Task 10

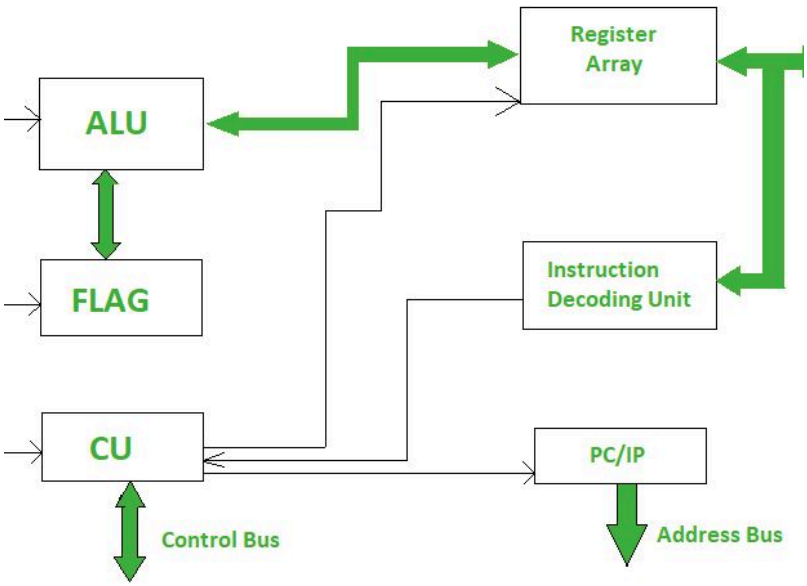
- **EMBEDDED SYSTEMS** 💻

is a combination of computer hardware and software designed for a specific function. Embedded systems might also function within a larger system. These systems can be programmable or have a fixed functionality.

- **Microprocessor**

A Microprocessor takes a bunch of instructions in machine language and executes them, telling the processor what it has to do. The microprocessor performs three basic things while executing the instruction:

- It performs some basic operations like addition, subtraction, multiplication, division, and some logical operations using its Arithmetic and Logical Unit (ALU). New Microprocessors also perform operations on floating-point numbers.
- Data in microprocessors can move from one location to another.
- It has a Program Counter (PC) register that stores the address of the next instruction based on the value of the PC, Microprocessor jumps from one location to another and makes decisions.



- **Microprocessor internal components**

1. **Arithmetic Logic Unit (ALU) : performs arithmetic operations**
2. **Control Unit (CU) : Directs the flow of data and instructions inside the processor.**

3. **Registers : Small, high-speed storage locations inside the CPU.**
   types of registers : (ACC-IR - PC -SP - GP)
4. **Cache Memory (in modern CPUs)**
5. **Clock**
6. **Buses (Data Pathways) : Internal communication lines that connect components.**

- **Data Bus : transfers actual data.**
- **Address Bus : carries memory or I/O addresses.**
- **Control Bus : carries control signals (read/write, interrupt, etc.).**

▢ Complex Instruction Set Computer (CISC)

CISC or Complex Instruction Set Computer is a computer architecture where instructions are such that a single instruction can execute multiple low-level operations like loading from memory, storing into memory, or an arithmetic operation, etc. It has multiple addressing nodes within a single instruction. CISC makes use of very few registers.

▢ Reduced Instruction Set Computer (RISC)

RISC or Reduced Instruction Set Computer is a computer architecture where instruction is simple and designed to get executed quickly. Instructions get completed in one clock cycle this is because of the optimization of instructions and pipelining (a technique that allows for simultaneous execution of parts, or stages, of instructions more efficiently process instructions). RISC makes use of multiple registers to avoid large interactions with memory. It has few addressing nodes.

• INSTRUCTION CYCLE

1. **Fetch: In this step, the microprocessor fetches the instruction from the memory location pointed to by the program counter (PC). The PC is incremented by one after the fetch operation.**
2. **Decode: Once the instruction is fetched, the microprocessor decodes it to determine the operation to be performed and the operands involved.**
3. **Execute: In this step, the microprocessor performs the operation specified by the instruction on the operands.**

4. **Store: Finally, the result of the execution is stored in the appropriate memory location or register**

- **PIPELINING**

a computer architecture technique that improves CPU performance by breaking instruction execution into sequential, overlapping stages. Instead of one instruction finishing before the next begins, multiple instructions are processed concurrently, with each instruction in a different stage of completion. This assembly-line-like approach increases the processor's efficiency and overall instruction throughput, similar to how a fast-food drive-through processes multiple orders at once

- **Memory**

1. **volatile memory**
2. **Non-volatile memory**
3. **Hybrid memory**

- ## volatile memory

Needs power to keep data → data lost when power is off.

Examples: RAM (SRAM, DRAM), Cache, Registers.

Pros: Very fast, good for running programs.

Cons: Loses data on shutdown, expensive, power-hungry.

- ## Non-volatile memory

Keeps data without power.

Examples: ROM, Flash .

Pros:*Permanent storage, cheaper per GB, low idle power.

Cons: Slower than RAM, limited write cycles (Flash).

- ## Hybrid memory

Mix of RAM speed + Non-volatile storage.

Examples: NVRAM .

Pros: Fast and retains data, durable.

Cons: Very costly, smaller capacity, less common