Chapter = 2
The Computer System Hardware

⊛ — What is computer hardware? What are the different hardware components?

Ans. The collection of physical parts of computer system like mouse, keyboard, monitor, hard disk etc. is called computer hardware.

Monitor, Motherboard, CPU, main memory (RAM), Keybard, mouse, Graphics card, Sound card, Optical disk drive, Hard disk drive etc. are the different hardware components.

⊛ CPU.

Central processing unit (CPU) is also often called the brain of computer. CPU consist of Arithmetic logic Unit (ALU) and Control Unit (CU). In addition, CPU also has a set of registers which are temporary storage areas for holding data and instructions. ALU performs all the arithmetic and logic operations on the data that is made available to it. CU is responsible for organizing the processing of data and instructions. CU controls and co-ordinates the activity of the other units of computer. CPU uses the registers to store the data, instructions during processing.

functions:-

i> CPU is the heart and brain of computer.

ii> It receives data as input.

iii> It follows instructions and process data accordingly.

iv> Presents the information as output to the user.

Components of CPU

i) **Arithmetic logic Unit (ALU):-**

ALU consists of two units arithmetic unit and logic unit. The arithmetic unit performs all the arithmetic operations on the data that is made available to it. Some of the arithmetic operations supported by the arithmetic unit are addition, subtraction, multiplication and division. The logic unit of ALU is responsible for performing logic operations. Logic operations include testing for greater than, less than or equal to condition. ALU performs arithmetic and logic operations and uses registers to hold the data that is being processed.

ii) **Control Unit (CU):-**

It organizes the processing of data and instructions. It acts as a supervisor and controls and coordinates the activity of the other units of computer. CU coordinates with the input and output devices of a computer. CU uses the instructions in the Instruction Register (IR)

to decide which circuit needs to be actived. It also instructs the ALU to perform arithmetic or ~~logic~~ logic operations. CU tells when to fetch the data and instructions, what to do, where to store results etc.

Registers:-

Registers are high-speed storage areas within the CPU, but have least storage capacity. Registers store data, instructions. and itermediate result of processing. Registers are often refered as the CPU's working memory. The data and instructions that require processing must be brought in the registers of CPU before they can be processed. For example, if two numbers are to be added; both numbers are brought in the registers, added and the result is also placed in a register. Registers are used for different purposes, with each register ~~surfing~~ serving a specific purpose. For example. Accumulator (Acc) stores the result of arithmetic and logic operations, Instruction register (IR) contains the current instruction most recently fetched.

⊗ **Memory Unit :-**

The physical device of computer which is capable of storing information is called memory unit. The function of memory unit is to store data and programs and speed equilization of various components. ~~There The main types of~~ The memory unit consists of following types :-

i) Cache memory :

Cache memory is a very high speed memory placed in between CPU and RAM. Cache memory increases the speed of processing. It is a storage buffer that stores the data that is used more often and makes them available to CPU at a fast rate. During processing, CPU first checks cache for the required data. If data is not found in cache, then it looks in the RAM for data. Cache memory is very expensive, so it is smaller in size. Generally computers have cache memory of sizes 256 KB to 2 MB.

ii) Primary memory :-

Primary memory is the main memory of computer. It is used to store data and instructions during the processing of data. Primary memory is a semiconductor memory. Primary memory is of two kinds - Random Access Memory (RAM)

and Read only Memory (ROM). RAM is volatile. It stores data when the computer is on. The information stored in RAM gets erased when the computer is turned off. ROM is non-volatile memory. The storage in ROM is permanent in nature. ROM comes programmed by the manufacturer. RAM provides a limited storage capacity, due to it's high cost.

ii) Secondary memory :-

The secondry memory stores data and instructions permanentaly. The information can be stored in secondry memory for a long time and is generally permanent in nature unless erased by user. It is a non-volatile memory. It provides back-up storage for data and instructions. Hard disk drive, Floppy drive and Optical drives are it's some examples. Secondry memory has a high storage capacity than primary memory. It is also cheaper than primary memory.

⚹ <u>Instruction format:</u> ~~Instruction set~~

An instruction format is a binary format which specifies a computer instruction. It specifies the address of the operand, the Opcode, the addressing mode of the instruction.

   i) <u>Operation code (Opcode)</u> → It is an instruction that tells processor what do do with the variable or data written besides it.

   ii) <u>Operand code</u> → ~~Operand is a variable that stores data.~~ It is the part of computer instruction that specifies data that is to be operating or manipulated.

⚹ <u>Instruction Set:</u>

The complete set of all the instructions in machine code that can be recognized and executed by a central processing unit. x64 and x86 are the example of an instruction set, which is common to find on computers today.

⚹ <u>Microprocessor :-</u>

An integrated circuit that contains all the functions of a central processing unit of a computer is called microprocessor.

(a). CISC architecture:-

CISC (Complex instruction set computing) has the ability to execute addressing modes or multi-step operations within one instruction set. It is the design of the CPU where one instruction performs many low-level operations. For example - memory storage, an arithmetic operation and loading from memory.

It minimize the number of instructions per program, sacrificing the number of cycles per instruction. Computers based on the CISC architecture are designed to decrease the memory cost.
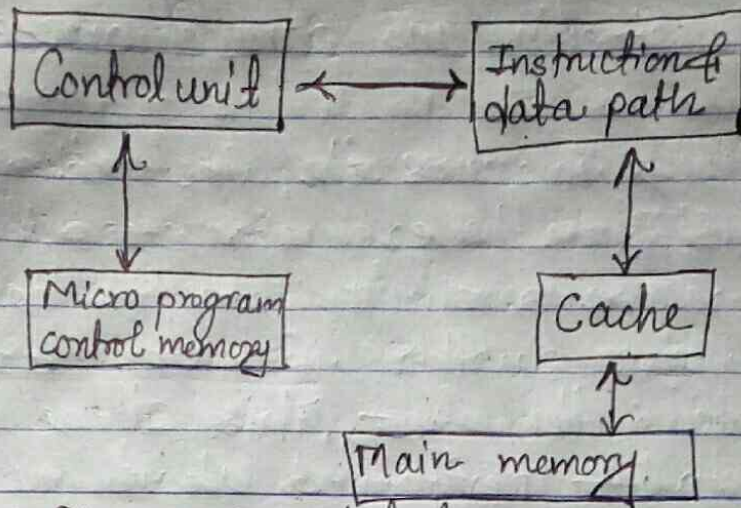
fig. CISC architecture.

(b). RISC architecture :—

RISC (Reduced instruction computing) is used in portable devices due to it's power efficiency. For example, Apple iPod and Nintendo DS. RISC is a type of microprocessor architecture that uses highly optimised set of instructions. RISC does the opposite, reducing the cycles per instruction at the cost of the number of instruction per program.
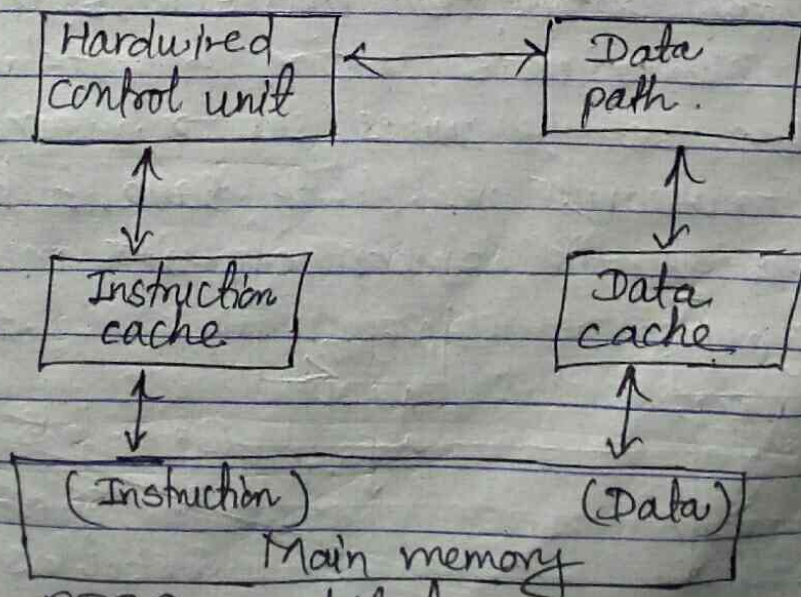

fig. RISC architecture.

✱ Differences between CISC architecture and RISC architecture.

CISC architecture	RISC architecture.
i) CISC stands for Complex Instruction Set Computer.	i) RISC stands for Reduced Instruction Set Computer.
ii) The average clock cycle per instruction (CPI) is in the range of 2 and 15.	ii) The average clock cycle per instruction (CPI) is in the range of 1.5.
iii) Performance is optimized with more focus on hardware.	iii) Performance is optimized with more focus on software.
iv) Execution time is very high	iv) Execution time is very less.
v) Decoding of instructions is complex.	v) Decoding of instructions is simple.
vi) It requires external memory for calculations.	vi) It does not require external memory for calculations.

Concept of pipeline and parallel processing

Pipelining improves the instruction execution speed by putting the execution steps in parallel. A CPU can receive a single instruction, begin executing it, and receive another instruction before it has completed the first. This allows for more instructions to be performed, about one instruction per clock cycle.

Parallel processing is the simultaneous execution of instructions from the same program on different processor. A program is divided into multiple processes that are handled in parallel in order to reduce execution time.

Concept and types of bus & Concept of external ports.

Bus is a set of electronic signal pathways that allows information and signals to travel between components inside or outside of computer. A bus is a set of wires used for interconnection, where each wire can carry one bit of data. A bus width is defined by the number of wires in the bus.
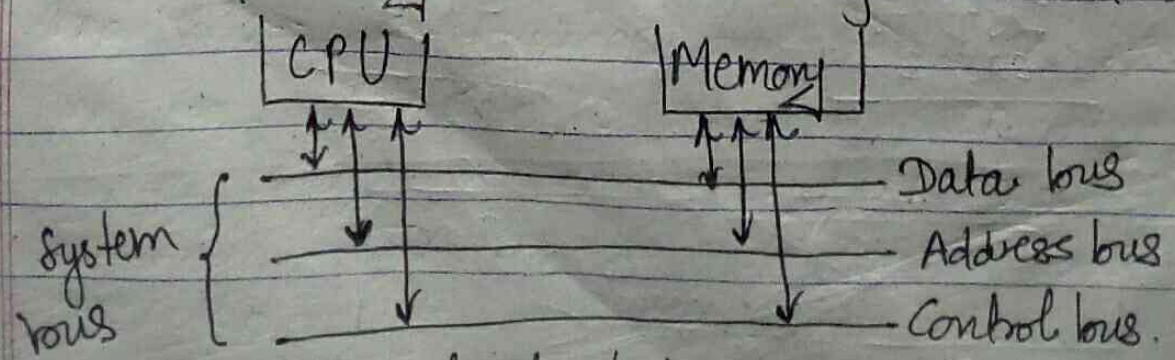
```
    ┌─CPU─┐              ┌─Memory─┐
    └──┬──┘              └───┬────┘
     ↑↑↑                   ↑↑↑
  ┌   ↓↓↓                   ↓↓↓        ─── Data bus
System│  ↓                    ↓          ─── Address bus
 bus  │   ↓                     ↓        ─── Control bus.
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· Fig. Interaction between CPU and memory

A computer bus can be divided into two types – Internal Bus and External Bus. Internal bus connects components inside the motherboard like CPU and system memory as shown in figure above. The external bus connects the different external devices peripherals, expansion slots, I/O ports and drive connections to rest of computer. A system bus is of three kinds data bus, address bus and control bus.

Data bus :- It transfers data between CPU and memory. The bus width of a bus affects the speed of computer. The size of data bus defines the size of the processor. A processor can be 8, 16, 32 or 64-bit processor.

System bus

CPU ⟷ Memory

Expansion bus

Controller   Controller   Controller
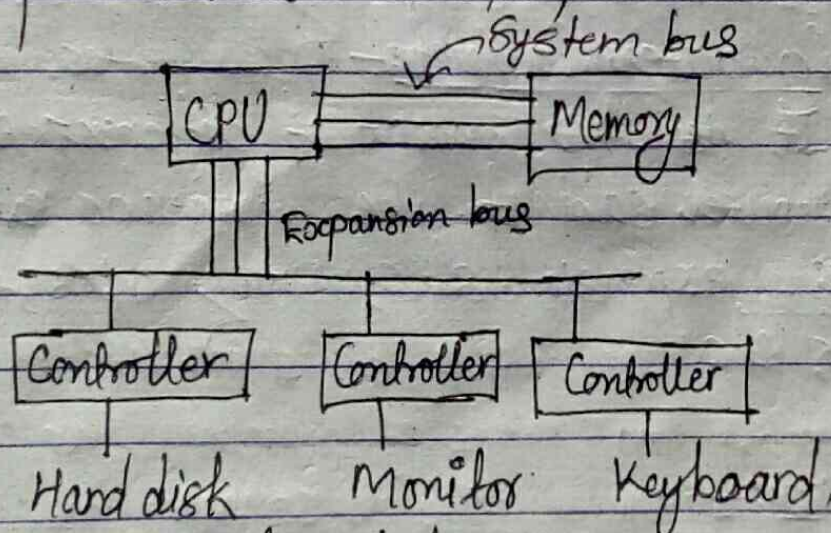
Hard disk   Monitor   Keyboard.

Fig. Interaction between CPU, memory and peripheral devices

Address bus :- It connects CPU and RAM with a set of wires similar to data bus. The width of address bus determines the maximum number of memory locations the computer can address.

Control bus :- Control bus specifies whether data is to be read or written to the memory.

External ports:—

The peripheral devices interact with the CPU of the computer via the bus. The connections to the bus from the peripheral devices are made via the ports and sockets provided at the sides of a computer. Some of the standard port connections available on the outer side of computer are ~~pos~~ port of mouse, keyboard, monitor, network, modem, audio port, serial port, USB port etc. The different ports are physically identifiable by their different shapes, size, contact of pins and number of pins.

⊛ Inside of Computer Cabinet:—

It is the concept of different components inside a computer cabinet like motherboard, ports and interfaces, expansion slots, memory chips, processor, hard disk etc.

1) Motherboard:—

The motherboard is most important component in the PC. It is a large Printed Circuit Board (PCB), having many chips, connectors, and other electronics mounted on it. The motherboard contains the processor, memory chips, interfaces, and sockets. Advanced Technology Extended (ATX) is the most common design of motherboard for desktop computers.

The Basic Input Output System (BIOS) and Complementary Metal-Oxide Semiconductor (CMOS) are present on motherboard.

① BIOS → It is the basic program used as an interface between the operating system and motherboard. The BIOS is stored in ROM and cannot be rewritten. BIOS contains the instructions for the starting up of the computer. It checks the operating system in hard drive. BIOS appeals the bootstrap loader to load the operating system in the memory. BIOS can be configured by using an interface named BIOS setup, which can be accessed when the computer is booting up (by pressing the DEL key).

② CMOS → When the computer is turned off, the power supply stops providing electricity to the motherboard. When the computer is turned on again, the system still displays the correct clock time. This is because CMOS chip saves some system information, such as time, system date and essential system settings. CMOS is kept powered by a button battery located on the motherboard. The CMOS chip is working even when the computer power is switched off.

ii> **Ports and Interfaces:-**

Motherboard has a certain number of I/O sockets that are connected to the ports and interfaces found on the rear side of a computer. We can connect external devices to the ports and interfaces, which get connected to computer's motherboard. Following are some of the ports.

     ⓐ Serial Port → to connect old peripherals.

     ⓑ Parallel Port → to connect old printers.

     ⓒ USB ports → to connect newer peripherals like cameras, canners, printers etc to the computer.

     ⓓ SCSI port → for connecting hard disk drives and network connectors.

     ⓔ. PS/2 port → To connect mouse and keyboard into PC.

iii> **Memory chips :-**

The RAM consists of chips on a small circuit board. Two types of memory chips Single In-line Memory Module (SIMM) and Dual In-line Memory Module (DIMM) are used in desktop computers. The CPU can retrive information from DIMM chip at 64 bits compared to 32 bits and 16 bits transfer with SIMM chips. DIMM chips are used in Pentium 4 onwards to increase the acess speed.

iv) **Processor** →

The processor or the CPU is the main component of computer. We should select a processor based on facts like it's speed, performance, reliability and motherboard support. Pentium Pro, Pentium 2 and Pentium 4 are some of the processors.

v) **Disk drives** →

The disk drives are present inside the machine. The common disk drives in the machine are hard disk drive, floppy drive and CD drive or DVD drive. These storage devices can store large amount of data permanentaly.