



Unit 1

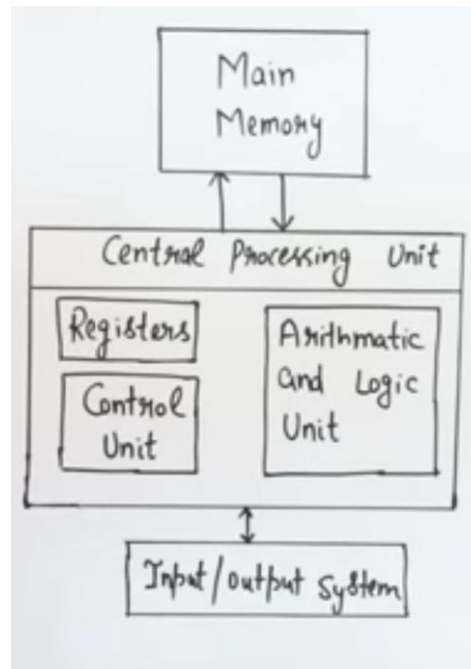
Explain basic computer functional units?

Functional units of computer are those essential different component which work together to execute instruction and carry out the overall functionality.

The units are:

1. CPU (Central Processing Unit): It is brain of a computer. It control the other components of computer. It perform arithmetic logical function and also execution of instruction.
2. Memory unit: This unit is responsive for the storing data, instruction. This unit has Ram, Rom. Ram is used to temporary storage and ROM for permanent storage
3. Input output unit: Input devices are devices that allow us to provide data or instruction to a computer. Example: keyboards or mice.
Output devices allows us to display or present information processed by the computer. Example: monitors or printers.
4. Arithmetic logical unit: It is a part of CPU, This unit perform arithmetic operation like addition subtraction multiplication division and logical AND, OR etc.
5. Register: It is also the part of CPU. It is a small High Speed storage within CPU used to temporally hold data and instruction during processing.

What is Von Neumann architecture? Characteristics?



It is a computer architecture that stores data and instruction in the same memory.

It described the structure of a computer with following key components –

CPU (The central processing unit): It is brain of a computer. It control the other components of computer. It perform arithmetic logical function and also execution of instruction.

It consist 3 major components:

i. **Control Unit(CU):**

- It is a part of CPU which is responsible for directing operation of the processor, means it handles all the instructions of processor.

ii. **Arithmetic and Logic Unit(ALU)**

- This unit performs arithmetic operation like addition, subtraction, division, multiplication and also perform logical instruction like AND, OR, etc.

iii. **Register:**

- It is also the part of CPU. It is a small High Speed storage within CPU used to temporally hold data and instruction during processing.

2. **Memory:** Stores data and instructions.

3. **I/O devices:** Input devices are devices that allow us to provide data or instruction to a computer. Example: keyboards or mice.

Output devices allows us to display or present information processed by the computer. Example: monitors or printers.

Characteristics

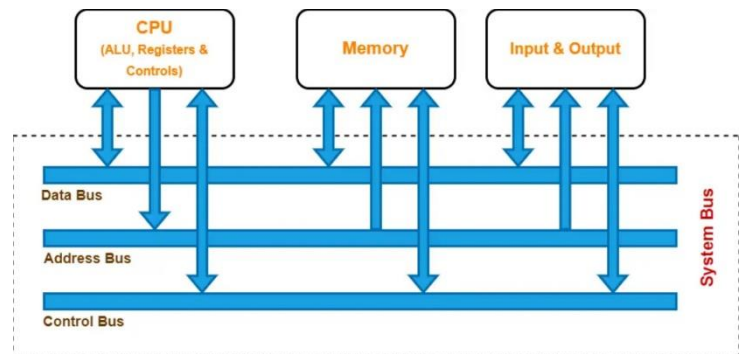
1. **Stored Program Concept:** Both data and instructions are stored in the same memory unit, allowing for the manipulation of program instructions as data.

2. **Sequential Execution:** Instructions are processed one after the other in a sequential fashion, ensuring orderly execution of programs.
3. **Single Control Unit:** A central control unit manages the execution of instructions, coordinating the flow of data and control signals within the system.
4. **Arithmetic Logic Unit (ALU):** Responsible for performing arithmetic and logical operations on data, the ALU is a critical component of Von Neumann architecture.
5. **Memory:** Programs and data are stored in a shared memory, enabling flexibility in programming and easy access to both instructions and data.

What is computer bus?

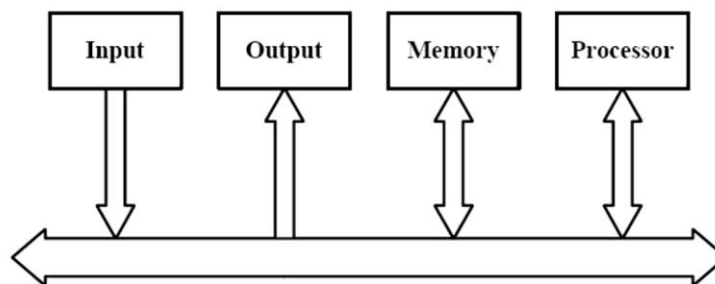
A bus is a communication pathway that allows data to be transferred between different computer components like CPU, memory etc.

- Types of bus
1. **Data Bus:** Transfers actual data between components.
 2. **Address Bus:** Specifies the memory address for data transfer.
 3. **Control Bus:** Carries control signals for coordinating activities.



Different Bus Structures:

1. **Single Bus:** A single bus architecture uses a single communication path for transferring data and control signals between different components of a computer system, such as the CPU, memory, and peripherals. It is simple but can lead to congestion.



2. **Multiple Buses (e.g., System Bus, Memory Bus):** Multiple bus architecture uses separate buses for different types of data or control signals.

For example, it may have one bus dedicated to data transfers between the CPU and memory, another for communication with peripherals.

This can enhance system performance by reducing contention for a single communication path.

Important Questions:

1. Explain the difference between Hardwired Control and Microprogrammed control.
 2. Explain the organization of control memory in Micro-programmed control with diagram.
 3. Write down the flowchart of both restoring and non-restoring division of integer numbers. (WBSCTE 2011, 2014, 2015, 2019)
 4. Show the non-restoring division steps of 13/3 (WBSCTE 2011, 2014, 2015)
 5. Write the algorithm of Restoring Division process. Show the restoring division steps of 12/3.
 6. Show the steps of multiplication using booth's algo 1011 * 10011
 7. RISC architecture is more suitable for pipeline implementation-explain. [WBSCTE 2014, 2019]
 8. Write down the features of RISC architecture?
 9. Explain different pipeline hazards and their possible solution. (2015)
 10. What do you mean by pipeline hazards/conflicts? Discuss the different types of hazards being observed and also explain the possible solutions. (2016, 2021)
 11. Discuss flynn's classification.
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Explain the work of control unit.

In computer architecture, the control unit is responsible for directing the various components of the CPU to execute instructions.

There are two main types of control units:

1. Micro-programmed Control Unit (MPC).
2. Hardwired Control Unit (HCU).

Micro-programmed Control Unit

a control unit that uses a set of microinstructions stored in memory to generate control signals.

The microinstruction is a set of instructions that can be modified or updated, allowing for greater flexibility and ease of modification.

❖ **Advantages:**

- **Easy Changes:** Microprogramming allows for quick updates and changes to the control signals without redesigning the entire CPU.
- **Simplified Instructions:** It helps create a simpler set of instructions, making it easier to design and understand complex operations.
- **Easier Debugging:** Debugging the control unit is more straightforward since microinstructions provide a clear link to machine instructions.
- **Supports Pipelining:** Microprogramming supports pipelining, a technique that improves instruction throughput.

❖ **Disadvantages:**

- Slower execution compared to hardwired control units due to the additional step of fetching microinstructions.
- Requires additional control memory, increasing overall hardware complexity.
- May consume more power compared to hardwired counterparts

Hardwired Control Unit (HCU)

HCU is a control unit that uses a fixed set of logic circuits to generate control signals for executing instructions. The control signals for each instruction are hardwired into the control unit, so the control unit has a dedicated circuit for each possible instruction.

❖ **Advantages:**

- Fast execution of instructions due to direct generation of control signals.
- Simple design and low hardware complexity.
- Typically more energy-efficient than microprogrammed control units.

❖ **Disadvantages:**

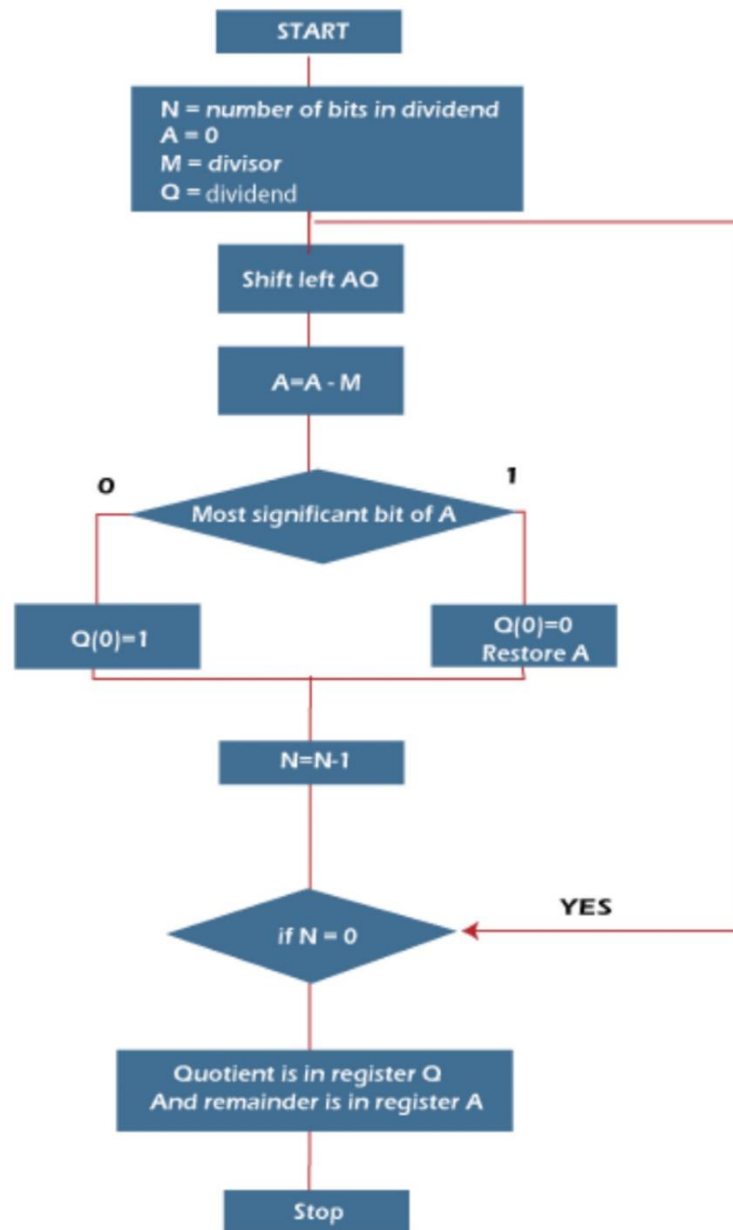
- Lack of flexibility; difficult to accommodate changes in the instruction set architecture.
 - Modifications to the control unit require hardware changes, making it less adaptable.
 - Prone to longer development cycles and increased complexity for larger instruction sets.
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Explain the functioning procedure of micro programmed control unit.

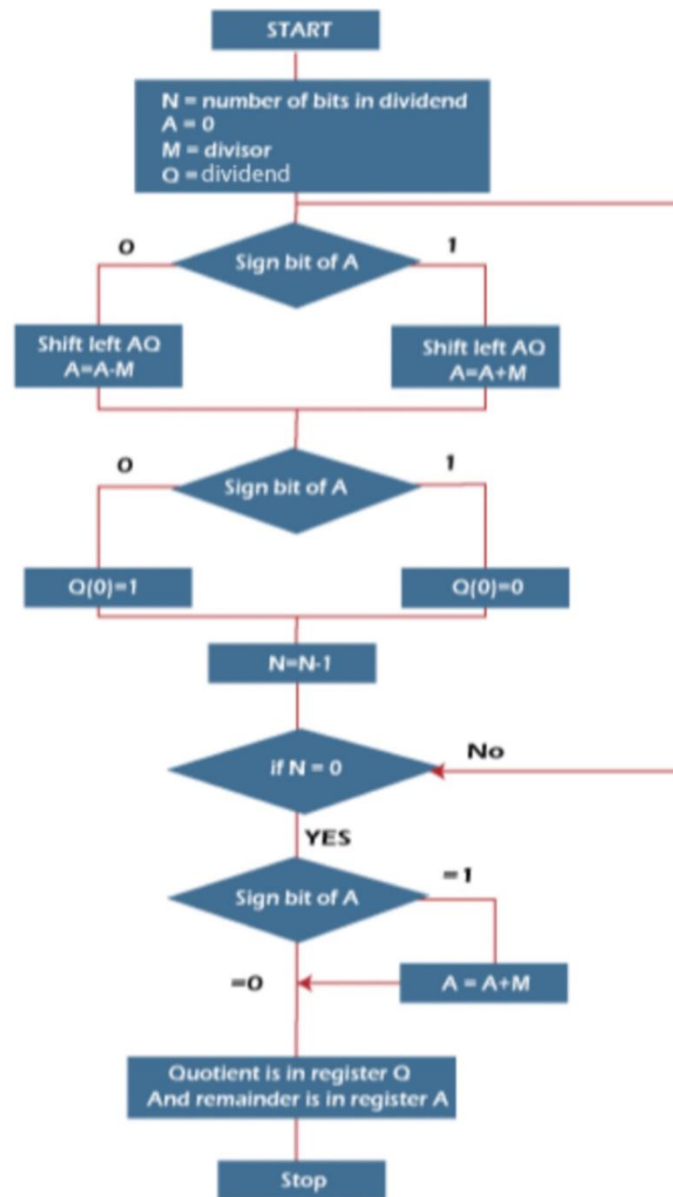
The main functioning procedure involves:

1. **Instruction Fetching:** Retrieve microinstructions from memory using the address derived from the current instruction.
 2. **Decoding:** Extract control signals from the fetched microinstruction, specifying operations to be performed during execution.
 3. **Execution:** Activate relevant components (e.g., ALU, registers) based on the decoded control signals to perform the desired operation for the given instruction.
 4. **Next Address Calculation:** Determine the address for the next microinstruction, often based on the result of the current operation or other conditions.
 5. **Branching:** Make decisions regarding control flow, leading to conditional or unconditional changes in the next microinstruction address.
 6. **Repeat:** Iterate through these steps for each instruction in the program, continually fetching, decoding, executing, and updating the microinstruction address until the program execution concludes.
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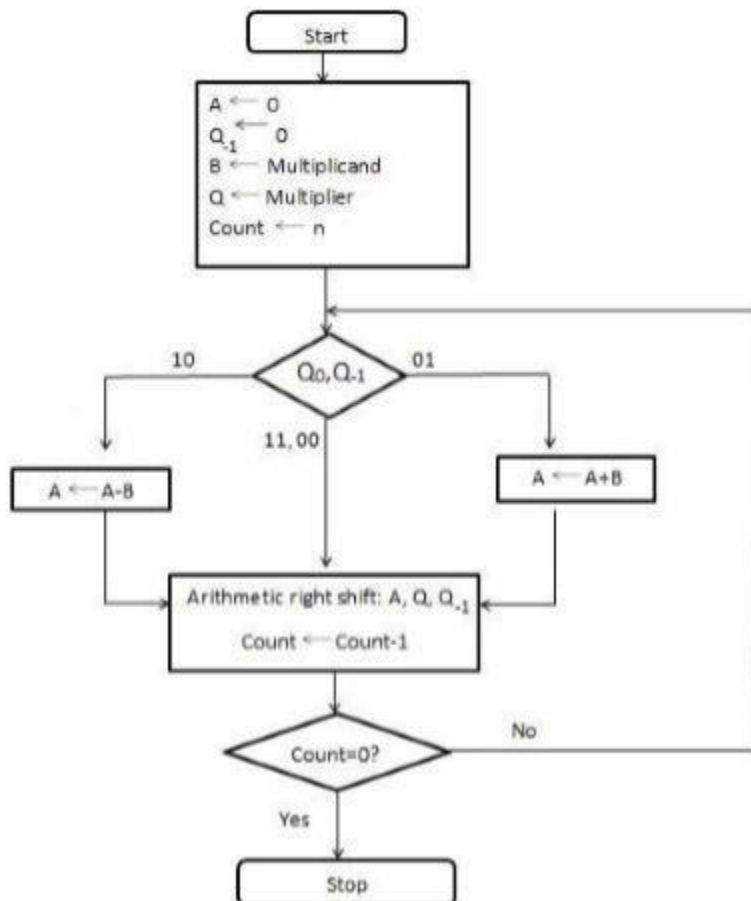
Flowchart of Restoring division Algorithm



Flowchart of non-restoring Algorithm



Flowchart of Booth's Algorithm



What is pipeline?

A pipeline is a process that breaks down instruction execution into stages, this enables processing of multiple instructions simultaneously. It increased efficiency.

What is pipeline hazards?

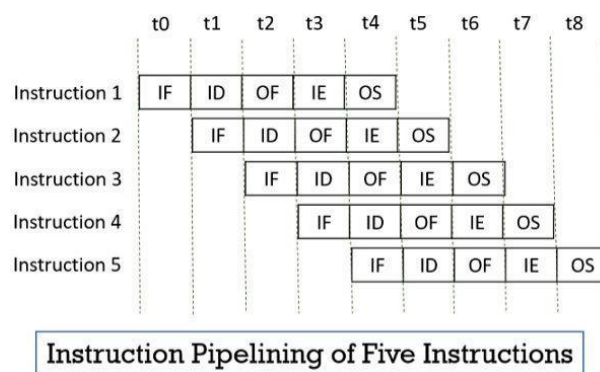
Pipeline hazards refer to disruptions in the continuous execution of instructions within a processor's pipeline architecture. These interruptions can happen for many reasons like data problem, changes in instruction flow, or problem in resource utilization.

Types:

1. Data Hazards: Data hazards occur in pipelining when the execution of one instruction depends on the results of another instruction that is still being processed in the pipeline.
2. Control Hazards (Instruction Hazards): This is caused by branch instructions in computer architecture. These instructions control the flow of program or instruction execution.
3. Structural Hazards: This arise when multiple instructions in the pipeline require access to the same resource in the same clock cycle. In this situation hardware is unable to handle all possible combinations.

What is Instruction pipeline?

An instruction pipeline reads instruction from the memory while previous instructions are being executed in other segments of the pipeline. Thus we can execute multiple instructions simultaneously.



What is RISC?

RISC (Reduced Instruction Set Computer) is a type of microprocessor architecture that uses a small, highly optimized set of instructions, aiming for simplicity and efficiency in the execution of tasks.

Examples: SPARC, POWER PC, etc.

Difference between RISC and CISC?

CISC	RISC
⦿ Emphasis on hardware	⦿ Emphasis on software
⦿ Multiple instruction sizes and formats	⦿ Instructions of same set with few formats
⦿ Less registers	⦿ Uses more registers
⦿ More addressing modes	⦿ Fewer addressing modes
⦿ Extensive use of microprogramming	⦿ Complexity in compiler
⦿ Instructions take a varying amount of cycle time	⦿ Instructions take one cycle time
⦿ Pipelining is difficult	⦿ Pipelining is easy

What is vector?

A vector is an ordered set of scalar data items, all of the same data type, stored in memory.

What is vector processor or array processor?

A vector processor is a specialized central processing unit (CPU) designed to efficiently execute instructions tailored for operating on large one-dimensional arrays of data called vectors.

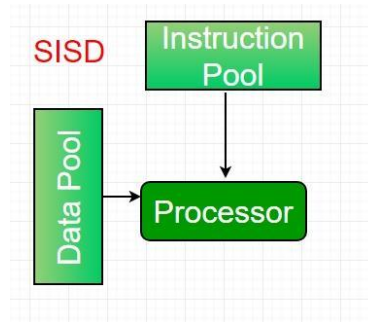
Flynn's classification:

Flynn's classification categorizes computer systems based on the number of instruction streams and data streams they can handle simultaneously.

There are four categories in Flynn's taxonomy:

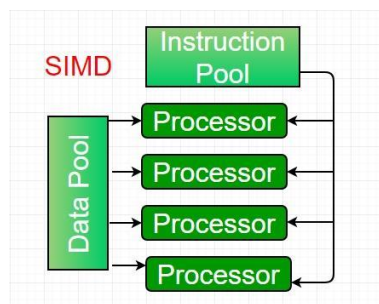
1. Single-instruction, single-data (SISD) systems:

This is an sequential processing model where one instruction is executed at a time on a single piece of data.

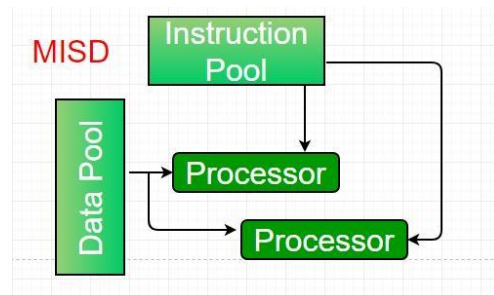


2. **Single-instruction, multiple-data (SIMD) systems:**

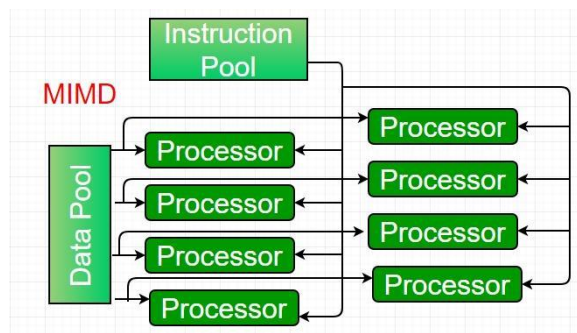
In this model, a single instruction is used to perform the same operation on multiple pieces of data simultaneously.



3. **Multiple-instruction, single-data (MISD) systems:** This multiprocessor machine is capable of multiple instructions operate on the same set of data.



4. **Multiple-instruction, multiple-data (MIMD) systems:** This model allows multiple processors to operate independently with their own set of instructions and data. Each processor can execute a different set of instructions on different data concurrently.

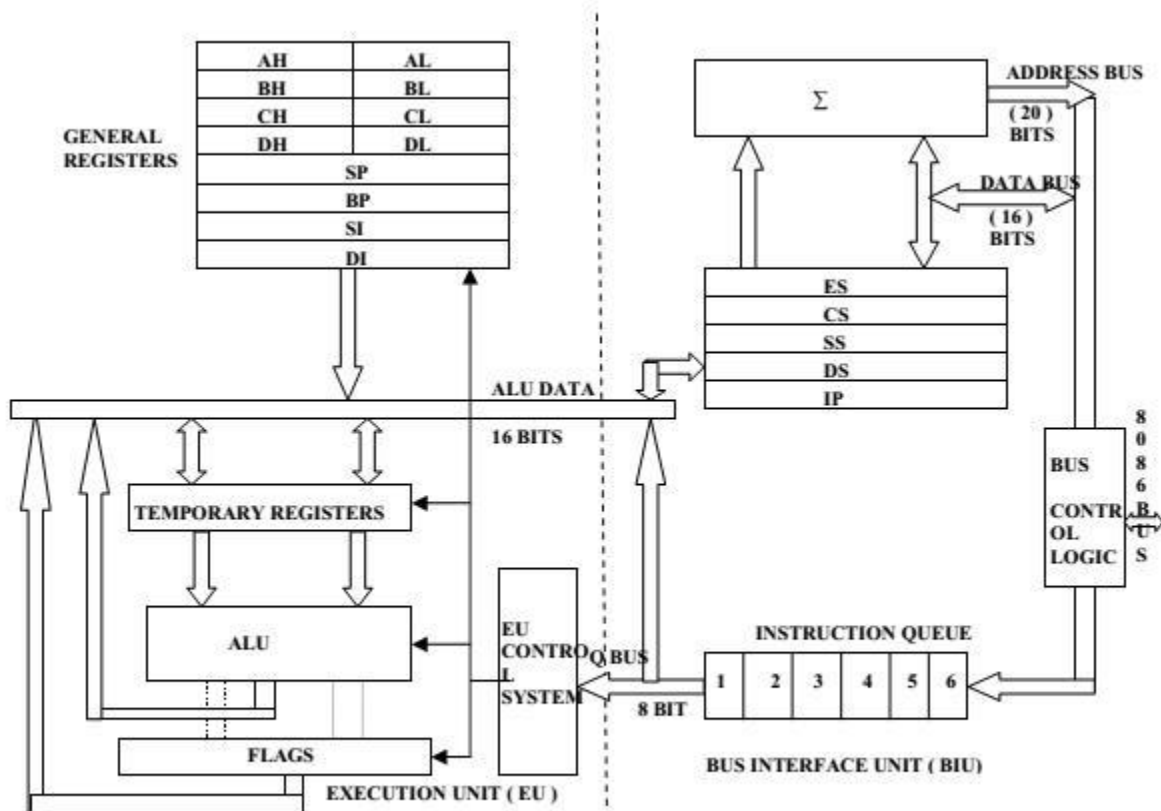


Unit 3

Basic idea about 8086 microprocessor:

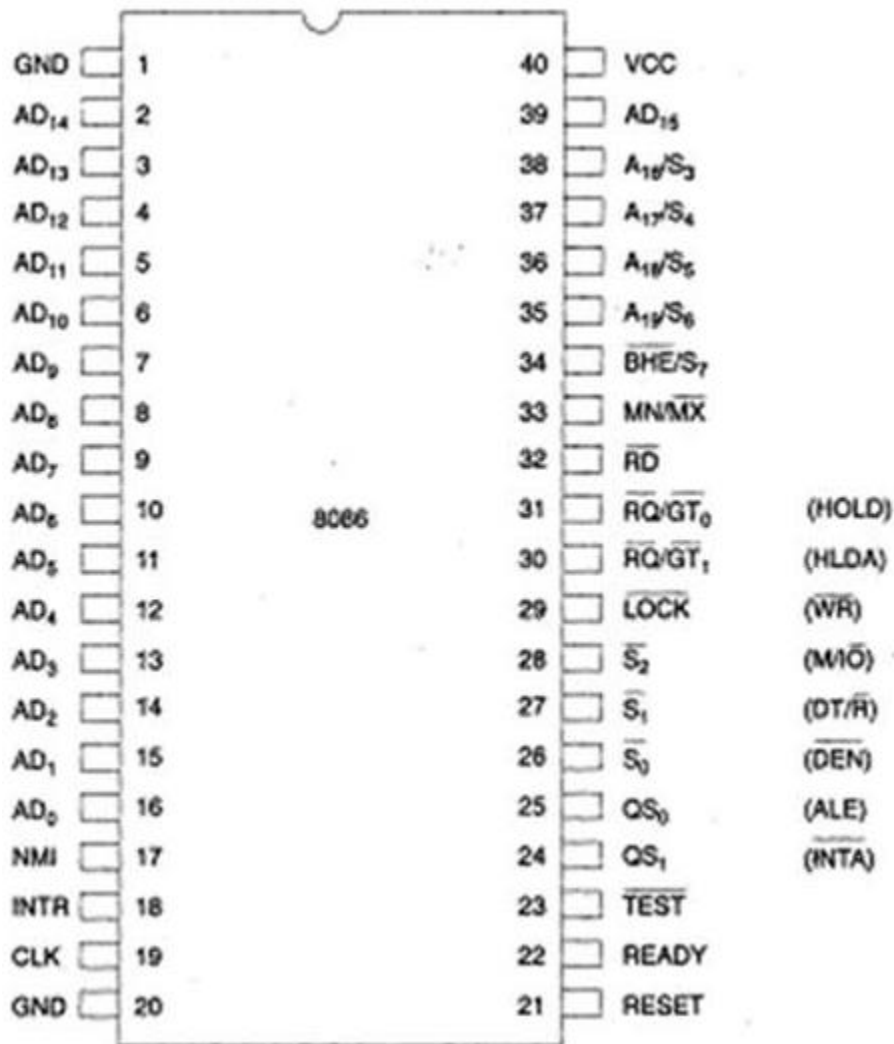
The 8086 microprocessor, introduced by Intel in 1976, is an improved version of the 8085 microprocessor. As a 16-bit processor, it features 20 address lines and 16 data lines, enabling a storage capacity of up to 1MB. It consists of powerful instruction set, which provides operations like multiplication and division easily.

Block Diagram of 8086:



Block Diagram of 8086

Pin Diagram of 8086:



Explain maximum and minimum mode of 8086 microprocessor?

In the 8086 microprocessor, there are two modes of operation: minimum mode and maximum mode:

Minimum mode

In this mode, 8086 microprocessor operates independently as the main processor, without any external coprocessors or support chip.

- Bus Configuration
Single 8-bit bus for both data and instructions.
Single 20-bit address bus.
- Support Chips:
Requires a minimum set of support chips like a clock generator, address latch, and bus controller.

Maximum Mode:

In this mode, 8086 microprocessor integrates with external coprocessors or support chips for enhanced system capabilities.

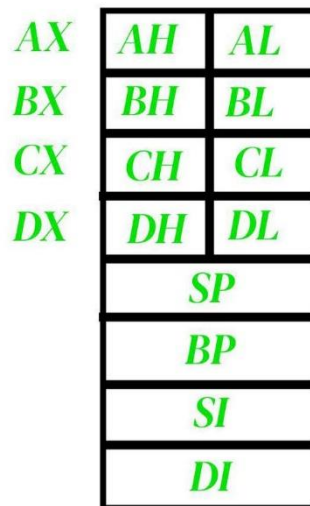
- **Bus Configuration:**
Multiplexed bus for both data and instructions.
Single 20-bit address bus.
- **Support Chips:**
Requires additional support chips, including a bus controller, clock generator, and data buffer.
- **Expansion Capability:**
Offers more capabilities for system expansion and integration with coprocessors.

General purpose registers in 8086 microprocessor

General-purpose registers are used to store temporary data within the microprocessor. There are 8 general-purpose registers in the 8086 microprocessor.

1. **AX (Accumulator):** Used for arithmetic and data operations. It is of 16 bits and is divided into two 8-bit registers AH and AL to also perform 8-bit instructions.
Example: ADD AX, AX ($AX = AX + AX$)
2. **BX (Base Register):** Often employed as a base register for memory access. It is of 16 bits and is divided into two 8-bit registers BH and BL to also perform 8-bit instructions.
Example: MOV BL, [500] ($BL = 500H$)
3. **CX (Counter Register):** Primarily used as a loop counter and for string operations. Example:
MOV CX, 0005
LOOP
4. **DX (Data Register):** Used in multiplication and division operations. It is of 16 bits and is divided into two 8-bit registers DH and DL to also perform 8-bit instructions. Example:
MUL BX ($DX, AX = AX * BX$)
5. **SI (Source Index):** Used as an index for the source in string operations. It is of 16 bits.
6. **DI (Destination Index):** Used as an index for the destination in string operations.

7. BP (Base Pointer): Typically points to the base of the stack frame.
8. SP (Stack Pointer): Points to the top of the stack. If the stack is empty the stack pointer will be (FFFE)H.



Explain different types Flag register of 8086 microprocessor

The flag register in the 8085 microprocessor is a special-purpose register that holds status flags indicating the outcome of arithmetic and logic operations. The flags are:

1. Sign flag(S): Set if the result of an operation is negative.
2. Zero flag(Z): Set if the result of an operation is zero.
3. Auxiliary Carry flag (AC): Used for Binary-Coded Decimal (BCD) arithmetic.
4. Parity flag (P): Set if the number of set bits in the result is even.
5. Carry flag (CY): Set if there is a carry-out from the most significant bit during addition or a borrow during subtraction.

What are the four segments registers of 8086

In the 8086 microprocessor architecture, there are four segment registers:

1. CS (Code Segment): Points to the beginning of the memory segment containing the currently executing program.
2. DS (Data Segment): Specifies the default location for storing and retrieving data.
3. SS (Stack Segment): Points to the segment where the stack is located, used for managing subroutine calls and local variables.
4. ES (Extra Segment): An additional segment register that can be used for extra data storage.

What is addressing mode? Different types of addressing

"addressing mode" refers to the method through which instructions receive the address of data or the destination address of the result.

1. **Immediate Addressing Mode:**

Definition: in this mode, the operand is specified directly within the instruction. It is a constant or immediate value rather than an address.

2. **Register Addressing Mode:**

Definition: Operand data is held in a processor register. The instruction refers directly to the register containing the data.

4. **Direct Addressing Mode:**

Definition: The operand's memory address is directly specified in the instruction. The data is located at the given address.

5. **Indirect Addressing Mode:**

Definition: The instruction specifies a memory address containing the actual address of the operand. It involves an extra memory access to fetch the operand.

6. **Indexed Addressing Mode:**

Definition: The operand's address is generated by adding a constant value or the content of another register to the index register.

7. **Relative Addressing Mode:**

Definition: Addresses are specified relative to the program counter or instruction pointer. It is commonly used in branch instructions to express offsets.

Unit 5

Different types of memory in computer

1. Primary Memory (or Main Memory):

- The main memory is the central storage unit. It is an essential component of a digital computer since it stores data and programs.

It is of two types:

RAM (Random Access Memory)

ROM (Read Only Memory)

2. Secondary Memory:

- Secondary memory is a type of computer memory that is used to store data and programs that can be accessed or retrieved even after the computer is turned off.
Example: Hard Disk Drive, Solid State Drive, DVDs etc.
3. Additional Memory:
- Cache Memory: Cache memory is a smaller high speed memory that stores copies of data from frequently used main memory location.
 - Virtual Memory: Virtual memory is a memory management method that uses a combination of physical RAM and disk space to expand available memory, enabling larger program execution and multitasking on computers.

What is cache memory?

Cache memory is a smaller high speed memory that stores copies of data from frequently used main memory location.

- Characteristics
 1. Cache is used to reduce time from accessing data from main memory.
 2. It is stays between the main memory and CPU.
 3. It is costlier than many memories.

Advantage of cache memory

- Faster Access Speeds: Cache memory is faster than main memory, reducing CPU wait times for data retrieval.
- Improved CPU Performance: By storing frequently accessed instructions and data, cache minimizes the need to access slower RAM or storage.
- Lower Power Consumption: Accessing cache requires less energy compared to fetching data from main memory or external storage.
- Temporary Storage: It serves as a temporary storage area for frequently used instructions and data, facilitating efficient execution of programs and tasks.
- Smaller Size: Cache memory is designed to be smaller in size compared to main memory, allowing for faster access due to its proximity to the CPU.

Virtual memory

Virtual memory is a memory management method that uses a combination of physical RAM and disk space to expand available memory, enabling larger program execution and multitasking on computers.

Advantage

- Enables Multitasking: Virtual memory allows multiple programs to run concurrently, as it provides the illusion of abundant memory space by utilizing both RAM and disk storage.
- Larger Program Execution: It facilitates the execution of larger programs that may not fit entirely into physical RAM, as data can be swapped between RAM and disk as needed.

- **Efficient Resource Utilization:** Virtual memory optimizes the utilization of physical RAM by allowing the operating system to store less frequently used data on the disk, freeing up space for actively used programs.
- **User Experience Improvement:** Users experience smoother multitasking and are able to run resource-intensive applications without encountering memory-related constraints.

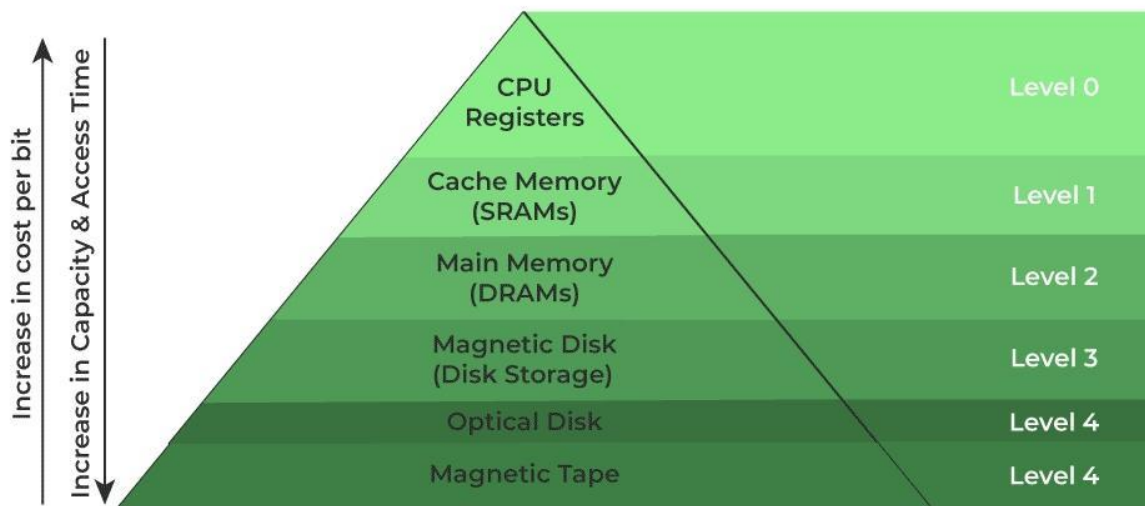
Memory hierarchy

Level 0 or Register: It is a type of memory in which data is stored and accepted that are immediately stored in the CPU. The most commonly used register is Accumulator, Program counter, Address Register, etc.

Level 1 or Cache memory: It is the fastest memory that has faster access time where data is temporarily stored for faster access.

Level 2 or Main Memory: It is the memory on which the computer works currently. It is small in size and once power is off data no longer stays in this memory.

Level 3 or Secondary Memory: It is external memory that is not as fast as the main memory but data stays permanently in this memory.



Memory Hierarchy Design

Virtual memory vs Cache memory

	Virtual Memory	Cache memory
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Basic	Extends memory capacity for the user Speeds up data access	Speeds up data access for the CPU
Function	Allows execution of larger programs	Stores copies of recently used data for faster execution
Memory management	Managed by the operating system	Managed by hardware
Size	Far larger than Cache memory	Bounded size
Mapping	Requires mapping structures	No mapping structures required
Nature	It is a technique	Its is a storage unit

SRAM vs DRAM

Static RAM	Dynamic RAM
➤ SRAM uses transistor to store a single bit of data	➤ DRAM uses a separate capacitor to store each bit of data
➤ SRAM does not need periodic refreshment to maintain data	➤ DRAM needs periodic refreshment to maintain the charge in the capacitors for data
➤ SRAM's structure is complex than DRAM	➤ DRAM's structure is simplex than SRAM
➤ SRAM are expensive as compared to DRAM	➤ DRAM's are less expensive as compared to SRAM
➤ SRAM are faster than DRAM	➤ DRAM's are slower than SRAM
➤ SRAM are used in Cache memory	➤ DRAM are used in Main memory