct will be reported to the Dean of Students Office.**
- **If any of the prohibited behaviors is caught, or reported and proved, the persons who cheat and those who help cheating fail the course.**

More Info

- https://passlab.github.io/ITSC3181/ or Canvas

- Questions and inquiry are welcome, email preferred.
  - Answer within 24-hours in business day
  - Send me again if you do not receive response after 24 hours.

Health and Safety Expectation During COVID-19

- Due to the COVID-19 pandemic, there might be new behavioral expectations for UNC Charlotte students and student organizations, **including the required face covering, social distance and vaccination, etc**. All students should review the behavioral expectations, along with the procedure for reporting and addressing noncompliance with those expectations available from [STUDENT HEALTH AND SAFETY EXPECTATIONS DURING COVID-19](https://scai.charlotte.edu/student-health-and-safety-expectations-during-covid-19) and [CLASSROOM EXPECTATIONS RELATED TO FACE COVERINGS](https://provost.charlotte.edu/news/2021-08-12/classroom-expectations-related-face-coverings) . Failure to follow these expectations may constitute a violation of the [Code of Student Responsibility](http://legal.uncc.edu/policies/up-406).