

Microprocessors and Microcontrollers

This report shall discuss the following topics:

- Topic 1: Microprocessors
- Topic 2: Microcontrollers
- Topic 3: Microprocessors vs Microcontrollers

1) Topic 1: Microprocessors

- A microprocessor is a programmable electronic device that acts as the Central Processing Unit (CPU) on a single IC.
- It can perform arithmetic, control, logical and input/output operations.
- It requires external devices like memory (RAM, ROM) and I/O devices to function.
- Working of a Microprocessor
 - Microprocessors operate following the Fetch-Decode-Execute cycle
 - The next instruction is fetched from the memory in the Fetch step.
 - In the Decode step, the Control Unit decodes the instruction into control signals.
 - In the Execute step, the Arithmetic Logic Unit performs the instructions to get an output, which is then stored in the memory.
- Architecture and Components of a Microprocessor
 - The Arithmetic Logic Unit (ALU) performs arithmetic and logical operations, working closely with the registers to process data.
 - The Registers are small high speed memory units used to store instructions, addresses and intermediate results.
 - The Control Unit coordinates all the operations of the microprocessor, decoding instructions, generating control signals, and controlling data flow between the ALU and Registers.
 - The Buses are used to transfer data between different components.
- Commonly used Microprocessors
 - Intel x86 line beginning with the 8086. The x86 architecture was quickly adopted due to its back compatibility with programs written for 8-bit processors and Complex Instruction Set Computing which allows a single instruction to perform multiple operations made it efficient.

- It has become a baseline for newer processors, such that 32- and 64-bit processors like Intel i9 and AMD Ryzen 7000 are still made on the x86 line.
- Advanced RISC (Reduced Instruction Set Computer) Machines (ARM) are used in lightweight low power devices due to their low cost, power consumption, and heat generation. They focus on efficiency rather than performance like the x86 does. Examples include the Apple M1-3 series chips.
- The Nvidia Jetson Nano uses an ARM Cortex-A57 processor.

2) Topic 2: Microcontrollers

- A microcontroller is an IC that combines the ALU and memory on the same chip, allowing higher efficiency and lower power at the cost of programmability.
- Working of a Microcontroller
 - Microcontrollers work on the Fetch-Decode-Execute cycle like microprocessors do. They simply integrate memory on board instead of as a separate component.
- Architecture and Components of a Microcontroller
 - Microcontrollers have similar components to microprocessors, but their architecture is different due to the inclusion of memory on chip.
 - Microcontrollers have memory in the form of ROM and RAM alongside the components of microprocessors.
 - Peripherals like General Purpose I/O (GPIO) allow interfacing of LEDs, switches, sensors and relays.
 - Timers like crystal oscillators are often included too.
- Commonly used Microcontrollers
 - The Intel 8051 or MCS-51 is a highly versatile low power MCU used in ECUs, sensors, and many consumer electronics like remotes, toys, glucose meters, pacemakers etc.
 - ATmega MCUs are used in Arduino development boards, with the ATmega328P being used in Arduino Uno boards.

3) Topic 3: Microprocessors vs Microcontrollers

- Microprocessors are designed for general purpose computing, allowing a large range of tasks to be achieved with high performance.

- Microcontrollers are designed for specific control tasks, where a minimal number of external parts are needed and efficiency is key.
- With the correct external parts, a microprocessor can do what a microcontroller does, but it will likely not be as efficient as a microcontroller.
- This difference decides where they get used, as devices like TV remotes do not require high performance, but just a simple controller, so a microcontroller would be preferred.