

Lecture 2

Learning outcomes:

- *The Basic computer system: Hardware basic concepts.*

What is a computer?

- A computer is a machine that can be programmed to automatically carry out sequences of *arithmetic* or *logical* operations (computation).
 - ✓ *Arithmetic operations* is a branch of mathematics, that involves the study of numbers, operation of numbers that are useful in all the other branches of mathematics. It basically comprises operations such as Addition, Subtraction, Multiplication and Division.
 - ✓ *A logical operator* is a symbol or word used to connect two or more expressions such that the value of the compound expression produced depends only on that of the original expressions and on the meaning of the operator. Common logical operators include AND, OR, and NOT.
- The computer is also defined as an electronic device that manipulates information, or data and it has the ability to store, retrieve, and process data.

Types of Computer

- ❑ There are two bases (size and data handling capabilities) on which we can define the types of computers.
- ❑ Here are some types of computers:
 - Super Computer
 - Mainframe computer
 - Mini Computer
 - Workstation Computer
 - ***Personal Computer (PC)***
 - Server Computer
 - Analog Computer
 - Digital Computer
 - Hybrid Computer
 - Tablets and Smartphone

Personal Computer (PC)



- A PC can be defined as a small, relatively inexpensive computer designed for an individual user.
- PCs are based on the microprocessor technology that enables manufacturers to put an entire Central Processing Unit (CPU) on one chip.
- Businesses use personal computers for word processing, accounting, desktop publishing, and for running spreadsheet and database management applications.
- At home, the most popular use for personal computers is playing games and surfing the Internet.
- Although personal computers are designed as single-user systems, these systems are normally linked together to form a network.

Computer System

- A basic computer system comprises **hardware**, the physical components like the CPU, memory (RAM), and storage (hard drives), and **software**, which includes the operating system (OS) and applications that direct the hardware to perform tasks.
- The system accepts input, processes data, stores information, and provides output, all managed by the operating system to serve user-specified functions.

Computer Hardware Basic Concepts

- ❑ **Computer hardware** refers to the physical parts of a computer and related devices that we can see and touch.
- The internal hardware parts of a computer are often referred to as components
- And the external hardware devices are usually called peripherals.

Types of Computer Hardware

❖ *In general, computer hardware components are divided into the following categories, which are:*

- Input Devices
- Output Devices
- Storage Devices
- Processing Devices

❑ Input devices:

An input device allows the user to interact directly with a computer, and these devices give data and instructions to the computer, such as:

- keyboards
- pointing devices (mouse)
- touchscreens
- touchpads
- tablet/pen input devices
- game controllers
- cameras
- microphones
- video capture devices
- scanners
- optical readers
- biometric devices
- data collection devices

DEVICE	USES	PHOTO
Game controllers	Game controllers are input devices designed specifically for use in games. They have directional inputs as well as action buttons linked to specific actions inside a game.	
Cameras	Cameras allow you to capture images. They are used for making video calls, participating in video conferences and recording videos from your computer.	
Microphones	Microphones allow you to record sounds and interact with a computer using your voice.	
Video capture devices	Video capture devices allow you to record a live video stream using your computer.	
Scanners	Scanners allow you to scan pictures of pages (such as, photos or contracts) directly onto your computer. Scanners are often packaged with optical character recognition (OCR) software that converts the text on a picture to text that can be used in a word processing application.	
Optical readers	Optical readers are devices that can read data from a physical object (such as, a QR code, barcode or a magnetic strip) into a computer.	
Biometric devices	These devices read data presented to a computer and compare it with the saved data. Biometric devices include fingerprint, iris and retina scanners, but these are not commonly used with desktop computers.	
Data collection devices	Data collection devices obtain data directly from a location where an event or transaction takes place.	

Input Devices

- Acts as the initial point for data entry into the computer system.
- Comprises devices like keyboards, mice, and scanners.
- Converts raw data into machine-readable form.
- Transmits converted data to the computer's main memory.
- Facilitates the seamless exchange of information between users and computers.

❑ Output devices

- An output device is any device that takes data stored on a computer and makes it available to the user in an easy to understand way.
- This data may be made available using pictures (such as on a monitor or printed to a page) or using sounds (such as with speakers and earphones).
- The output devices can be divided into the following:
 - display devices – monitors (LCD, LED, OLED)
 - printers (Inkjet, Ink tank, Laser, 3-D)
 - data projectors (HDMI, VGA)
 - Speakers and headphones

❖ Display Devices – Monitors (LCD, LED, OLED)



- All computer software is built around a visual representation of data, therefore the monitor is one of the most important output devices for any computer.
- Light-emitting diode (LED) screens offer higher resolutions than Liquid Crystal Display (LCD) and can achieve better contrast ratios due to their backlighting system.
- On the other hand, Organic Light-emitting diode (OLED) displays have an even higher resolution than LED displays, as well as very good black levels and wide viewing angles.

❖ **Printers (Inkjet, Ink tank, Laser, 3-D)**

A printer allows a computer to use data and output it to paper.



❖ Data Projectors (HDMI, VGA)



- Projectors use a bright light to project the content displayed on a computer monitor onto any flat surface. One example of where projectors are used is at the cinema. They use large, high quality projectors to display the movie on the screen in front of you.
- However, projectors can also be connected to computers at home or in office settings, to display your computer's screen on a wall or screen.
- There are two types of cables connecting video output devices:
 - ✓ VGA – an analog video-only connection.
 - ✓ HDMI – a digital video audio connection.

❖ Speakers and Headphones

They are very popular output devices and give sound as output.



Closed-back headphones



It creates an isolated audio experience so that only you can hear the sounds you want to hear.

In-ear headphones



Known for portability, versatility, and convenience. They go a little more deeply into the ear to provide comfort, sound isolation, and sound accuracy.

Bluetooth headphones



Offer wireless connectivity to various devices through radio transmitter technology (RF). They have a small computer chip inside of them that allows you to pair with the device you are playing music from.

Output Devices

- Delivers processed information to users in readable formats.
- Includes devices like printers and monitors.
- Presents data as either soft copy (on-screen) or hard copy (on paper).
- Converts binary data into human-readable formats.
- Completes the cycle of information exchange by enabling users to interpret and utilize results effectively.

❑ Storage Devices

- Storage devices all serve the same general purpose: to store data. Because of the differences in storage capacity, portability and speed, different storage devices are generally used for different reasons.
- When evaluating any storage device, there are certain things that you must take into consideration. These are:
 - **function** – that determines whether you need an SSD or an HDD.
 - **storage capacity** – that determines how much information you can save on the device.
 - **portability** – that determines how easily it can be carried around and moved from one computer to another.
 - **use** – that determines what the storage device will most likely be used for. This includes transferring files and running applications.
 - **volatility** – that determines if the device will lose the data when turned off. You do not want a device that will lose all data in case of a power outage.
 - **reliability and durability** – that determines how likely the device is to break down.

Types of Storage Devices

❖ Hard Disk Drive (HDD)

- A computer hard disk drive is a secondary storage device consisting of magnetic disks or platters that rotate at high speed.
- Its main function is to store data permanently by controlling the positioning, reading and writing of data onto the hard disk.
- The main benefits of a Hard Disk Drive (HDD) are low cost per gigabyte, offering high storage capacities at an economical price, and long-term data longevity for data that isn't frequently accessed, making them ideal for bulk storage and backups.

❖ Solid-State Drive (SSD)



- Solid-state drives (or SSDs) are a type of storage device that, unlike hard drives, do not have any moving parts.
- Instead, SSDs make use of special floating gate transistors to store data electronically. Solid state drives (SSDs) are generally many times faster than normal hard drives.
- Since SSDs have no moving parts, they are much quieter, more reliable and robust than HDDs. They also generate less heat, thus increasing their life span, and uses less power than an HDD, which means they are more durable than HDDs and more suitable for mobile devices.

❖ Hybrid Storage Device

- A hybrid storage device is a storage device that combines an HDD with an SSD. By doing this, the hybrid storage device can take advantage of the storage capacity of the HDD as well as the speed of the SSD.
- Hybrid drives work by storing commonly used files that require high speeds (such as operating system files) on the faster SSD storage, while storing large, less commonly used files (such as media files) on the high capacity HDD.

❖ External (Portable) Hard Drives



- Portable (or external) hard drives are used outside of the computer case.
- Portable hard drives are a lot easier to move around than fixed hard drives. However, thanks to USB connectors, they can quickly be connected to different computers and are ideal for transferring large amounts of data or backing up data outside of your computer. They are sensitive to rough handling.

❖ Flash Drives (Disks)



- Flash drives are very small, portable storage drives that store information using a similar method to SSD.
- Flash drives connect to a USB port, which makes it easy to transfer data quickly between devices.

❖ SD/Memory Cards



- SD/Memory cards (especially MicroSD cards) are tiny electronic storage devices.
- Because of their small physical size, SD cards are often used in portable devices such as smartphones, tablets and cameras to provide storage capacity.

❖ CD, DVD and Blu-Ray Drives

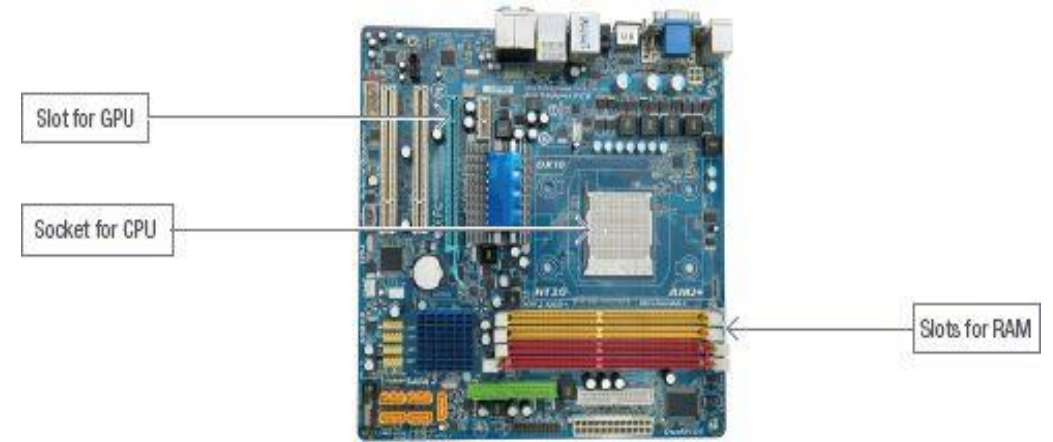


- CDs (compact discs), DVDs (digital versatile disc) and Blu-ray discs are popular portable forms of storage that can be read using a dedicated CD, DVD or Blu-ray drive. These discs store information optically, which means the information is stored using lights or electromagnetic waves.
- The advantage of writing data to CDs or DVDs is that the discs are affordable. These optical drives are also backwards compatible. This means that a newer optical drive (like a Blu-ray drive), can read all older optical forms (like CDs and DVDs). However, an older optical drive (like a CD drive) can only read CDs.

❖ Processing Devices

- The processing devices are the computer hardware components that help to handle the processing of the information, storage and retrieval process of the information.
- *There are different types of processing devices for computers such as:*
 - ✓ Motherboard
 - ✓ CPU - GPU
 - ✓ Memory

❑ Motherboard

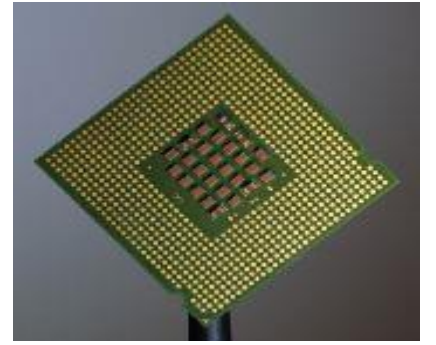


- A computer's motherboard is a large printed circuit board that physically connects all the different components.
- On the motherboard, there are specific positions where the CPU, GPU and RAM can be inserted.
- There are also connectors that allow you to connect a power supply to a computer.
- In addition, the motherboard has several ports that allow you to plug in devices, such as keyboards, speakers and monitors easily.

▪ *The functions of the motherboard is to:*

- Provide a place for other devices or interfaces to be connected to (such as more memory or another graphics cards).
- Distribute power to the various components.
- Act as a communication hub as the components send and receive information through the motherboard.

❑ Central Processing Unit (CPU)-The microprocessor



- The central processing unit (CPU) is located inside the computer case on the motherboard. It is the part of a computer responsible for receiving and carrying out computer instructions (processing).
- Each CPU can be made up of multiple cores, which are independent processing units that can complete tasks on their own (multithreading vs multiprocessing). By adding multiple cores to a CPU, the processing power available to the computer can increase dramatically, with little heat gain. These types of processors are called multi-core processors.

- The CPU is also known as the heart of the computer. It consists of three units, generally known as the Control Unit (CU), Arithmetic Logical Unit (ALU), and the Memory Unit.
- **The Control Unit** is the part of the computer's central processing unit (CPU), which directs the operation of the processor.
- It is the responsibility of the control unit to tell the computer's memory, arithmetic/logic unit, and input and output devices how to respond to the instructions that have been sent to the processor.

- It fetches internal instructions of the programs from the main memory to the processor instruction register, and based on this register contents, the control unit generates a control signal that supervises the execution of these instructions.
- A control unit works by receiving input information which it converts into control signals, which are then sent to the central processor.
- The computer's processor then tells the attached hardware what operations to perform.
- The functions that a control unit performs are dependent on the type of CPU because the architecture of the CPU varies from manufacturer to manufacturer

- **Arithmetic logic unit (ALU)** is a digital circuit that provides arithmetic and logic operations.
 - It is the fundamental building block of the central processing unit of a computer.

- **Memory devices** are digital systems that store data either temporarily or for a long term.
 - Digital computers to hard disks have built-in memory devices that can store the data of users or manufacturers.

Central Processing Unit (CPU)

- Often referred to as the brain of the computer, the CPU executes instructions, performs calculations, and manages data manipulation.
- Functions as the computer's “brain,” overseeing all tasks and operations.
- Executes arithmetic and logical operations.
- Controls data processing, software operations, and hardware interactions.
- Consists of the Arithmetic Logic Unit (ALU), Control Unit (CU) and Memory.

■ **Graphics Processing Unit (GPU)**



- The graphics processing unit (GPU) is located on plug-in cards on the motherboard or in the same chip as the CPU.
- It is responsible for creating and doing the calculations needed to display images on the screen.

□ Memory



- Memory is the electronic holding place for the instructions and data a computer needs to reach quickly. It's where information is stored for immediate use. It refers to the components where data is stored temporarily (RAM) or permanently (ROM, hard drives, etc.).
- Memory is one of the basic functions of a computer, because without it, a computer would not be able to function properly.
- Memory is also used by a computer's operating system, hardware and software.

- There are technically two types of computer memory: primary (RAM and ROM) and secondary (storage devices).
- Primary memory is built inside the computer. As a result, data can be read from and written to primary memory extremely quickly. This gives the processor fast access to the data and instructions that the primary memory holds.
- **The types of primary memory:**
 - *Random access memory (RAM)*
 - *Read only memory (ROM)*

- **Random-access memory (RAM)**, is physical hardware that temporarily saves data.
 - ✓ It serves as the computer's 'working' memory. RAM provides space for your computer to read and write data to be accessed by the CPU.
 - ✓ RAM is volatile, meaning that all data is lost once the electricity is disconnected or the power is lost.

- **Read Only Memory (ROM)**, It is more permanent than RAM.
 - ✓ Data stored in these chips is non-volatile -- it is not lost when power is removed. Data stored in these chips is either unchangeable or requires a special operation to change.

Memory vs. Storage

- When comparing memory and storage, we first need to identify the role of the components.
- The computer's main memory is the RAM. You can think of RAM as a workspace or workbench the computer uses to get work done. When you double-click on an app, or open a document, or do almost anything on your computer, RAM gets used to store the code of the app and the data while the processor (CPU) is working on it.
- The storage unit i.e. HDD, SSD or Flash drive, by contrast, is the cupboard or storage shelf you might use to permanently store your tools, apps, data and completed work. So, when the task is complete and you click save in the app, the resulting output is stored permanently on the storage unit.

Comparison Between Primary Memory (RAM) and Secondary Memory (storage devices):

Feature	Primary Memory (RAM)	Secondary Memory
Volatility	Volatile (data lost when power is off)	Non-volatile (data retained when power is off)
Access Speed	Faster	Slower
Capacity	Limited (a few GBs to tens of GBs)	Large (hundreds of GBs to TBs or more)
Cost	More expensive per GB	Cheaper per GB
Usage	Temporary storage for active processes	Long-term storage for data and programs

Ports: Means of connecting peripheral devices to your computer.

- **Monitor Ports** – Used to connect a monitor to the computer.

- PCs usually use a *VGA* (Video Graphics Array) analog connector (also known as a D-Sub connector) that has 15 pins in three rows. Typically blue in colour.



- Or *HDMI* (a digital video audio connection) which is a widely adopted and widely used standard for connecting audio-video devices, such as TVs, computer monitors, and Blu-ray players.



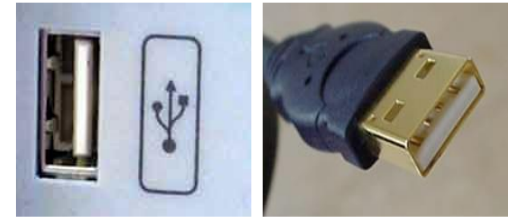
❑ NOTE:

- ✓ **VGA:** Supports lower resolutions by modern standards, typically up to 1080p (1920x1080), though it was originally designed for 640x480. The analog nature can cause a loss of image sharpness, especially at higher resolutions.
- ✓ **HDMI:** Supports much higher resolutions, from 1080p up to 4K and beyond. HDMI maintains perfect video quality due to its digital transmission.

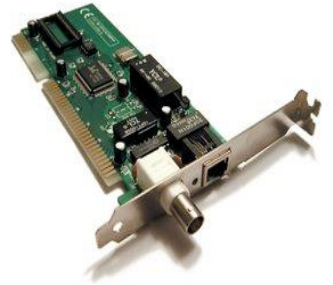
- **Parallel Port** – Most often used to connect a printer to the computer. 25-pin connector. Long and skinny, often pink in colour. Transmits data at 50-100 Kb/s.



- **USB Port** – Universal Serial Bus. Now used to connect almost all peripheral devices to the computer. USB 1.1 transmits data at 1.5 Mb/s at low speed, 12 Mb/s at full speed. USB 2.0 transmits data at 480 Mb/s.



- **Network Card** – Used to provide a computer connection over a network. Transmit data at 10/100/1000 Mb/s.
- **Ethernet Port** – This port is used for networking and fast internet connections. Data moves through them at speeds of either 10 megabits or 100 megabits or 1 gigabit (1,000 megabits) depending on what speed the network card in the computer supports. Little monitor lights on these devices flicker when in use.
- **Power Supply** – Gives your computer power by converting alternating current (AC) supplied by the wall connection to direct current (DC).



A functional System Diagram of a Computer

- ❖ The basic functional components or elements of a digital computer system basically have the hardware and software.
- The hardware is the physical component/part such as a keyboard, mouse, monitor, etc.
- The software is the set of programs and instructions that perform several specific operations.

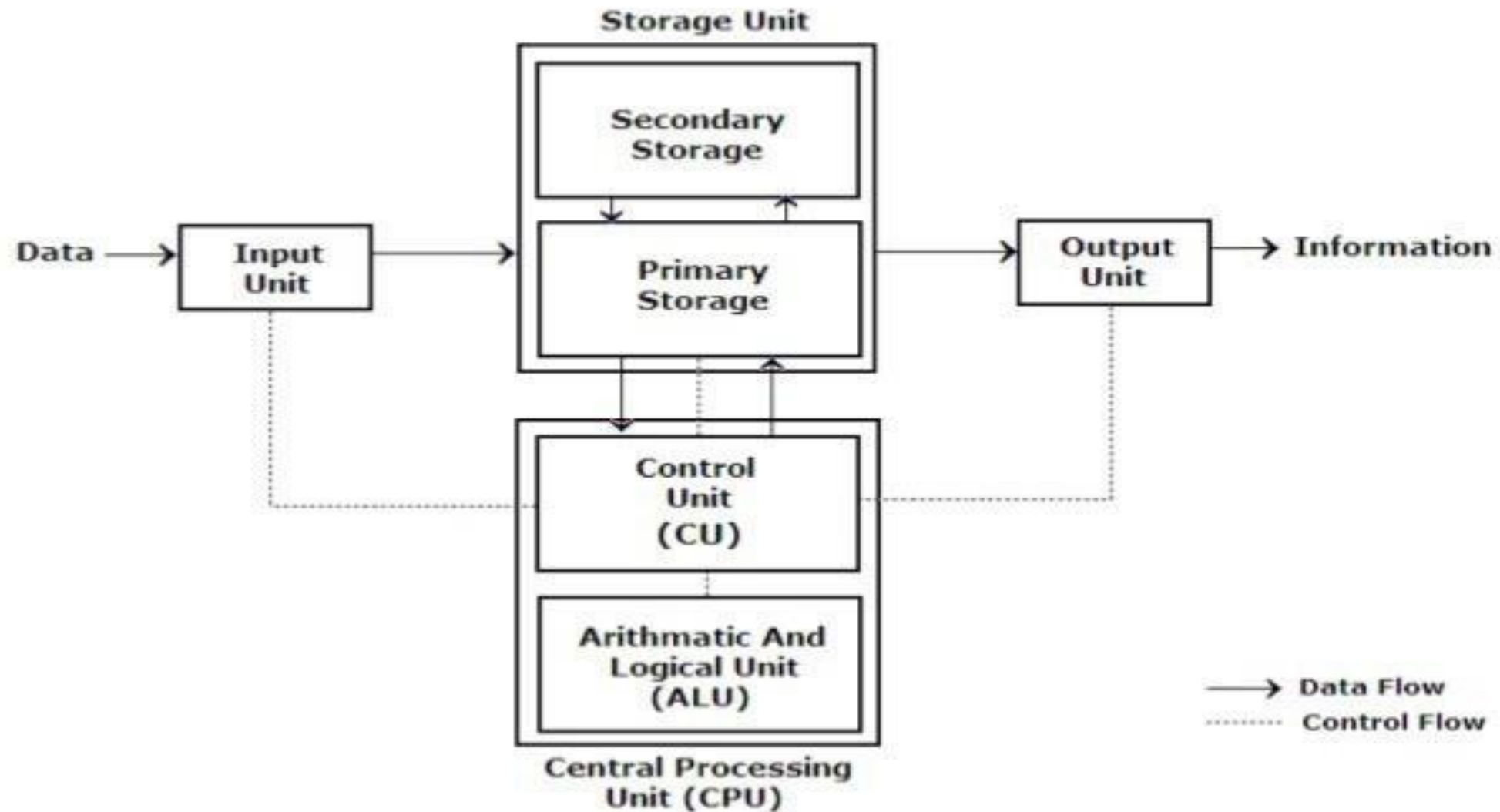
What is Block Diagram of Computer System?

- The Block Diagram of a Computer shows how data and instructions flow between the CPU, memory, and I/O devices, managed by the Control Unit.
- Simply put, it explains how computers work, from taking input, processing it, to giving the desired output.

Components of a Computer's Block Diagram

- Input Unit
- Output Unit
- Central Processing Unit (CPU)
- Control Unit (CU)
- Arithmetic and Logic Unit (ALU)
- Memory Unit a) Primary Memory b)Secondary Memory

Block diagram of computer



- ✓ As shown in the diagram input is given to the CPU through input devices.
- ✓ This input goes to memory and the control unit gets instructions from memory.
- ✓ The control unit now decides what to do with the input or instructions and transfers it to ALU.
- ✓ Now, ALU performs various operations like addition, subtraction, multiplication, division, logical operations, etc.
- ✓ After that, the final result gets stored in memory and finally passed to output devices to give the output.
- *So, this is how the CPU works.*

Bus System

❖ **Bus System:** The bus system consists of a set of communication pathways that enable data transfer between different components of the computer. It facilitates the exchange of information between the CPU, memory, input/output devices, and other peripherals. This can include:

- Data Bus: Carries the actual data.
- Address Bus: Carries the address where the data needs to go.
- Control Bus: Carries control signals.

❖ What is bus on RAM?

- System RAM speed is controlled by bus width and bus speed.
- Bus width refers to the number of bits that can be sent to the CPU, and bus speed refers to the number of times a group of bits can be sent each second.
- A bus cycle occurs every time data travels from memory to the CPU.