Dear students!

Today we are going to learn, a new course.

That is Microcontroller Architecture And Programming.

The name of the module is microprocessor and microcontroller.

These outlines of the course are:

1. Introduction
2. Microprocessors and Microcontrollers
3. Microcontroller types

These are the learning outcomes:

At the end of the module, learner will be able to:

- Understand the difference between microprocessors and microcontrollers.
- Describe the prominent standard features of a typical microcontroller.
- Understand the different types of Microcontroller.
- Name several contemporary microcontroller manufacturers.

Today, the technology has drastically changed the world around us.

The credit goes to the developments in fabrication of integrated circuits, commonly known as IC's and the invention of microprocessors and hence the computers.

The computers, started to be widely used in the field of computations and processing in scientific areas and thereafter in defense, industries, business, education, etc. and now in private uses too. This was mainly possible due to the developments in microprocessors.

Now let us make clear, the difference between the computer and the microprocessor.

Computer : A computer is an electronic device, used for storing and processing data, as per the instructions given to it. The data is in binary form, and the arrangement of sequence of instructions (also in binary form) required to operate the computer, is known as computer program.

Computer operations, are carried out in a special, binary circuit called, a central processing unit- CPU

A computer CPU, is made of semiconductor material (usually silicon) consisting of, millions of transistor arrangement, which is employed to perform the different operations like addition, subtraction, logic functions etc. The CPU is to be “told what to do” or programmed by a sequence of binary values called the “computer program” and is stored in a separate device called memory. This memory, again is made of semiconductor material, consisting of millions of transistor arrangement, referred as an Integrated circuit.

The CPU is designed to automatically get the sequence of instructions, from the memory, and do the processing.

Thus “the fundamental” of computer, is CPU and the memory.

Microprocessor : Microprocessor, is a general-purpose digital -CPU on a chip.

To make a complete computer, from microprocessor, one must add memory (ie. RAM and ROM), oscillator, parallel and serial data ports, “special purpose devices”, such as counters, interrupt handlers, input/output devices etc. By adding mass storage devices like disk drive and I/O peripheral devices such as keyboard and CRT display, yield a computer which can be used to run the general-purpose, software applications.

The term microprocessors includes, a basic hardware architecture. So that any type of system, small or big can be configured as per the application demands.

The prime use of microprocessor is

- to read data,
- perform, extensive calculations on the data
- store those calculations and
- display, the results for human use.

Microcontrollers: we all are familiar with the smart devices like DVD, TV, washing machines, telephones, etc. … list is big, which are, programmable and “very intelligent”. They use microcontrollers.

What is microcontroller?

A by-product of microprocessor development, was a Microcontroller. The same fabrication technique and programming concepts, that make possible, the general-purpose microprocessor, is also used for microcontrollers.

Fig 2. shows the block diagram of a typical microcontroller. The design has all the features required, to make a complete, computer. Thus a microcontroller is a true computer on chip.

Like microprocessor, a microcontroller is a general- purpose device, that is meant to read data, perform limited calculations on the data, and control its environment based on those calculations.

The basic functional block of microcontroller contains ALU, RAM, ROM, PC, SP, I/O ports, interrupts, clock timer etc. The details of each of these blocks will be learned in the next module.

The prime use of the microcontroller is to control the operation of a machine using fixed program, that is stored in the ROM and that does not change over the, "life time" of the system.

Comparing Microprocessors and Microcontrollers

1. The microcontroller can function as a computer with out adding any external digital parts. While microprocessor must have many additional parts to be operational.

2. Microprocessor is concerned with rapid movement of code and data from external address to chip, while Microcontroller is concerned with rapid movement of **bits** within the chip.
3. Microprocessor have many operational codes (op codes) for moving data from external memory to the CPU while Microcontroller may have one or two.

Let use summaries the difference between Microprocessor & Microcontroller

- General-purpose microprocessor contains
    - No RAM
    - No ROM

No, I/O ports. The microprocessor, have the advantage of versatility on the amount of RAM, ROM, and I/O ports and thus any powerful computation may be achieved. While microcontroller has

- CPU (microprocessor)
- RAM
- ROM
- I/O ports
- Timer
- ADC and other peripherals
- Less computing power

The fixed amount of on-chip ROM, RAM, and number of I/O ports makes it suitable for very specific purpose applications, with much less cost.

TYPES OF MICROCONTROLLERS

Microcontroller can be categorized on the basis of architecture and service providers.

a. **ACCORDING TO BITS.**

1) **4-BIT MICROCONTROLLERS**: ALU performs arithmetic and logical operations on a nibble - a 4-bits instruction. Internal bus width is of 4-bits only. It is Small size, minimum pin count and low cost controllers. It is a, Low power consumption device and used for low end applications like LED & LCD display drivers, portable battery chargers, etc.

   Examples: Renasa M34501 256 and ATAM862 series from ATMEL, are the examples as seen on the display.

2) **8-BIT MICROCONTROLLERS** : ALU performs arithmetic and logical operations on a byte (8-bits) instruction. Internal bus width is 16-bits wide .

   Examples: Intel 8051 family and Motorola MC68HC11 family.

3) **16-BIT MICROCONTROLLERS** : ALU performs arithmetic and logical operations on a word (i.e. 16-bits) instruction. And its internal bus width is also 16-bit. This device gives enhanced performance, computing capability and greater precision as compared to the 8-bit microcontrollers.

Examples: Intel 8096 family, Motorola MC68HC12 and MC68332 families.

4) **32-BIT MICROCONTROLLERS**: ALU performs arithmetic and logical operations on a double word (i.e. 32-bits) instruction. Internal bus width of 32-bit. This device gives much more enhanced performance, computing capability with greater precision as compared to 16-bit microcontrollers.

Examples: Intel 80960 family, Motorola M683xx and Intel/Atmel 251 family

b. ACCORDING TO MEMORY/DEVICES

1) **EMBEDDED MICROCONTROLLERS** : An embedded system has a microcontroller unit that has all the functional blocks (including program as well as data memory) available on a the single chip.

Example: 8051, 8052

The 8051 device has Program & Data Memory, I/O Ports, Serial Communication, Counters and Timers and Interrupt Control logic all on the single chip.

2) **EXTERNAL MEMORY MICROCONTROLLERS**: this system has a microcontroller unit that does not have all the functional blocks available on a chip. All or part of the memory units are externally interfaced using additional an interfacing circuits.

   Example: 8031 This device has no program memory on the chip.

c. ACCODING TO INSTRUCTION SET

1) **CISC (COMPLEX INSTRUCTION SET COMPUTER) ARCHITECTURE MICROCONTROLLERS:** Has an instruction set that supports, many addressing modes for the arithmetic and logical instructions, data transfer and memory accesses instructions. Many of the instructions allows the programmer to use one instruction in place of many simpler instructions.

   Example: Intel 8096 family.

2) **RISC (REDUCED INSTRUCTION SET COMPUTER) ARCHITECTURE MICROCONTROLLERS:** Contains an instruction set that supports, fewer addressing modes, for

the arithmetic and logical instructions, and for data transfer instructions. Allows simultaneous access of program and data. This increases execution speed; Allow each instruction to operate on any register or use any addressing mode; has Smaller chip size and pin count and, lastly consumes very low power.

d) ACCORDING TO MEMORY ARCHITECTURE

The architectures of microcontrollers differ in the way data and programs, are stored and accessed.

1) ***VON-NEUMAN*** **/ PRINCETON ARCHITECTURE:** Single data bus, is used to fetch both instructions and data. The program instructions and data are stored in a common main memory. When such a microcontroller addresses main memory, it first fetches an instruction, and then it fetches the data to support the instruction. This architecture simplifies the microcontroller design because only one memory is accessed. The weakness is that two separate, fetches can slow up the controller's operation.

   Example: Motorola 68HC11.

2) **HARVARD ARCHITECTURE** : Separate data bus and an instruction bus is used. Execution occur, in parallel.

Therefore much faster execution of the programme takes place than *Von-Neuman* architecture. Design complexity is the major challenge for this architecture.

Example: Intel MCS-51 family and PIC microcontrollers (Programmable Intelligent Computer).

The reference / books are shown on the display.

Thank you very much.