



# Computer Organization

COMP2120

Qi Zhao

January 14, 2024

## Introduction



## Basic information

- **Qi Zhao**, Assistant Professor, CS department  
BSC and Phd, Tsinghua; Post-doc, UMD
- **Research:** Quantum computing and Quantum information
- **Teaching:** Computer organization A and B
- **Contact:** zhaoqi@cs.hku.hk, CYC 401A  
<https://qizhao-quantum.github.io/>



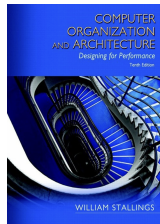
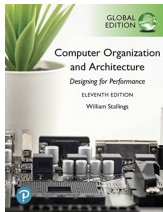
## Getting help

- **Office Hour:** Thursday, 1-2pm  
additional office hours before the final exam
- **TAs:**  
Xu Jue, [xujue@connect.hku.hk](mailto:xujue@connect.hku.hk)  
Wang Yue, [u3011047@connect.hku.hk](mailto:u3011047@connect.hku.hk)  
Yu Wenjun, [wjyu@connect.hku.hk](mailto:wjyu@connect.hku.hk).
- **1:1 Appointment:** Feel free to schedule 1:1 appointments wit us!



## About this course

- **Book:** Computer Organization and Architecture, 10th or 11th edition, by William Stallings



- Lecture notes available online before the class recordings only available for add/drop period
- **Tentative grading:**  
Final Examination 60%,  
5 Assignments 30%,  
Tutorial Exercise and Attendance (in-class quiz) 10%.



## About this course: Plagiarism

- **Plagiarism**
  - First Attempt: be warned in writing and receive zero mark for the whole assignment or the whole test
  - Subsequent Attempt: the case shall be referred to the Programme Director for consideration.
- **Both** the student who copies other's work and the student who offers his/her work for copying shall be penalized.



## About this course: Late Penalty

- **Late Penalty:**

First 2 hours - No penalty

From 2-12 hours - deduct 10%

From 12-24 hours - deduct 25 %

For every subsequent 24 hours - deduct 25%

For 2 days, deduct 50%, 3 days 75%, and you will get 0 marks after 4 days

- No extensions, no exceptions



## About this course

- Parts of the lecture notes come from Professor Chan's lecture notes on Computer Organization and book by William Stallings.  
Some pictures come from the internet, e.g., wikipedia. The materials are only used for teaching. The lecture notes and other materials are copyright protected and must not be shared, uploaded or distributed without permission.
- Share your **comments** and **feedback** with us. We appreciate your feedback.



## About this course

- Expected course Learning Outcomes
  - **Basic Computer Organization:** Understand the basic components of a computer, including CPU, memories, and input/output, and their organization.
  - **Design Issues:** Understand the cost performance tradeoff in designing memory hierarchy and instruction sets.
  - **Assembly Language Programming:** Understand and be able to use assembly languages for solving simple problems. Understand the relationship between high level language and assembly language.
  - **Modern Trends:** Be able to follow the trends in computer design and appreciate the design philosophy behind.
- Understand key **concepts and principles**, don't memorise!





# About this course

- Teaching plan

Week	Monday 11:30AM - 12:20PM	Thursday 10:30AM - 12:20PM
1	[Jan 15] Introduction evolution	[Jan 18] Evolution, Digital logic
2	[Jan 22] Number Representation	[Jan 25] Number Representation Computer Arithmetic
3	[Jan 29] Tutorial 1	[Feb 1] Computer Arithmetic
4	[Feb 5] Tutorial 2	[Feb 8] Instruction execution cycle
5	[Feb 12] Chinese New Year	[Feb 15] Chinese New Year
6	[Feb 19] Tutorial 3	[Feb 22] Memory Hierarchy
7	[Feb 26] Cache Memory	[Feb 29] Cache Memory
8	[Mar 4] Reading week	[Mar 7] Reading week
9	[Mar 11] Tutorial 4	[Mar 14] Cache Memory, External Storage
10	[Mar 18] External Storage Input/Output	[Mar 21] Input/Output
11	[Mar 25] Instruction set	[Mar 28] Instruction set
12	[Apr 1] Easter Monday	[Apr 4] Ching Ming Festival
13	[Apr 8] Tutorial 5	[Apr 11] Addressing Models
14	[Apr 15] Assembly Language Programming	[Apr 18] O/S Support Processor Organization and RISC
15	[Apr 22] Tutorial 6	[Apr 25] Processor Organization and RISC



# Why study computer organization

- How do computers work?
- For programmers, how does the code work?
- x86 and ARM processors
- How to buy a laptop or desktop?



Hover over image to Zoom in



## ALIENWARE AURORA R15

- 13th Gen Intel® Core™ i9 13900KF (24-Core, 68MB Cache, 3.0GHz to 5.8GHz P-Core Thermal Velocity)
- Windows 11 Home, English, Simplified Chinese, Traditional Chinese (Dell Technologies recommends Windows 11 Pro for business)
- NVIDIA(R) GeForce RTX(TM) 4090, 24GB GDDR6X
- 32GB Dual Channel DDR5 (2x 16GB) at 4800MT/s; up to 64GB (additional memory sold separately)
- 512GB NVMe M.2 PCIe SSD (Boot) + 1TB 7200RPM SATA 6Gb/s (Storage)
- 1350W Platinum PSU, Light, Alienware Cryo-tech(TM) Edition CPU Liquid Cooling & Clear Side Panel
- Ports & slots

Online Price ~~HK\$48,999~~

**HK\$44,999**

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- Design New Computers



# Computer Organization and Architecture

- **Computer Architecture** – refers to those attributes of a system visible to a programmer, or those attributes that have a direct impact on the logical execution of a program
  - Design a house, bathroom, kitchen, master room, guest room,...
  - whether a computer has a multiply instruction
- **Computer Organization** – refers to the operational units and their interconnections that realizes the architectural specification.
  - Build a house, bricks and techniques,...
  - how to implement multiply, is there a hardware multiply unit or is it done by repeated addition?



# Computer Organization and Architecture

- The Intel family, or the IBM 370 family (Mainframe Computer). The machines shared the same architecture, i.e. same instruction set etc. Program written for a member of the family, e.g. Intel Pentium, can be executed in other members as well, like i3, i5, i7, i9 processor etc.





# Computer Organization and Architecture

- More recently, the ARM architecture is just an architectural design from a British company, ARM Holdings. They sell their design to other companies, who have their own implementation. (e.g. Samsung, Huawei have their own implementation of the ARM architecture)





# Structure and Function

## Computer as a complex system

- Computer Structure: The way in which the components are interrelated.
- Computer Function: The operation of each individual component as part of strcuture.



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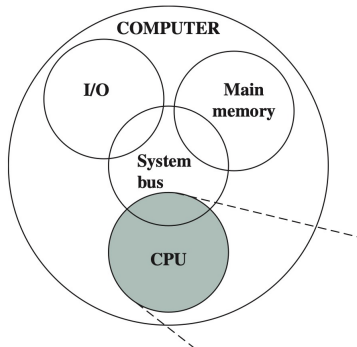
## Structure

- A computer can be described in different levels.
- The designer only needs to deal with a particular level of the system at a time.
- Each level depends on a simplified, abstracted characterization of the system at the next lower level.



# Internal Structure of Computer

- **Central Processing Unit (CPU)** – controls the operation of the computer and performs its data processing functions.
- **Main Memory** – Stores data/program
- **Input/Output (I/O)** – moves data between computer and its external environment.
- **System Interconnection** – provides communication among CPU, main memory and I/O.

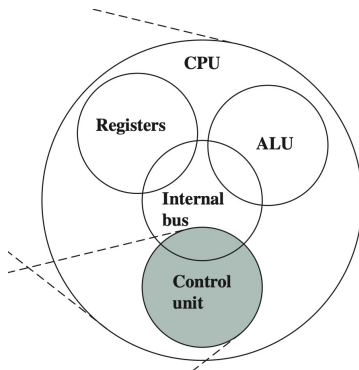






## Internal Structure of CPU

- **Control Unit** – Controls the operation of the CPU.
- **Arithmetic and logic unit (ALU)** – performs data processing functions.
- **Registers** – provides storage internal to the CPU.
- **CPU interconnection**– provides for communication among the control unit, ALU and registers.





- You can go down level by level, until you reach the basic building block – the transistors
- How to perform simple arithmetic/logical operation via ALU, such as ADD, SUB, AND, OR, NOT.
- How to store data and program?
- How to move data from one place to another.