

CMP 104 – COMPUTER SYSTEM DESIGN (3 UNITS)

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Lecture Hours/Grading Policy

- **Lecture hours**
 - **Mondays:** 1:00PM - 3:00 PM
 - **Venue:** NLT
- Attendance: **5%**
- Mid Semester Tests: **20%**
- Practical, Assignments, term paper, review articles, etc.: **15%**
- End of Semester Exam: **60%**
- **NOTE:** A strict **70% Attendance** is mandatory for sitting for the Semester Exam.

Course Contents (Part 1)

- Introduction
- The Need for Acquiring PC Building Skills
- Overview of the Basic Structure of a Computer System
- Simple Overview and Identification of Computer Hardware Components in use: The Chassis, Power Pack, Motherboard, Floppy Disk Drive, Hard Disk Drive, CD-Rom Drive, Keyboard, Mouse, Video Card, Processor, Monitor, Memory (RAM)
- PC Assembly: Procedure for setting up a PC
- PC Disassembly: Pulling a system apart
- PC Care and Maintenance
- Diagnosis of Common PC faults

Course Contents (Part 2)

- Setting up an Operating System, Installing Windows
- Creating Partitions and Logical Drives, Active Partitions, Delete Partitions
- Troubleshooting, Regular Preventative Maintenance of whole system, Breakdown Maintenance
- Diagnostic Charts; System, Display, Power Supply, Boot up, Hard drive, FDD, Serial Port;
- Basic use of Multi-Meter

PART I

- INTRODUCTION

What is a SYSTEM?

- A **set of interconnected components** that has an expected behaviour observed at the **interface** with its **environment**.
- A system is a collection of elements or components that are organized for a common purpose.
- A system is a group of interacting or interrelated entities that form a unified whole. A system is delineated by its spatial and temporal boundaries, surrounded and influenced by its environment, described by its structure and purpose and expressed in its functioning.

Elements of a SYSTEM?

- **COMPONENTS**
 - The individual parts of a system: constituting the system.
- **ENVIRONMENT**
- Things that are not part, but could influence the behaviour of the system.
- **INTERFACE**
 - The interaction between a system and its environment
 - Primary interface of a personal computer include:
 - Display
 - Keyboard
 - Speaker
 - Network connection
 - Power cord
 - Atmospheric pressure
 - Ambient temperature
 - Humidity
 - Electromagnetic noise environment

SYSTEM

- **A SYSTEM**

- We are interested in systems that are predominately digital.

- **EXAMPLES**

- The personal computer
- The onboard engine controller of automobile
- The telephone system
- The internet
- An airline ticket reservation system
- The space shuttle ground control system
- A world wide web

What is Computer System?

- A system intended to store, process or communicate information under automatic control.
- It is an **electronic device** that not only stores data but also processes and manipulates data to carry out functions. Upon receiving valid instructions, a computer can perform a variety of operations.
- A computer system is a set of **integrated devices** that input, process, output and store data and information.
- Computer systems are currently built around at least one digital processing device. There are five main hardware components in a computer system: *Input, Processing, Storage, Output and Communication devices*.

SUB SYSTEM

- **SUB SYSTEM**
 - A system that is in one context, a component of another system
 - Examples of computer system sub systems are
 - Hardware system
 - Software system
 - i/o system
 - Memory system
 - Processor system
- To Analyse a system, determine
 - what things constitute the components of the system
 - what the granularity (size) of the components should be
 - where the boundary of the system lies
 - the environment of interest of the system.

COMPUTER SYSTEM DESIGN

- A computer (Hardware) system consists of a processor, memory, I/O, and the interconnections among these major components.
- A computer system Design:
 - Is the process of **defining** the architecture, components, modules, interfaces, and data for a computer **system** to satisfy specified requirements.

PERSONAL COMPUTER (PC)

- A personal computer (PC) is a small computer with a microprocessor, designed for use by an individual.
- A personal computer (PC) is a multi-purpose computer whose size, capabilities, and price make it feasible for individual use.
- A personal computer is a general-purpose, cost-effective computer that is designed to be used by a single end-user. Every PC is dependent on microprocessor technology, which allows PC makers to set the entire central processing unit (CPU) on a single chip.
- PC is a computer with its own operating system and a wide selection of software, intended to be used by one person.
- A PC can be a microcomputer, desktop computer, a laptop computer, a tablet PC, notebooks or a handheld PC etc. *This course will focus on desktops and laptops/notebooks.*

PERSONAL COMPUTER (PC)

- You must be wondering, how we were able to squeeze down all the electronic circuits into smaller and smaller packages to the modern design where laptops are mere fraction of inches thick and very lightweight. The invention of **Integrated Circuits** in 1958 made it all possible.
- An **integrated circuit** (also called an **IC** or just a **chip**) is a complete electronic circuit consisting of more than one individual components such as transistors, diodes, resistors, capacitors, and the conductive pathways that connect all the components, all made from a single piece of **silicon crystal**.

THE NEED FOR ACQUIRING PERSONAL COMPUTER (PC) BUILDING SKILLS

- ❖ Knowing how to build your own computer can benefit you in more ways than you may realize. Some of these ways are:
 - 1. **It saves you a lot of money:** Most people go out in search of a computer based on what they use it for and let the salesmen lead you into buying what they want to sell you. The salesmen usually know their stuff and also know that what they are selling to you may either be a piece of garbage or an overpriced unit.
 - 2. **You have a full understanding of the Hardware and other internal components:** building it yourself allows you first-hand knowledge of the components inside the tower and where they go. Buying custom parts also gives you warranties on the individual components through the manufacturers that may be far better than what a prebuilt PC warranty may offer.
 - 3. **It prevents you from being cheated:** knowing how to build your pc helps you to identify all the original internal components, which saves you from being cheated by people who sell sub-standard and fake components.

THE NEED FOR ACQUIRING PERSONAL COMPUTER (PC) BUILDING SKILLS

- 4. **It affords you the opportunity of understanding all the details of computer configuration:** most people do not understand what all of this computer statistics means. To sum it up the processor processes the information and a dual or quad-core or better means that it has multiple processors to process information faster.
- 5. **You own all the component parts with their drivers:** Among the benefits of purchasing your own parts to build a PC, each part will have a disc with its drivers and sometimes bonus software. Drivers are what tells the part how to function and where to send information, and so on.
- 6. **Fault diagnosis is easy:** Having owner's manuals for nearly every part in your PC makes it great because it becomes easier to diagnose what has gone wrong with your unit if ever it crashes or stops working.

THE NEED FOR ACQUIRING PERSONAL COMPUTER (PC) BUILDING SKILLS

- 7. **It can be a source of income for you:** knowing how to do it can be a source of income for you or even make you an employer of labour most especially in recent times when white-collar jobs are not readily available.
- 8. **It is fun doing it yourself:** You can pay someone to assemble these components which may put you over our target price or you can do it yourself. It is a delicate process but fun to learn. You need to make sure you are in a static free zone, preferably on the kitchen floor wearing no socks. You will need tiny assembly tools for the mounting screws or the right sized screwdriver if you own one. Follow installation directions which also come with your components.
- 9. **As a computer scientist, it is just in order for you to know it:** computer science is your discipline and computers are the major tools you will be dealing with; it is therefore important for you to know all the basics about building a computer.

THE NEED FOR ACQUIRING PERSONAL COMPUTER (PC) BUILDING SKILLS

Assignment

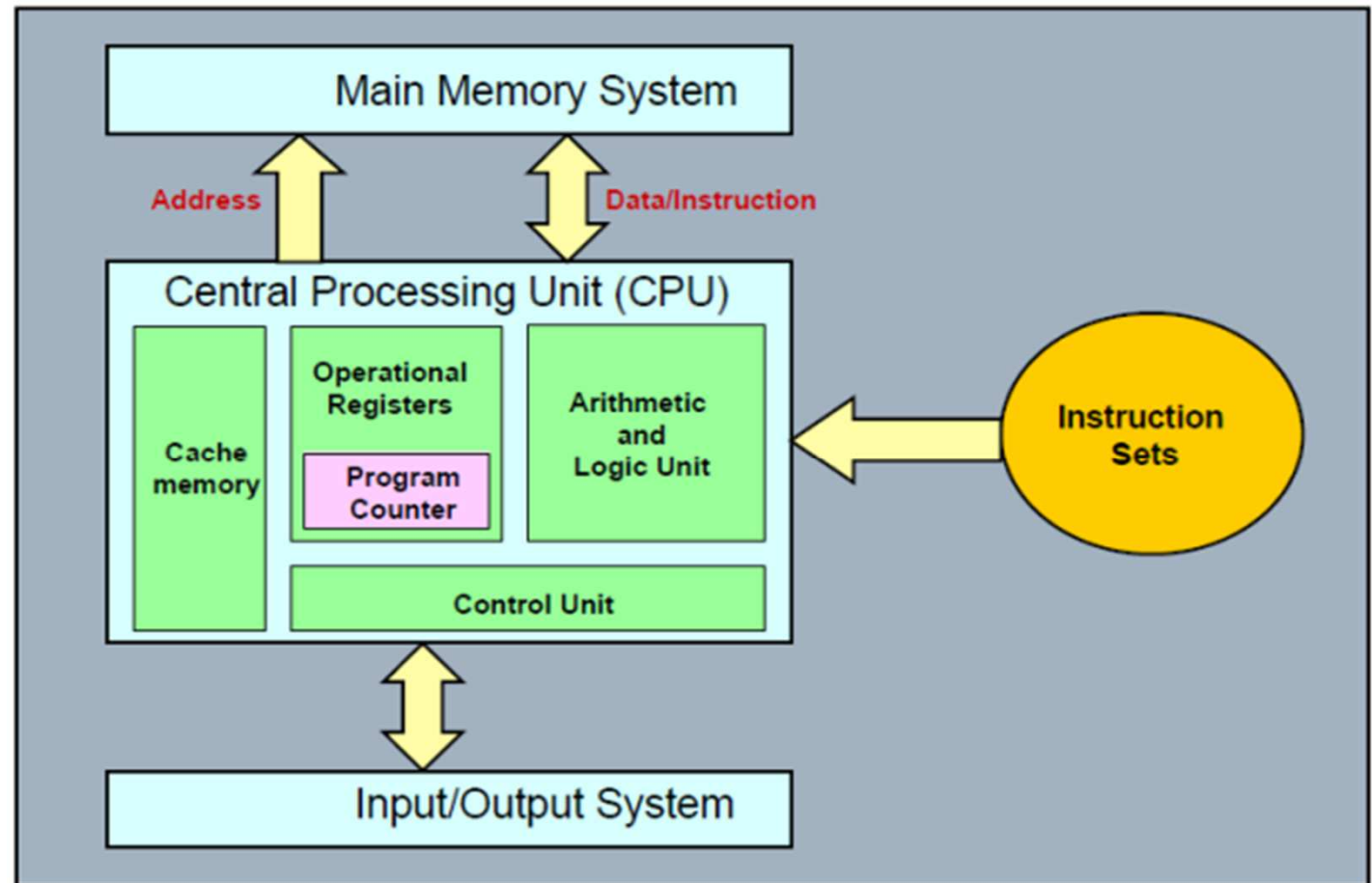
- Find out other reasons why you need PC building skills.

THE BASIC STRUCTURE OF A COMPUTER SYSTEM

- A computer is based on **three main structures**. They are input/output, process and storage.
- In other words, a PC consists of three main parts. They are:
 - 1. An Input/output (I/O) system
 - 2. A processor – Central Processing Unit (CPU)
 - 3. A main-memory system (Storage)

THE BASIC STRUCTURE OF A COMPUTER SYSTEM

- These functional units of a PC are thus described by the diagram below.



Information handled by a computer

❖ The information handled by a computer are:

✓ **Instructions**

- They govern the transfer of information within a computer as well as between the computer and its I/O devices
- They specify the arithmetic and logic operations to be performed

✓ **Data**

- Numbers and encoded characters that are used as operands by the instructions

Input Unit

- **Input unit** connects the external environment with internal computer system. It provides data and instructions to the computer system. Commonly used input devices are keyboard, mouse, magnetic tape etc.
- Data and Instructions are fed into the computer through this unit.
- **Input unit performs following tasks:**
 - ✓ Accepts the data and instructions from the outside environment.
 - ✓ Converts it into machine readable format.
 - ✓ Supplies the converted data to computer system.

Output Unit

- It connects the internal system of a computer to the external environment. It provides the results of any computation, or instructions to the outside world. Some output devices are printers, monitor etc.
- The results of processed data or information is sent to the user through this unit.

Memory Unit (Storage Unit)

- **Memory** is the storage area in which programs are kept when they are running and that contains the data needed by the running programs.
- This unit holds the data and instructions. It also stores the intermediate results before these are sent to the output devices. It also stores the data for later use.

❖Types of memory

- ✓ **Volatile memory:** storage that retains data only if it is receiving power, such as dynamic random access memory (DRAM)
- ✓ **Non-volatile memory:** a form of memory that retains data even in the absence of a power source and that is used to store programs between runs, such as flash memory

Memory Unit (Storage Unit)

❖ Classes of Memory

The storage unit of a computer system can be divided into two classes or categories:

- ✓ **Primary memory (Primary Storage):** it is also called the main memory. It is a volatile memory used to hold programs while they are running (during execution); typically consists of DRAM in today's computers.
- This memory is used to store the data which is being currently executed.
- It is used for temporary storage of data. The data is lost, when the computer is switched off. RAM is used as primary storage memory.

Memory Unit (Storage Unit)

❖ Classes of Memory

- ✓ **Secondary memory (Secondary Storage):** they are nonvolatile memory used to store programs and data between runs (executions); typically consists of magnetic disks in today's computers.
- The secondary memory is slower and cheaper than primary memory.
- It is used for permanent storage of data. Commonly used secondary memory devices are hard disk, CD etc.
- The memory consists of storage cells, each capable of storing one bit of information.
- The storage cells are processed in groups of fixed size called **words**. To provide easy access to any word in the memory, a distinct address is associated with each word location. The number of bits in each word is often referred to as the word length of the computer. Typical word length is from 16 to 64 bits. The capacity of the memory is one factor that characterizes the size of a computer.

The Central Processing Unit (CPU)

- A **Central Processing Unit (CPU)**, also called a *central processor* or *main processor*, is the electronic circuitry within a computer that executes instructions that make up a computer program. The CPU performs basic arithmetic, logic, controlling, and input/output (I/O) operations specified by the instructions.
- **The Processing Unit:** This is the part of the computer that does all the control, the processing and storage.
- The CPU consists of a control unit, registers, the arithmetic and logic unit, the instruction execution unit, and the interconnections among these components.
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The Central Processing Unit (CPU)

- The **two typical components of a CPU** include the following:
- **The arithmetic logic unit (ALU)**, which performs arithmetic and logical operations.
- **The control unit (CU)**, which extracts instructions from memory and decodes and executes them, calling on the ALU when necessary.

The Central Processing Unit (CPU)

- Therefore, the **Control Unit** and **ALU** are together known as CPU.
- CPU is the brain of computer system. It performs following tasks:
 - ✓ It performs all operations.
 - ✓ It takes all decisions.
 - ✓ It controls all the units of computer.

The Central Processing Unit (CPU)

❖ Arithmetic and Logic Unit

- Most computer operations are performed in the arithmetic and logic unit (ALU) of the processor.
- All the calculations are performed in ALU of the computer system. The ALU can perform basic operations such as addition, subtraction, division, multiplication etc. Whenever calculations are required, the control unit transfers the data from storage unit to ALU. When the operations are done, the result is transferred back to the storage unit.
- For example, consider two numbers stored in the memory are to be added. They are brought into the processor, and the actual addition is carried out by the ALU. Then sum may be stored in the memory or retained in the processor for immediate use. Typical arithmetic and logic operations are: addition, subtraction, multiplication, division, comparison, complement, etc.
- When operands are brought into the processor, they are stored in high-speed storage elements called registers. Each register can store one word of data.

The Central Processing Unit (CPU)

❖ Control Unit

- The control unit is the nerve center that sends control signals to other units and senses their states. Thus the control unit serves as a coordinator of the memory, arithmetic and logic, and input/output units.
- It controls all other units of the computer. It controls the flow of data and instructions to and from the storage unit to ALU. Thus it is also known as **central nervous system** of the computer
- The operation of a computer can be summarized as follows:
 - ✓ The computer accepts information in the form of programs and data through an input unit and stores it in the memory.
 - ✓ Information stored in the memory is fetched, under program control, into an ALU, where it is processed
 - ✓ Processed information leaves the computer through an output unit
 - ✓ All activities inside the machine are directed by the control unit

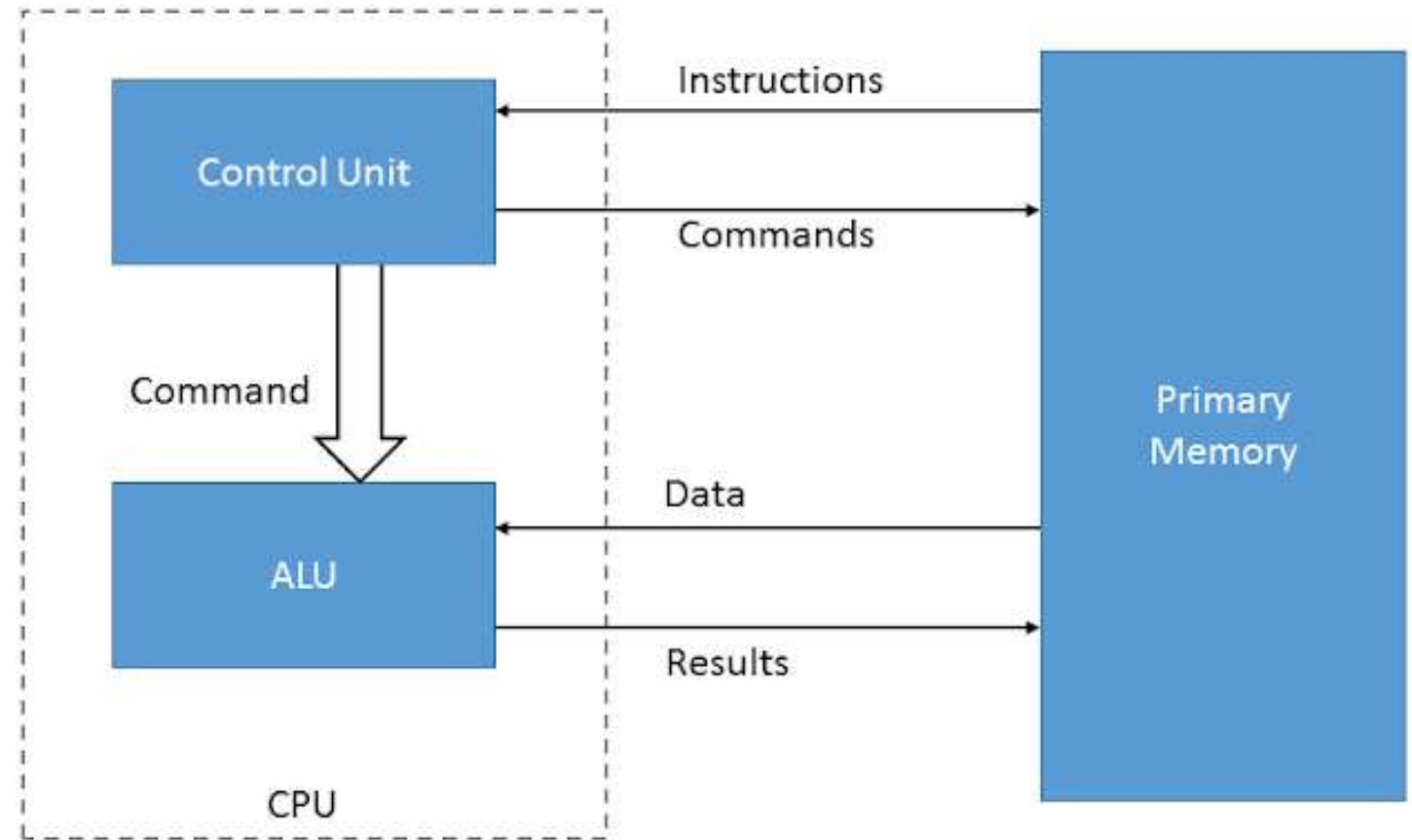
The Central Processing Unit (CPU)

❖ Functions of Control Unit:

Functions of control unit can be categorized into following Five categories

- ✓ Fetching instructions one by one from primary memory and gather required data and operands to perform those instructions.
- ✓ Sending instructions to ALU to perform additions, multiplication etc.
- ✓ Receiving and sending results of operations of ALU to primary memory.
- ✓ Fetching programs from input and secondary memory and bringing them to primary memory.
- ✓ Sending results from ALU stored in primary memory to output.

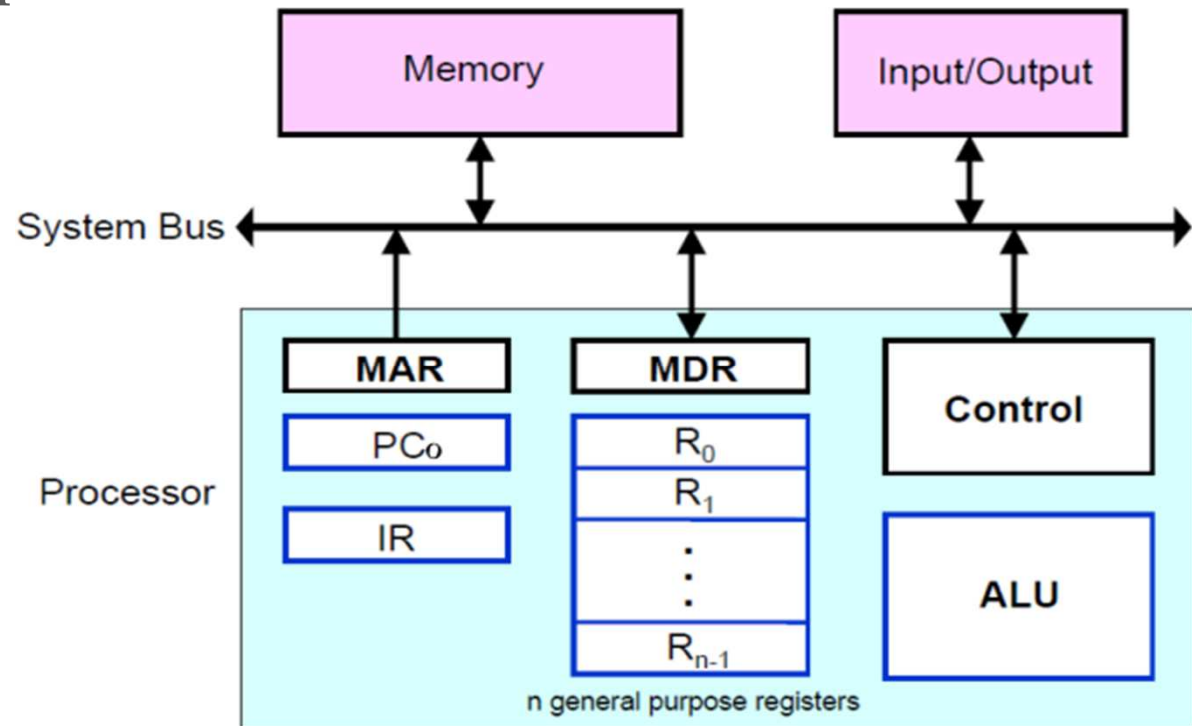
The Central Processing Unit (CPU)



Functions of Control Unit

Basic Operational Concepts of a PC

- To perform a given task an appropriate program consisting of a *list of instructions* is stored in the memory.
- Individual instructions are brought from the memory into the processor, which executes the specified operations. Data to be stored are also stored in the memory. The figure below shows **how memory and the processor can be connected**.



Other Components of the CPU

- In addition to the ALU & the Control Unit circuitry, the processor contains a number of registers used for several different purposes.
- **The instruction register (IR):-** Holds the instructions that are currently being executed. Its output is available for the control circuits which generates the timing signals that control the various processing elements in one execution of instruction.
- **The program counter (PCo):-** This is another specialized register that keeps track of execution of a program. It contains the memory address of the next instruction to be fetched and executed.
- **General Purpose Registers:** Besides IR and PCo, there are n-general purpose registers R_0 through R_{n-1} .
- The other two registers which facilitate communication with memory are:
 - **1. MAR – (Memory Address Register):-** It holds the address of the location to be accessed.
 - **2. MDR – (Memory Data Register):-** It contains the data to be written into or read out of the address location.

Instructions and Data Flow within a PC

- ❖ Obtaining an overall perspective of the function of each computer system components involves understanding the instruction and data flow within a computer system. This is better described in stages as follows:
 - **Step A:** Instructions and data which come from the input devices are stored in primary memory under the direction of the control unit.
 - **Step B:** The control unit examines one instruction and interpreters it (since only one instruction can be executed at a time).
 - **Step C:** The control unit sends appropriate electronic signals to the ALU and to primary storage.

Instructions and Data Flow within a PC

- **Step D:** The required data items are transferred to the ALU, where calculations and/or comparisons are performed.
- **Step E:** The result is transferred back to primary storage unit. Steps B to E are continued until all instructions have been executed.
- **Step F:** The control unit signals the primary storage unit to transfer the result to the output device.
- ❖ This basic sequence illustrated is fundamental to most computer systems.

Operating Steps for Instruction Execution

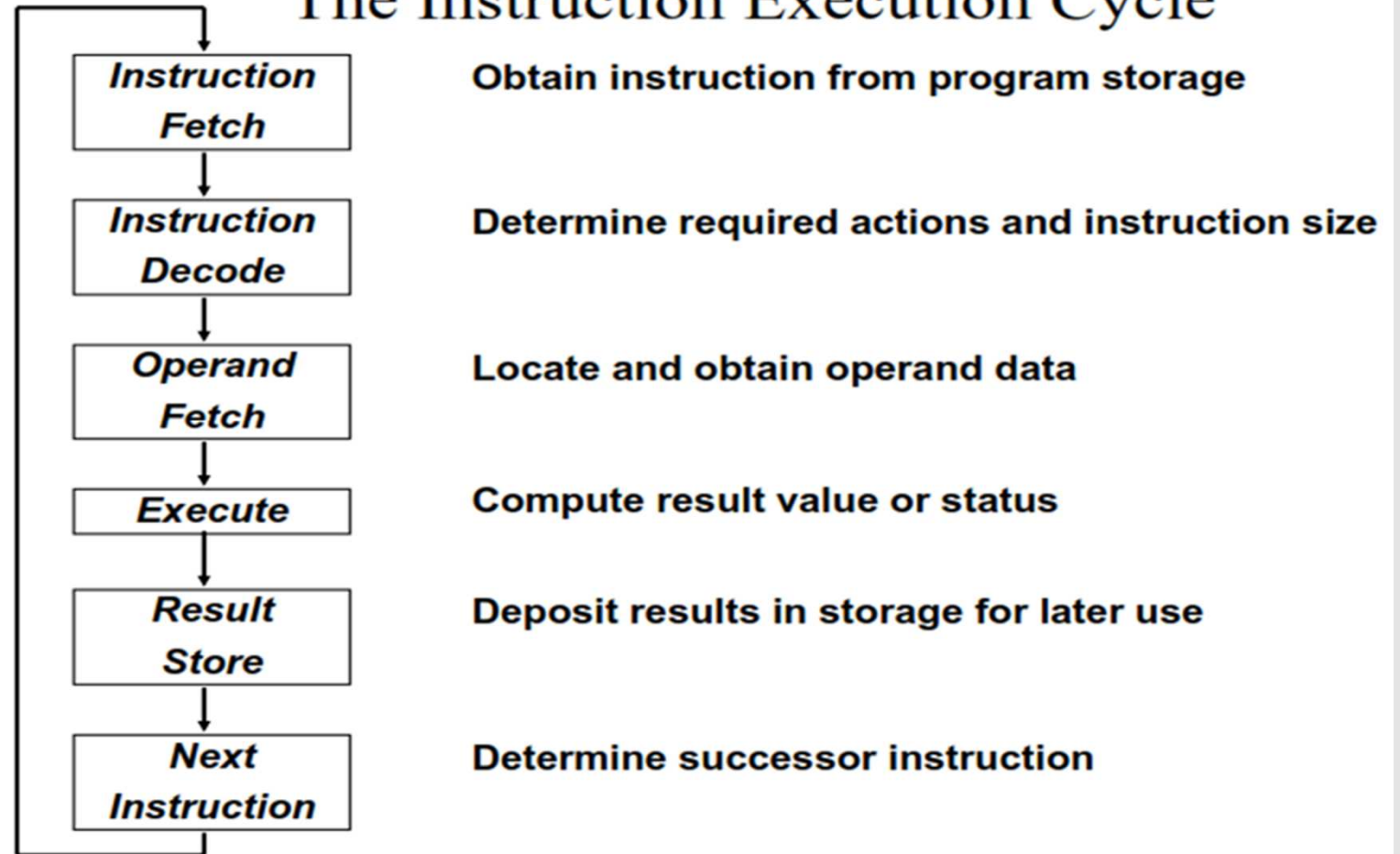
- 1. Programs reside in the memory and usually get these through the input/output unit.
- 2. Execution of the program starts when the **PCo** is set to point at the first instruction of the program.
- 3. Contents of **PCo** are transferred to MAR and a Read Control Signal is sent to the memory.
- 4. After the time required to access the memory elapses, the address word is read out of the memory and loaded into the **MDR**.
- 5. Now contents of **MDR** are transferred to the **IR** and now the instruction is ready to be decoded and executed.
- 6. If the instruction involves an operation by the **ALU**, it is necessary to obtain the required operands.

Operating Steps for Instruction Execution

- 7. An operand in the memory is fetched by sending its address to **MAR** & initiating a read cycle.
- 8. When the operand has been read from the memory to the **MDR**, it is transferred from **MDR** to the **ALU**.
- 9. After one or two such repeated cycles, the **ALU** can perform the desired operation.
- 10. If the result of this operation is to be stored in the memory, the result is sent to **MDR**.
- 11. Address of location where the result is stored is sent to **MAR** and a write cycle is initiated.
- 12. The contents of **PCo** are incremented so that **PCo** points to the next instruction that is to be executed.

The Instruction Execution Cycle

The Instruction Execution Cycle








Components of the Digital Computer System

- There are two basic parts to a computer: **Hardware & Software**. Hardware are the physical components of the system while software are the programs, logical routines and instructions that makes the hardware function.
- **Hardware** is the term for all the physical components of a computer. They are the electrical, electronics and mechanical parts of the computer. They can be seen, touched and held.

Basic Components of the Digital Computer System: *INPUT DEVICES*

- ❖ An input device gathers inputs and translates it into a form that the computer can process.
- ❖ The categories of Input Devices includes:
 - **1. Text input devices**
 - ✓ *Keyboard* - a device to input text and characters by depressing buttons (referred to as keys or buttons).
 - **2. Pointing devices**
 - ✓ *Mouse* - a pointing device that detects two dimensional motion relative to its supporting surface.
 - ✓ *Optical Mouse* - uses light to determine mouse motion.
 - ✓ *Trackball* - a pointing device consisting of an exposed protruding ball housed in a socket that detects rotation about two axes.
 - ✓ *Touch screen* - senses the user pressing directly on the display

Pointing Devices

Pointing Device	Picture	Definition
Mouse		❖ A mouse is a small plastic box with buttons on top and a rolling ball or optical 'reader' underneath
Pointing stick		❖ A pressure-sensitive pointing device shape like pencil eraser positioned between keys on a keyboard
Touchpad		❖ A small, flat, rectangle pointing device that is sensitive to pressure and motion device
Joystick		❖ An input device with a vertical lever moved to control pointing devices or on-screen objects
Trackball		❖ A stationary pointing device with a ball on top or side

Basic Components of the Digital Computer System: *INPUT DEVICES*

➤3. Gaming devices

- ✓ **Joystick** - a control device that consists of a handheld stick that pivots around one end, to detect angles in two or three dimensions and reports its angle or direction to the device it is controlling.
- ✓ **Game pad** - a hand held game controller that relies on the digits (especially thumbs) to provide input.
- ✓ **Game controller** - a specific type of controller specialized for certain gaming purposes.

➤4. Image, Video input devices

- ✓ **Image scanner** - a device that provides input by analyzing images, printed text, handwriting, or an object.
- ✓ **Web cam** - a video camera used to provide visual input that can be easily transferred over the internet.
- ✓ **Other examples include:** Fingerprint scanner; Barcode reader 3D scanner; Laser rangefinder; digital camera; digital camcorder.

➤5. Audio input devices

- Audio input devices allow a user to send audio signals to a computer for processing, recording, or carrying out commands.
 - ✓ **Microphone** - an acoustic sensor that provides input by converting sound into electrical signals.

Basic Components of the Digital Computer System: *OUTPUT DEVICES*

- Any machine capable of representing information from a computer is considered an output device. Their function is to display, print, or transfer the output, or results, of processing from the computer memory.
- The **output devices** includes:
- **Printer** - a device that produces a permanent human-readable text or graphic document.
- **Speakers** - typically a pair of devices (2 channels) which convert electrical signals into audio.
- **Headphones** - for a single user hearing the audio.
- **Monitor** - an electronic visual display with textual and graphical information from the computer.

The Monitor

- The monitor is also known as the **Video Display Terminal (VDT)** and **Visual Display Unit (VDU)**.
- The monitor is connected through VGA Cable to the CPU. It does not work until you connect it to the CPU. The monitor consists of a cathode ray tube and a fluorescent screen.
- **Function:** The core function of the Monitor is to allow users to interact with the computer.
- **Types of computer monitors:**
 1. Cathode Ray Tube Monitors (CRT)
 2. Liquid Crystal Display Monitors (LCD)
 3. Thin Film Transistor (TFT) Monitors
 4. Light Emitting Diodes Monitors (LED)
 5. Digital Light Processing (DLP) Monitors
 6. Touchscreen Monitor
 7. Plasma Screen Monitors
 8. OLED Monitors (Organic Light Emitting Diode)

The Printer

➤ **Function:**

- Printers Print out the hardcopy of data as Text and Image onto the paper.
- They take electronic data and gives the output as the hard copy.

➤ **Types of Printers**

1. Laser Printers
2. Solid Ink Printers
3. LED Printers
4. Business Inkjet Printers
5. Home Inkjet Printers
6. Multifunction Printers
7. Dot Matrix Printers
8. 3D Printers

The Speaker

➤ **Function:** Speakers convert electronic signals into sound (audio)

➤ **Types of Speakers**

1. Dynamic
2. Subwoofer
3. Horn
4. Electrostatic
5. Planar-Magnetic

The Headphones

➤ **Function:** To convert electronic signals into audio without disturbing people.

➤ **Types of Headphones**

1. Closed-Back Headphones
2. Open-Back Headphones
3. On-Ear Headphones
4. Over-Ear Headphones
5. In-Ear Headphones
6. Earbuds
7. Bluetooth Headphones
8. Noise-Cancelling Headphones

The Projector

➤ **Function:**

- To project images, videos and graphical contents on to a surface or the wall.
- Projectors are used in presentations, watching movies, teachings, etc.

➤ **Types of Projectors**

1. Digital Light Processing (DLP)
2. Liquid Crystal Display (LCD)
3. Cathode Ray Tube (CRT)