Computer Organization & Architecture

Cybersecurity Department

Course Code: ***CBS219***

Lecture 1: Course overview & Introduction to Computer Organization and Architecture

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Agenda

- Course Overview & Objectives
- Assessment & Grading Policy
- Presentation Guidelines & Topics
- Submission Policy
- Classroom Rules & Expectations

Course Overview

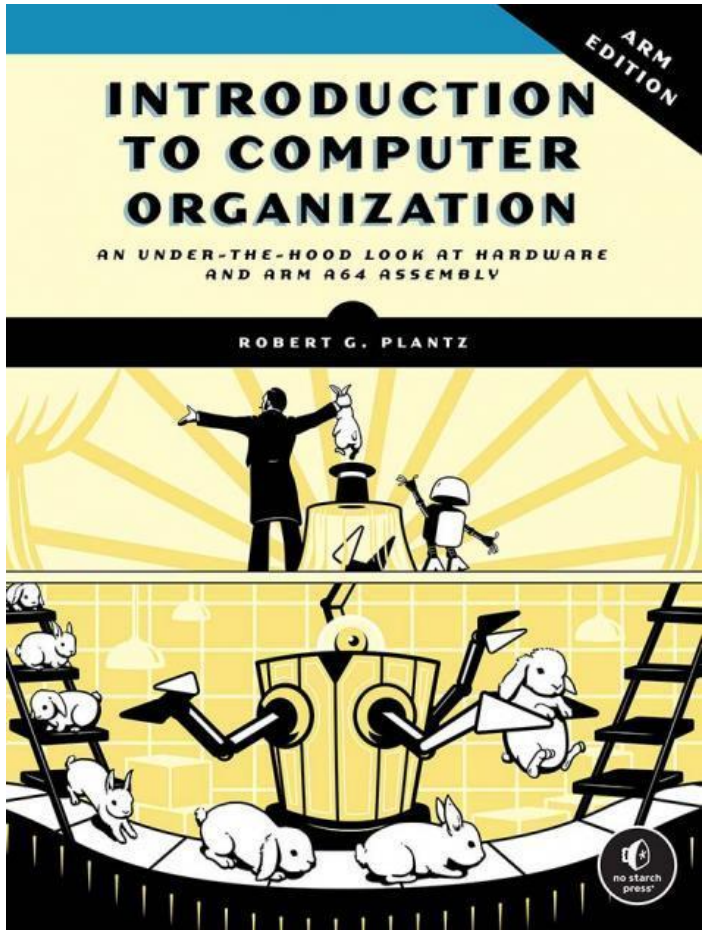
- This course provides a **theoretical understanding of how computers work internally** , focusing on the structure, organization, and functioning of computer hardware. You will learn how data is **represented, stored, and processed**, and how the **CPU, memory, and input/output systems** interact to execute instructions.
- The course also explains **number systems, logic gates, Boolean algebra, and instruction flow**, helping you understand how computers perform tasks at the hardware level.
- Emphasis is given to how this knowledge supports **system performance, efficiency, and cybersecurity awareness**.

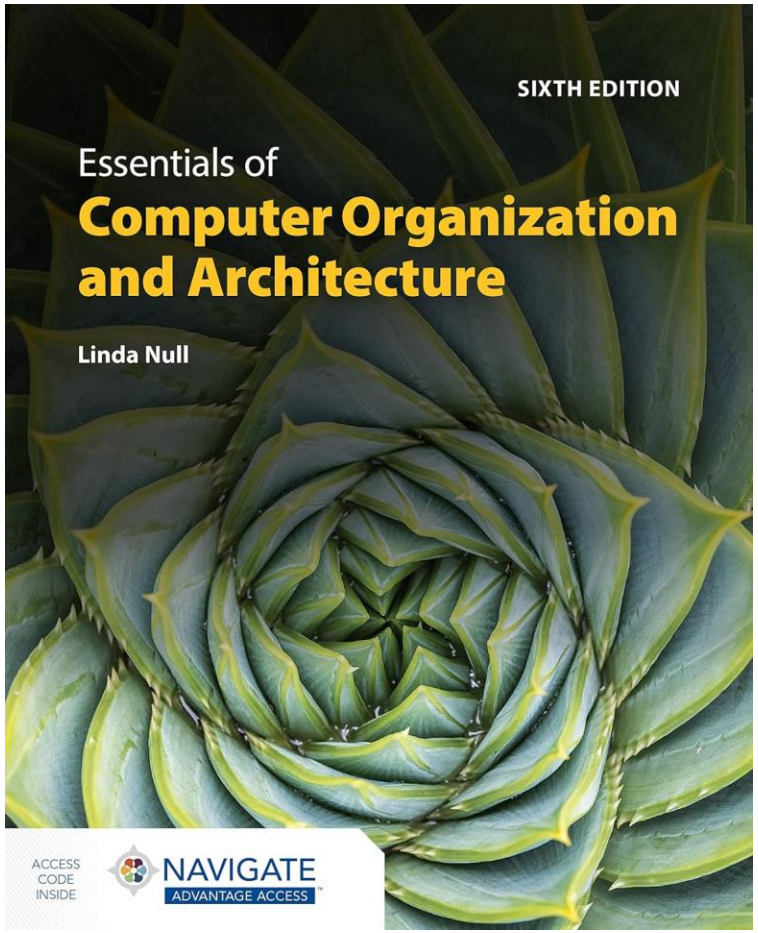
Lecture Learning Outcomes

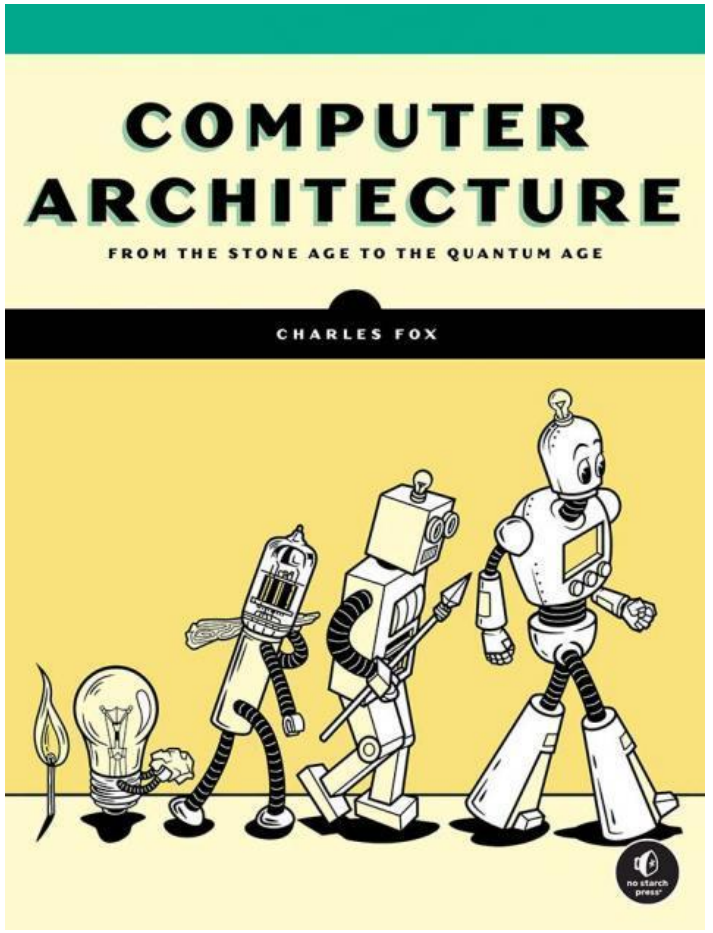
By the end of this lecture, students will be able to:

- Define Computer Organization and Computer Architecture and distinguish between them
- Identify and explain the main components of a computer system
- Describe the basic data flow using the input–process–output–storage model
- Explain the functional role of CPU, memory, I/O devices, and system bus
- Relate the importance of COA to system performance and cybersecurity

Course Materials







Assessment and Grading

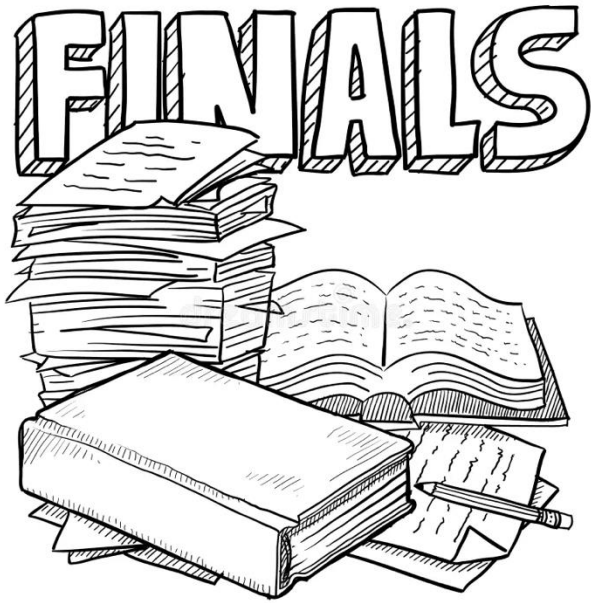
Assessment Type	Weight	Quantity
Quiz	20%	2-3
Assignments	10%	Through out the semester
Presentation	10%	1
Midterm Exam	20%	1
Final Exam	40%	1

Exam Format (Midterm & Final)

- Covers all **theoretical materials/topics** they are paper based exams.

Exam questions may include:

- Short answers
- Definitions & Explanations
- Scenario-based questions
- Multiple-choice questions
- True or False
- Problem-solving tasks



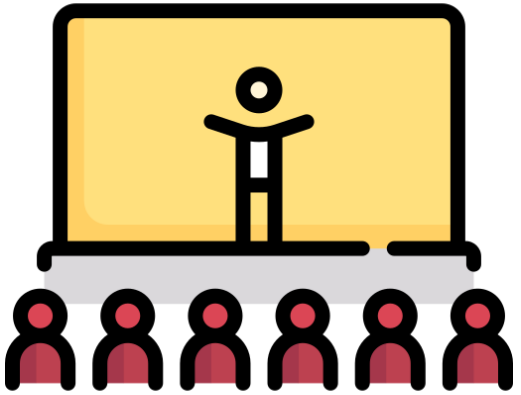
Quiz Format

- Short and simple
- 10–15 minutes only
- Small tasks
- Checks weekly understanding

Assignment

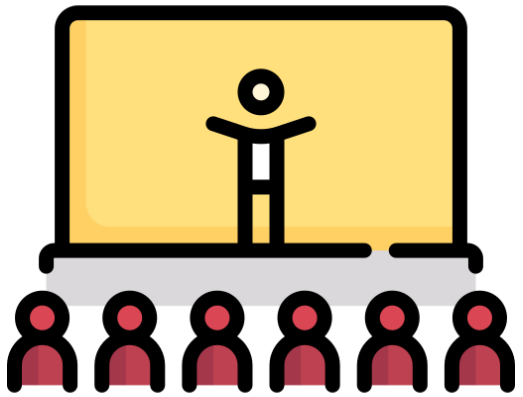
- Work in groups of 3–4
- Every couple of weeks we will have a mini project.
- Submit it by the deadline. **No extensions allowed.**

Presentation Guidelines



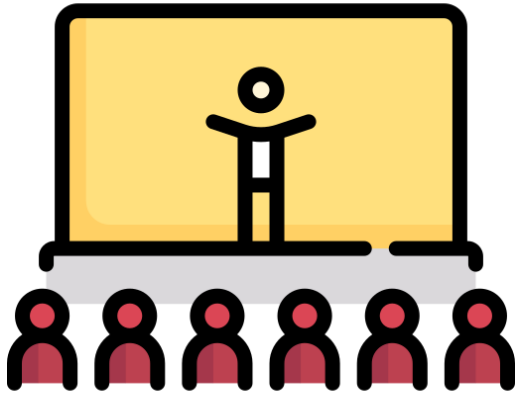
- **Form groups of 6 students.**
- **Choose ONE topic** within your group (first come, first served).
- **Inform the Class Representative**:
  - Class Rep writes **all groups**, **all member names**, and the **chosen topic, and sends full list in one single email by 19 October 2025**.
- **Time:** 20 minutes per group → **15 min** presentation + **5 min** Q&A.
- **Submit slides via Google Classroom only.**
- **Deadline: 27 November 2025.**
- **Everyone presents.**

Presentation Topics



- Evolution of Computer Architecture
- Von Neumann vs. Harvard Architecture
- Structure and Function of a Computer
- CPU Organization and Components
- Memory Hierarchy in Computer Systems
- Cache Memory and Mapping Techniques
- Instruction Cycle and Pipelining
- Instruction Set Architecture (ISA)
- Number Systems and Data Representation
- Amdahl’s Law and System Performance

Presentation Topics



- Bus Architecture and Data Interconnection
- Main Memory and Storage Technologies
- RAID and Data Reliability
- Input/Output Organization and Interrupts
- RISC vs. CISC Architectures
- Multicore and Parallel Processing
- Microprogrammed vs. Hardwired Control Units
- Embedded Systems and ARM Architecture
- Hardware and Security Vulnerabilities (e.g., Spectre, Meltdown)
- Future Trends: Quantum and Neuromorphic Computing

Submission Policy

- Submit via **Google Classroom** only.
- **No late** submissions, and **no extensions** allowed.
- **Not** more than **25% AI-generated content** is allowed.
- Marks deducted for plagiarism.

Classroom Rules

- **Arrive on Time**: Students arriving **more than 5 minutes late** will not be allowed to enter and will be marked absent.
- **Attendance Matters**: Absences are recorded and may affect grades.
- **Respectful Environment**: Maintain silence, avoid distractions, and respect classmates and the instructor.
- **Devices Policy**: Phones and laptops should only be used for class activities.
- **Assignments & Exams**: Must be submitted/completed on time. No late submissions.
- **Academic Integrity:** Cheating or plagiarism is strictly prohibited.
- **Privacy Rule**: **Recording videos or taking photos without permission is not allowed.**

Contact Information

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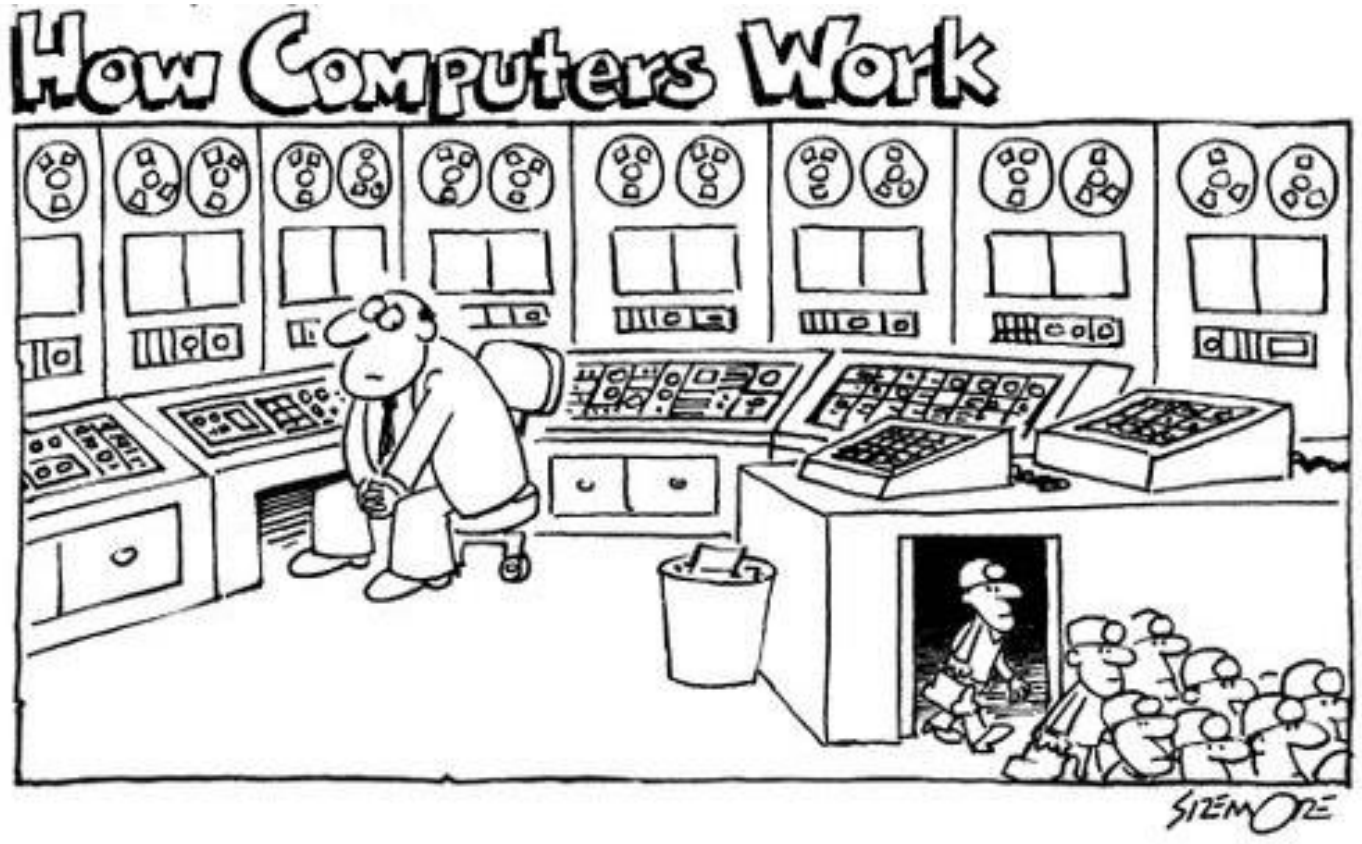
Office Hours: Main Building – Room 321

Computer Organization & Architecture



What is Computer Organization & Architecture?

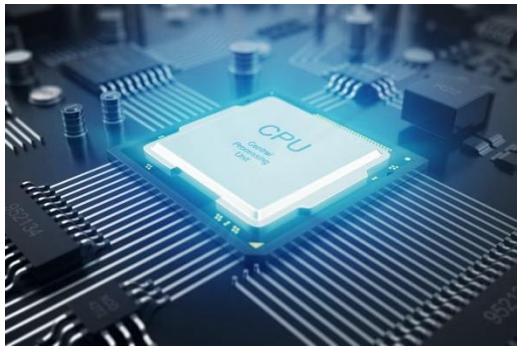
- **Computer Organization and Architecture (COA)** is the study of how computers are built and how they work internally. It explains **how hardware components interact** and **how instructions are executed** to perform tasks such as typing, gaming, or browsing the web.

- COA connects **hardware** (the physical parts you can touch) and **software** (the programs you use). **Architecture** describes **what** a computer does, and **organization** describes **how** it does it.

Why We Study COA?

Understanding COA helps you:

- Know **how computers actually work** behind the screen.
- Learn **how to make software run faster and more efficiently**.
- Diagnose and fix **hardware and performance problems**.
- Understand the **relationship between security and hardware**.
- Build a foundation for advanced courses like:
  - Operating Systems
  - Networking
  - Computer Architecture
  - Cybersecurity



COA explains how that data moves from the **keyboard → CPU → memory → screen**.

Difference Between Computer Organization and Computer Architecture

Aspect	Computer Architecture	Computer Organization
Meaning	Logical design of a computer system, what it does	Physical structure, how it is built and works
Focus	Programmer's view (instruction set, memory addressing, data formats)	Hardware designer's view (circuit design, signals, connections)
Example	Defines how many bits per instruction, or what operations CPU supports	Explains how data moves through buses and how signals control devices

Basic Components of a Computer System

A computer is made up of several main parts that work together to perform tasks. Let's understand each one clearly.

1. **Central Processing Unit (CPU) – The Brain of the Computer**
2. **Memory Unit – The Storage Area**
3. **Input/Output Devices – Communication with the User**
4. **System Bus – The Communication Path**

Central Processing Unit (CPU)

- The **CPU** is responsible for executing all instructions given to the computer. It performs all **processing** and **controls** the flow of data.

Main Parts of CPU:

- **Arithmetic Logic Unit (ALU):** performs all arithmetic (add, subtract) and logical (AND, OR, compare) operations.
- **Control Unit (CU)**: directs all operations by sending control signals to other parts.
- **Registers**: small high-speed storage inside CPU that temporarily hold data and instructions.

Memory Unit

- Memory stores **data**, **programs**, and **instructions** that the CPU needs to process.

Type	Description	Example
Primary Memory	Directly accessible by CPU	RAM, ROM
Secondary Memory	Used for long-term storage	Hard Disk, SSD
Cache Memory	High-speed temporary memory near CPU	L1, L2 cache

- **RAM (Random Access Memory)**: temporary storage; data is lost when the power is off.
- **ROM (Read-Only Memory)**: permanent; stores startup instructions.
- **Cache:** very fast memory used to speed up CPU operations.

Input/Output Devices

These devices allow data to enter or leave the computer system.

Type	Function	Examples
Input Devices	Send data to the computer	Keyboard, Mouse, Scanner, Microphone
Output Devices	Display results to the user	Monitor, Printer, Speaker

Practice Exercise 1

Seema withdraws cash from an **ATM** machine using her debit card. Answer the following:

- Identify the **hardware** used in this process.
- Classify the types of **software** involved.

Practice Exercise 1 – Answer

Hardware

Input Devices

- Card Reader (for reading debit card)
- Keypad (for entering PIN)
- Touchscreen (if available)

Output Devices

- Display Screen (for showing instructions)
- Cash Dispenser (for dispensing money)
- Receipt Printer (for printing transaction)
- Speaker (optional audio feedback)

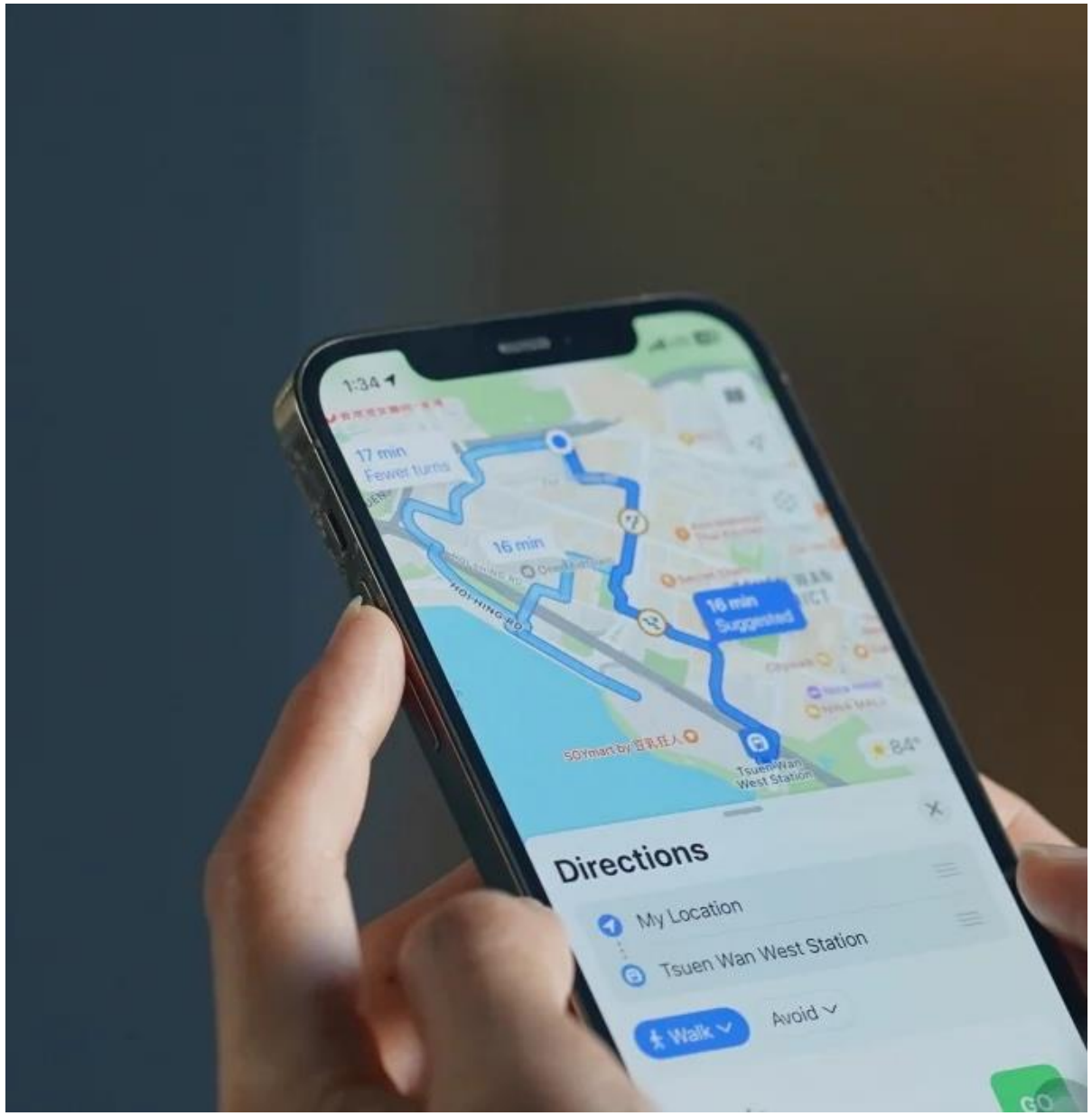
Software

System Software

- ATM Operating System (ATMOS))

Application Software

- Banking Software App



Practice Exercise 2

Sarmad uses **Google Maps** on his **smartphone** to find the fastest route to a restaurant. Answer the following:

- Identify the **hardware** used in this process.
- Classify the types of **software** involved.

Practice Exercise 2 – Answer

Smartphone used: ***iPhone***

Hardware (iPhone)

Input Devices

- Touchscreen (for typing)
- Microphone (for voice commands)

Output Devices

- Touchscreen (for showing Google Maps result)
- Speaker (gives voice directions)

Software

System Software

- iOS (Apple's operating system)

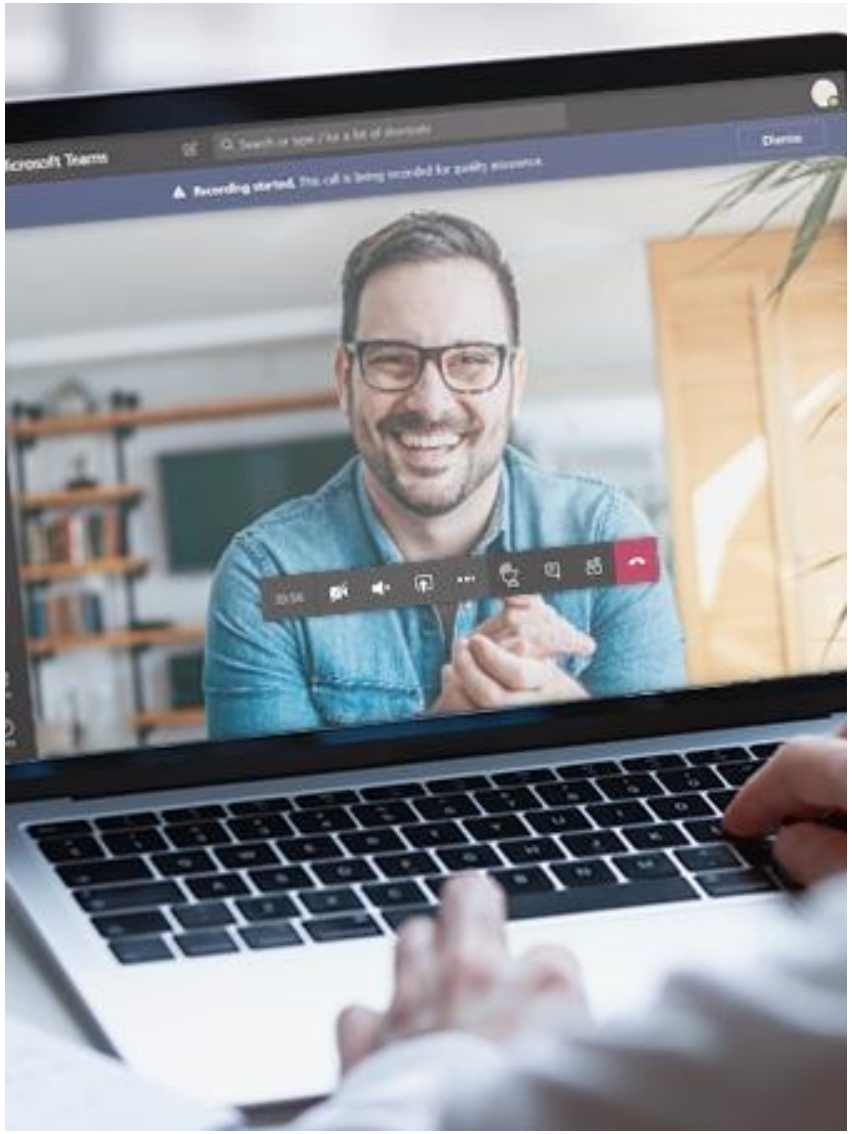
Application Software

- Google Maps App

Practice Exercise 3

A student uses her **laptop** to attend an online lecture through the **Microsoft Teams** app. The student interacts with the instructor via video and by sharing a presentation. Answer the following:

- Identify the **hardware** used in this process.
- Classify the types of **software** involved.



Practice Exercise 3 – Answer

Hardware

Input Devices

- Keyboard (for typing)
- Microphone (for voice interaction)
- Mouse (for navigation)
- Webcam (for video communication)

Output Devices

- Screen (displays the lecture and slides)

Software

System Software

- Windows 11 Operating System

Application Software

- Microsoft Teams App
- Microsoft PowerPoint (for presenting slides)

System Bus

- The **System Bus** is like a **highway** that connects all components together (CPU, memory, input/output).
- It transfers data, addresses, and control signals.

Bus Type	Description
Data Bus	Transfers actual data between CPU and memory
Address Bus	Carries the address of data in memory
Control Bus	Sends control signals (read/write, interrupt)

Example:
When CPU needs data from memory:
•It sends the **address** through Address Bus,
•The **data** travels back through Data Bus,
•The **Control Bus** manages when to read or write.

How All Components Work Together

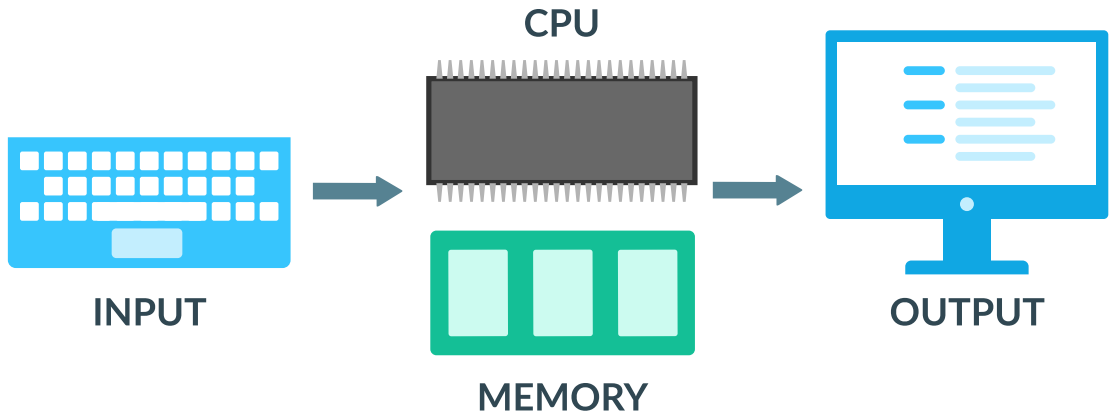
Let's see the **data flow** inside a computer step by step:

- **Input** → User provides data (e.g., typing or clicking).
- **Processing** → CPU processes data using instructions stored in memory.
- **Storage** → Results are saved in memory or disk.
- **Output** → Processed information is displayed to user.

Example:

When you search on Google:

- You type (input).
- CPU processes your request.
- Temporary data stored in RAM.
- Result shown on screen (output).



Importance of COA in Cybersecurity and IT

Understanding COA helps in:

- **Hardware-level security:** Detecting and preventing attacks like buffer overflow or hardware Trojans.
- **Performance optimization:** Making software compatible with hardware.
- **System configuration:** Choosing the right CPU, memory, and components for secure systems.
- **Troubleshooting:** Finding causes of system crashes, overheating, or slow performance.

References

- Plantz, R. G. (2020). Introduction to computer organization: An under-the-hood look at hardware and ARM64 assembly (ARM ed.). No Starch Press.
- Null, L., & Lobur, J. (2018). Essentials of computer organization and architecture (6th ed.). Jones & Bartlett Learning.


Any
Question