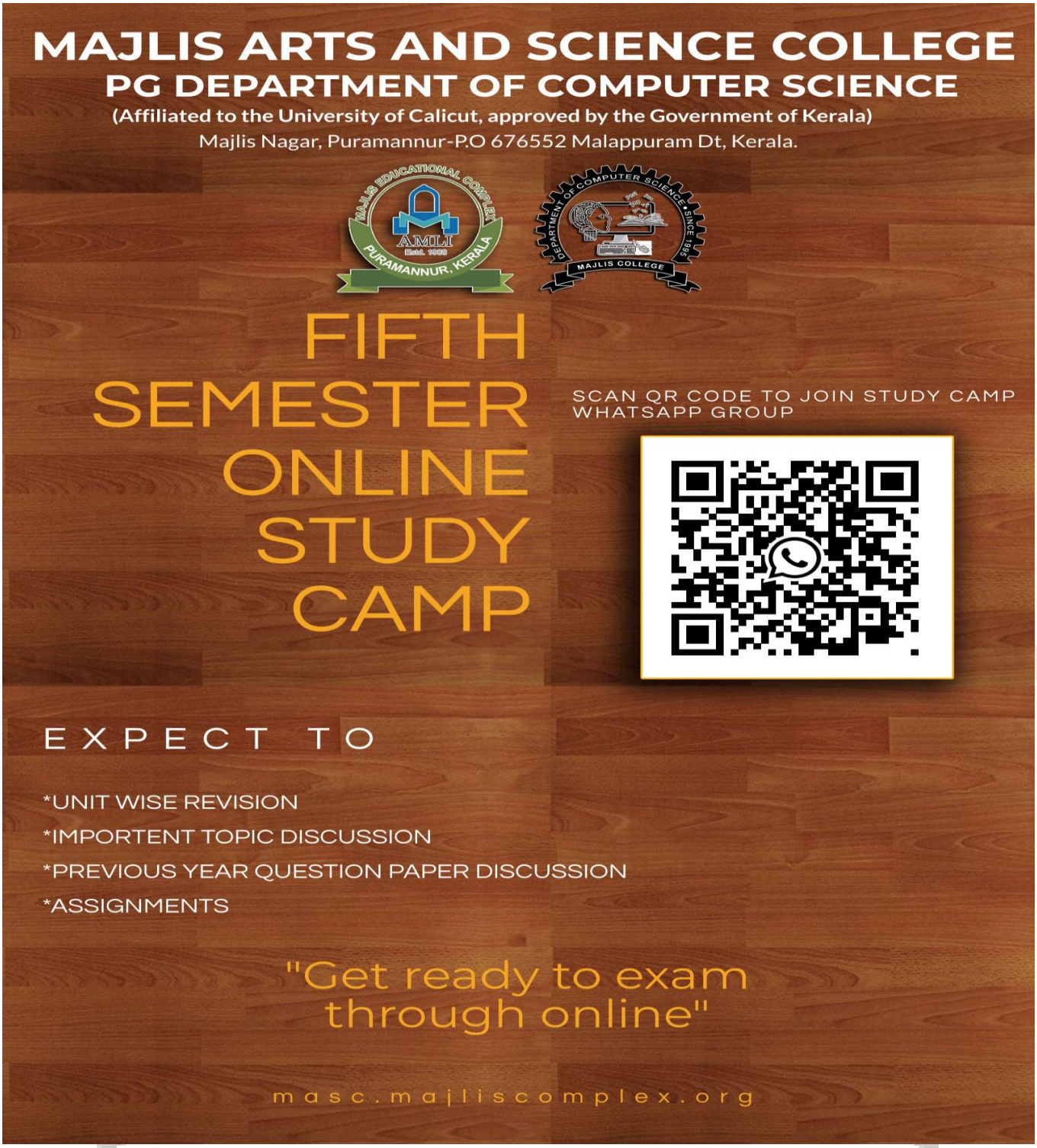


COMPUTER ORGANISATION AND ARCHITECTURE

MODULE 3

1. **An accumulator based computer supports ----- instruction format.**
   Zero Address Instruction Format
2. **-- is the first process in instruction execution**
   Fetch
3. **CISC stand for---**
   complex instruction set computer
4. **What is an instruction?**
   An instruction is an order given to a computer processor by a computer program
5. **What is an instruction set?**
   An instruction set is a group of commands for a CPU in machine language
6. **What is PSW?**
   The Program Status Word (PSW) contains status bits that reflect the current CPU state
7. **Explain register organization of CPU.**

Register	Symbol	Number of bits	Function
Data register	DR	16	Holds memory operand
Address register	AR	12	Holds address for the memory
Accumulator	AC	16	Processor register
Instruction register	IR	16	Holds instruction code
Program counter	PC	12	Holds address of the instruction
Temporary register	TR	16	Holds temporary data
Input register	INPR	8	Carries input character
Output register	OUTR	8	Carries output character

8. **Explain two and one address instruction.**
   TWO-ADDRESS INSTRUCTIONS
   Two address instructions are the most common in commercial computers. Here again each address field can specify either a processor register or a memory word.
   The program to evaluate X = (A + B) ∗(C + D) is as follows:
   MOV R1, A R1← M [A]
   ADD R1, B R1← R1 + M [B]
   MOV R2, C R2← M [C]
   ADD R2, D R2← R2 + M [D]
   MUL R1, R2 R1← R1∗R2
   MOV X, R1 M [X] ←R1

The MOV instruction moves or transfers the operands to and from memory and processor registers. The first symbol listed in an instruction is assumed to be both a source and the destination where the result of the operation is transferred.

ONE-ADDRESS INSTRUCTIONS

One-address instructions use an implied accumulator (AC) register for all data manipulation. For multiplication and division there is a need for a second register. However, here we will neglect the second and assume that the AC contains the result of tall operations.

The program to evaluate X= (A + B) ∗(C + D) is

```
LOAD A     AC ←M [A]
ADD B      AC ←A [C] + M [B]
STORE T  M [T] ←AC
LOAD C    AC ←M [C]
ADD   D    AC ←AC + M [D]
MULT A     C ←AC ∗M [T]
STORE  X  M [X] ←AC
```

All operations are done between the AC register and a memory operand. T is the address of a temporary memory location required for storing the intermediate address

9. Explain the block diagram of a basic computer

Computer system consists of three parts, that are central processing unit (CPU), Input Devices, and Output Devices. The Central Processing Unit (CPU) is divided into two parts again: arithmetic logic unit (ALU) and the control unit (CU). The set of instruction is in the form of raw data.

A large amount of data is stored in the computer memory with the help of primary and secondary storage devices. The CPU is like the heart/brain of the computer. The user does not get the desired output, without the necessary option taken by the CPU. The Central processing unit (CPU) is responsible for the processing of all the instructions which are given by the user to the computer system.

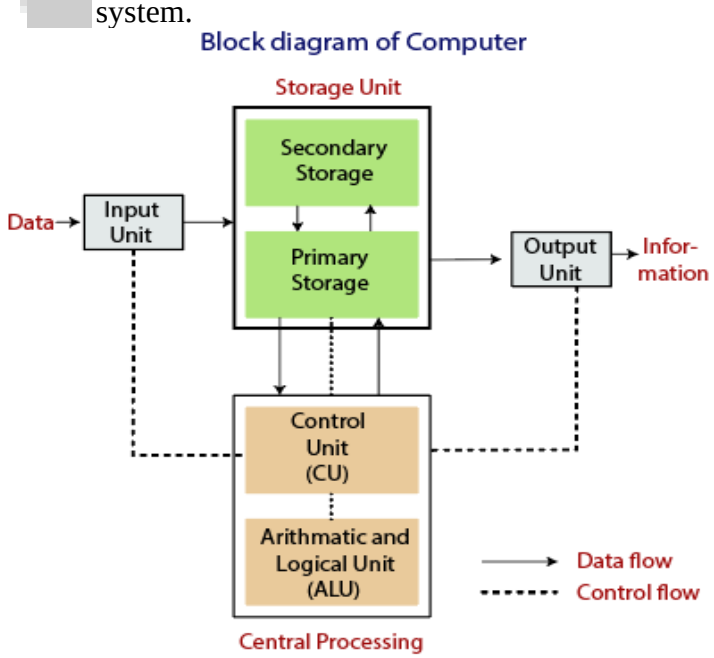


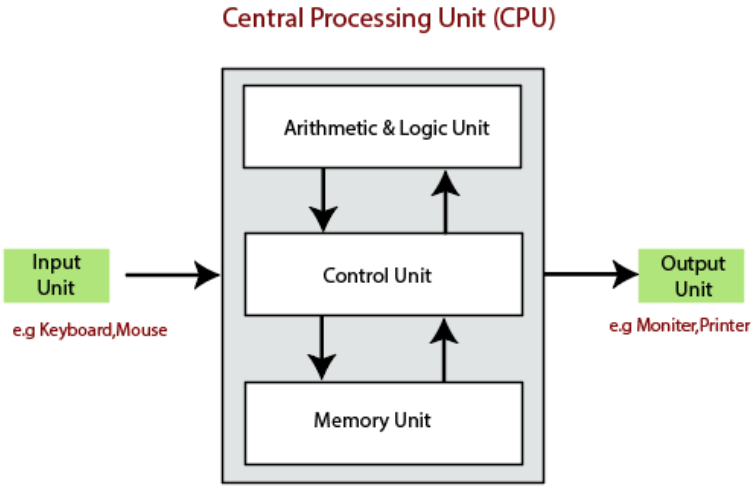
Fig: Block Diagram of the computer.

The data is entered through input devices such as the keyboard, mouse, etc. This set of instruction is processed by the CPU after getting the input by the user, and then the computer system produces the output. The computer can show the output with the help of output devices to the user, such as monitor, printer, etc.

- CPU (Central Processing Unit)
- Storage Unit
- ALU(Arithmetic Logic Unit)
- Control Unit

Central Processing Unit (CPU)

The computer system is nothing without the Central processing Unit so, it is also known as the brain or heat of computer. The CPU is an electronic hardware device which can perform different types of operations such as arithmetic and logical operation.



The CPU contains two parts: the arithmetic logic unit and control unit. We have discussed briefly the arithmetic unit, logical unit, and control unit which are given below:

Control Unit

The control unit (CU) controls all the activities or operations which are performed inside the computer system. It receives instructions or information directly from the main memory of the computer.

When the control unit receives an instruction set or information, it converts the instruction set to control signals then; these signals are sent to the central processor for further processing. The control unit understands which operation to execute, accurately, and in which order.

Arithmetic and Logical Unit

The arithmetic and logical unit is the combinational digital electronic circuit that can perform arithmetic operations on integer binary numbers. It presents the arithmetic and logical operation. The outputs of ALU will change asynchronously in response to the input. The basic arithmetic and bitwise logic functions are supported by ALU.

Storage Unit

The information or set of guidelines are stored in the storage unit of the computer system. The storage unit provides the space to store the data or instruction of processed data. The information or data is saved or hold in computer memory or storage device. The data storage is the core function and fundamental of the computer components.

10. **Define instruction cycle?**

Fetching the instruction: The next instruction is fetched from the memory address that is currently stored in the program counter (PC) and stored in the instruction register (IR). At the end of the fetch operation, the PC points to the next instruction that will be read at the next cycle.

Decode the instruction: During this cycle the encoded instruction present in the IR (instruction register) is interpreted by the decoder.

Read the effective address: In case of a memory instruction (direct or indirect) the execution phase will be in the next clock pulse. If the instruction has an indirect address, the effective address is read from main memory and any required data is fetched from main memory to be processed and then placed into data registers. If the instruction is direct, nothing is done at this clock pulse. If this is an I/O instruction or a Register instruction, the operation is performed (executed) at clock Pulse.

Execute the instruction: The control unit of the CPU passes the decoded information as a sequence of control signals to the relevant function units of the CPU to perform the actions required by the instruction

11. **What is the need for registers?**

Registers are a type of computer **memory** used to quickly accept, store, and transfer data and instructions that are being used immediately by the CPU

12. **What is MAR?**

The Memory Address Register (**MAR**) contains **12** bits which hold the address for the memory location.

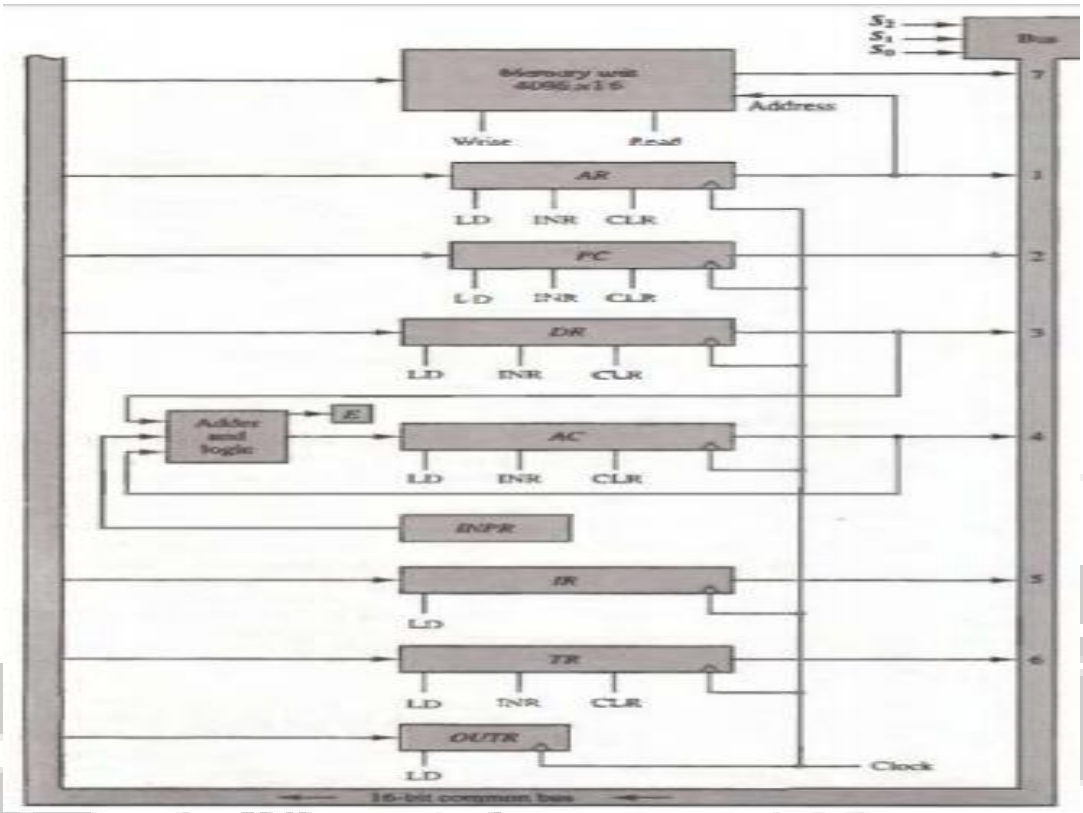
13. **What is bus?**

A **computer bus** (often simply called **bus**) is part of most computers. Its role is to transfer data, signals, or power between some of the components that make up a **computer**

14. **Define stack.**

Memory stacks are linear data structures (locations) used to store data in a computer's memory

15. **Explain the system bus structure of a basic computer**



The Common Bus•To avoid excessive wiring, memory and all the register are connected via a common bus.

•The specific output that is selected for the bus is determined by S2S1S0

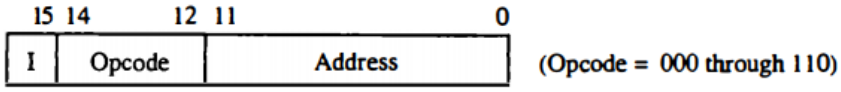
.•The register whose LD (Load) is enable receives the data from the bus.

•Registers can be incremented by setting the INR control input and can be cleared by setting the CLR control input

.•The Accumulator's input must come via the Adder & Logic Circuit. This allows the Accumulator and Data Register to swap data simultaneously

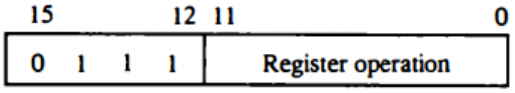
.•The address of any memory location being accessed must be loaded in the Address Register

16. What are the basic computer instruction formats?



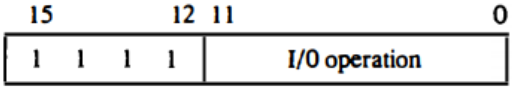
(Opcode = 000 through 110)

(a) Memory – reference instruction



(Opcode = 111, $I = 0$)

(b) Register – reference instruction



(Opcode = 111, $I = 1$)

(c) Input – output instruction

17. What are the different types of instructions?

Computer instructions are a set of machine language instructions that a particular processor understands and executes. A computer performs tasks on the basis of the instruction provided.
An instruction comprises of groups called fields. These fields include:

- The Operation code (Opcode) field which specifies the operation to be performed.
- The Address field which contains the location of the operand, i.e., register or memory location.
- The Mode field which specifies how the operand will be located.

A basic computer has three instruction code formats which are:

1. Memory - reference instruction
2. Register - reference instruction
3. Input-Output instruction

Memory - reference instruction

(Opcode = 000 through 110)

In Memory-reference instruction, 12 bits of memory is used to specify an address and one bit to specify the addressing mode 'I'.

Register - reference instruction

(Opcode = 111, I = 0)

The Register-reference instructions are represented by the Opcode 111 with a 0 in the leftmost bit (bit 15) of the instruction.

Note: The Operation code (Opcode) of an instruction refers to a group of bits that define arithmetic and logic operations such as add, subtract, multiply, shift, and compliment.

A Register-reference instruction specifies an operation on or a test of the AC (Accumulator) register.

Input-Output instruction

(Opcode = 111, I = 1)

Input-Output instruction does not need a reference to memory and is recognized by the operation code 111 with a 1 in the leftmost bit of the instruction. The remaining 12 bits are used to specify the type of the input-output operation or test performed.

18. Define Instruction Cycle

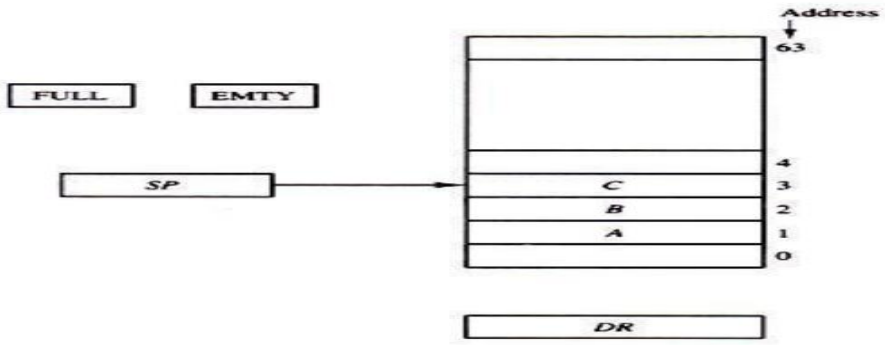
The instructions of a program are carried out by a process called the instruction cycle

19. Explain stack organization

A stack is a storage device that stores information
item stored last is the first item retrieved.
The physical registers of a stack are always available for reading or writing

- The register that holds the address for the stack is called a stack pointer(SP)
- stack pointer always points at the top item in the stack.

Register stack



It is a 64 word stack

- The one-bit register FULL is set to 1 when the stack is full,
- The one-bit register EMTY is set to 1 when the stack is empty of items
- In a 64-word stack, the stack pointer contains 6 bits because 2^ 6 = 64.
- DR is the data register that holds the binary data to be written into or read out of the stack.
- The operations on stack are PUSH (insertion of data into the stack) and POP(retrieval of data from the stack)

POP:

- A new item is deleted from the stack if the stack is not empty (if EMTY = 0). The pop operation consists of the following sequences of microoperations:

DR ← M [SP]	Read item on top of the stack
SP ← SP - 1	Decrement stack pointer
IF (SP = 0) then (EMTY ← 1)	Check if stack is empty
FULL ← 0	Mark the stack not full

The top item is read from the stack into DR. The stack pointer is then decremented. If its value reaches zero, the stack is empty, so EMTY is set to 1.

PUSH:

- If the stack is not full (FULL =0), a new item is inserted with a push operation. The push operation consists of the following sequences of microoperations:

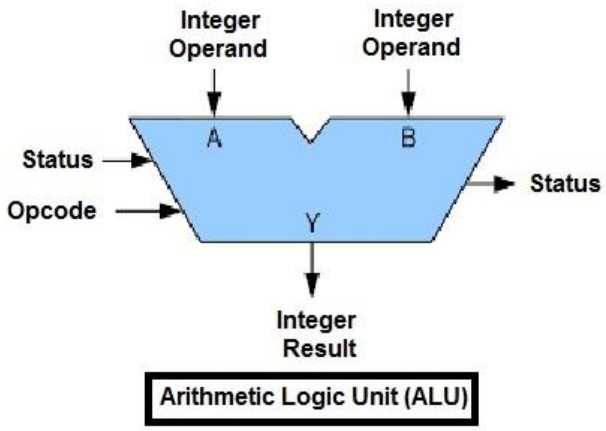
SP ← SP + 1	Increment stack pointer
M [SP] ← DR	WRITE ITEM ON TOP OF THE STACK
IF (SP = 0) then (FULL ← 1)	Check is stack is full
EMTY ← 0	Mark the stack not empty

· The stack pointer is incremented so that it points to the address of next-higher word. A memory write operation inserts the word from DR into the top of the stack.

· SP holds the address of the top of the stack and that M[SP] denotes the memory word specified by the address presently available in SP.

20. Write about the design of arithmetic and logic unit

Inside a computer, there is an Arithmetic Logic Unit (ALU), which is capable of performing logical operations (e.g. AND, OR, Ex-OR, Invert etc.) in addition to the arithmetic operations (e.g. Addition, Subtraction etc.). The control unit supplies the data required by the ALU from memory, or from input devices, and directs the ALU to perform a specific operation based on the instruction fetched from the memory. ALU is the "calculator" portion of the computer.



An arithmetic logic unit(ALU) is a major component of the central processing unit of the a computer system. It does all processes related to arithmetic and logic operations that need to be done on instruction words. In some microprocessor architectures, the ALU is divided into the arithmetic unit (AU) and the logic unit (LU).

An ALU can be designed by engineers to calculate many different operations. When the operations become more and more complex, then the ALU will also become more and more expensive and also takes up more space in the CPU and dissipates more heat. That is why engineers make the ALU powerful enough to ensure that the CPU is also powerful and fast, but not so complex as to become prohibitive in terms of cost and other disadvantages.

ALU is also known as an Integer Unit (IU). The arithmetic logic unit is that part of the CPU that handles all the calculations the CPU may need. Most of these operations are logical in nature. Depending on how the ALU is designed, it can make the CPU more powerful, but it also consumes more energy and creates more heat. Therefore, there must be a balance between how powerful and complex the ALU is and how expensive the whole unit becomes. This is why faster CPUs are more expensive, consume more power and dissipate more heat.

Different operation as carried out by ALU can be categorized as follows –

- **logical operations** − These include operations like AND, OR, NOT, XOR, NOR, NAND, etc.
- **Bit-Shifting Operations** − This pertains to shifting the positions of the bits by a certain number of places either towards the right or left, which is considered a multiplication or division operations.
- **Arithmetic operations** − This refers to bit addition and subtraction. Although multiplication and division are sometimes used, these operations are more expensive to make. Multiplication and subtraction can also be done by repetitive additions and subtractions respectively.

21. What are the 4 types of instruction type formats

- THREE ADDRESS
- TWO ADDRESS
- ONE ADDRESS
- ZERO ADDRESS

22. Define PC.

PC(program counter),It hold the address of the instruction to be execute next