UNIT-6 MICROCONTROLLER

MICROPROCESSOR :

A microprocessor is an integrated circuit (IC) which incorporate core functions of a computer's central processing unit (CPU). It is a programmable, multipurpose, silicon chip, clock driven, register based, accepts binary data as input and provides output after processing it as per the instructions stored in the memory.

MICROCONTROLLER :

* A Microcontroller is a computer system on a chip that does a job. It contains an integrated processor, memory (a small amount of RAM, program memory, or both) and programmable input/output peripherals, which are used to interact with things connected to the chip.
* Basically microcontroller consists of following components
  - → central processing unit (CPU)
  - → program memory (Rom - Read only memory)
  - → Data memory (Random Access memory)
  - → Timers & Counters
  - → I/O ports (I/O - input/output)
  - → Serial communication interface
  - → Clock circuit (oscillator circuit)
  - → Interrupt Mechanism
* Based on bits we have three type of microcontroller
  - → 8 bit Microcontroller
  - → 16 bit Microcontroller
  - → 32 bit Microcontroller

Need of Microcontroller :

- Microcontroller are embedded within such devices so that they can control the features or actions of those devices.
- Another name for a Microcontroller is therefore an Embedded controller.
- A Microcontroller is required to gather inputs via various sensors, human intervention etc.

Advantages of Microcontroller :

* It is special type of processor which is small, flexible so program will run easily
* It has fast speed because integrated inside processor
* It is very chip in circuit
* It takes small time for perform tasks
* It is easy to use and maintain
* Same time it will perform task so human effort saved much more
* It is easy to interface RAM, Rom

Disadvantages of Microcontroller

* It has more complex architecture
* It takes more time in development so cost increase
* It can't interface high power device
* It is used in micro equipment mostly.

Distinguish between microprocessor and microcontroller

Microprocessor	Microcontroller
-> Microprocessor is the heart of computer system	-> Microcontroller is the heart of embedded system
-> It is just a processor, memory and I/O components have to be connected externally	-> Microcontroller has external along with external memory and I/O components.
-> Cannot be used in compact systems and hence inefficient	-> Can be used in compact systems and hence it is an efficient technique
-> Cost of the entire system increase	-> Cost of the entire system is low.
-> Due to external components the entire power consumption is high, Hence it is not suitable to used with devices running on stored power like battery	-> Since external components are low, total power consumption is less and can be used with devices running on stored power like batteries
-> most of the microprocessor do not have power saving features	-> most of microcontroller have power saving mode
-> Since memory and I/O components are all external each instruction will need external operation, hence it is relatively slower	-> Since components are internal, most of the operation are internal hence speed is fast.

Microprocessor	Microcontroller
* Microprocessor have less number of registers, hence more operations are memory based	→ microcontroller have more number of registers, hence the programs are easier to write
→ microprocessor have less number of registers, hence more operations are memory based	→ microcontroller have more number of register, hence the programs are easier to write
→ microprocessor are based on von neumann model / architecture where program and data are stored in same memory module	→ microcontroller are based on harvard architecture where program memory and data memory are separate
→ It is used for general purpose	→ It is used for application purpose

Classification of microcontroller :

Different microcontroller are

1. 8 bit microcontroller
2. 16 bit microcontroller

8 bit Microcontroller :

* 8 bit Microcontroller is basically used to execute arithmetic and logical operation like addition subtraction, Multiplication & division.

* It process 8 bits of data at a time

Exa: intel 8031 and 8051 microcontroller

* 31 has 64 Kb program memory address space and 64Kb data memory address space
* The microcontroller can only read from program memory such as ROM/EPROM/EEPROM and the signal PSEN is used as read control for reading program memory.
* The Microcontroller can read and write with data memory RAM.

16 bit Microcontroller :

* The width of the data pipe line in 16 bit Microcontroller is 16 bit
* A 16 bit microcontroller is a self-contained system that includes memory, a processor and peripheral that can easily be embedded to any system to enable smooth operation.
* 16 bit microcontroller are more efficient in processing math operations on numbers that are longer than 8 bit
* It is more accurate and have longer digits

CISC Processor :

* A complex instruction set computer (CISC) is a computer in which single instruction can execute several ~~several~~ low level operations (such as a load from memory an arithmetic operation, and a memory store)
* It contain a large set of computer instructions that range from very simple to very complex.
* It is used in automation devices.

RISC Processors :

* A reduced instruction set computer or RISC is a computer instruction set that allows a computer microprocessor to have fewer cycles per instruction
* A RISC computer has a small set of simple and general instructions rather than a large set of complex and specialized one.

Difference between CISC and RISC instructions :

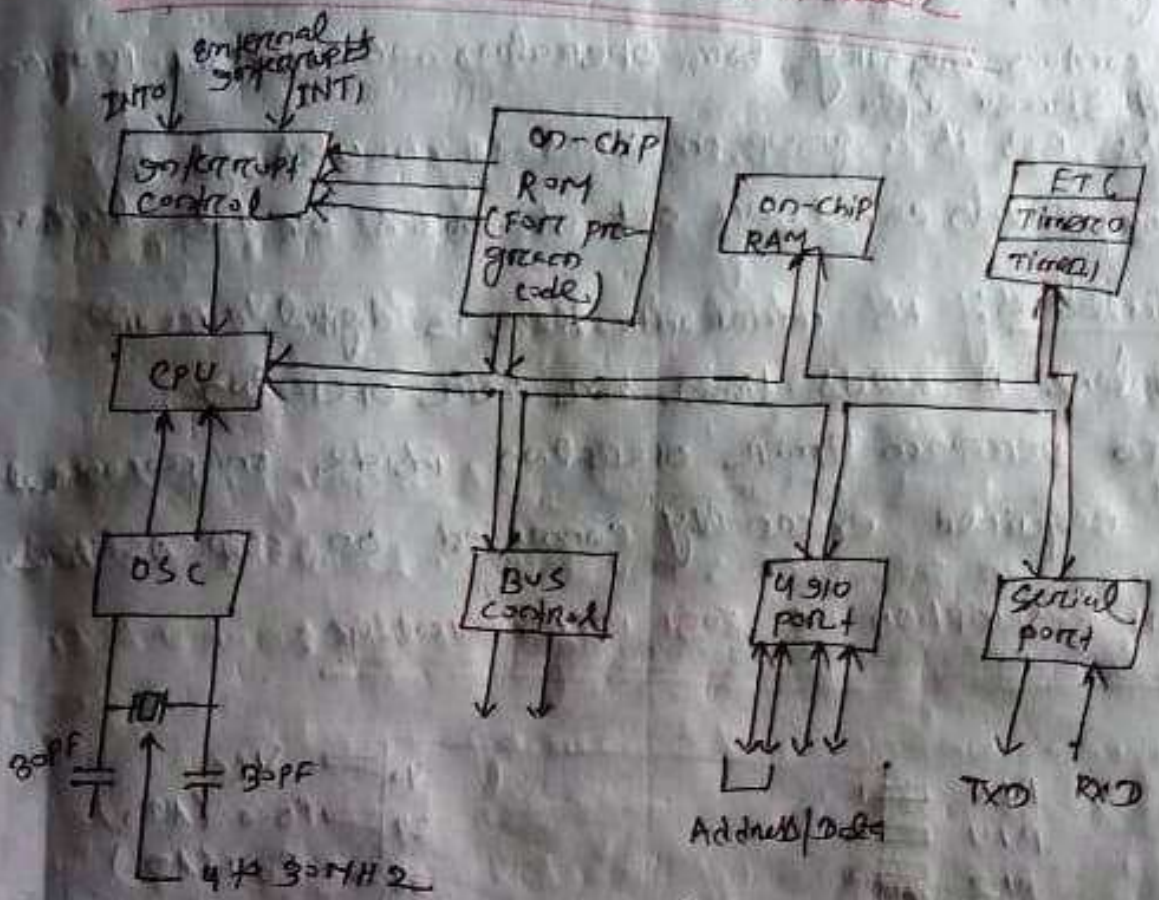
CISC	RISC
* Emphasis on hardware	* Emphasis on software
* multiple instructions sizes and formats	* Instructions of same set with few formats
* Less Register	* Uses more Register
* More addressing modes	* Fewer addressing modes
* Extensive use of micro-programming	* Complexity in compiler
* Instructions takes a varying amount of cycle time	* Instruction take one cycle time
* Pipelining is difficult	* Pipelining is easy.

8051 Microcontroller :

* It is designed by Intel in 1981
* It is an 8bit microcontroller
* It is built with 40 pins DIP.
* It uses 4kb of ROM
* It uses 128 bytes of RAM

* It uses 2, 16 bit timers.
* It consists of four parallel 8 bit ports, which are programmable as well as addressable as per the requirement.

Architecture of 8051 microcontroller



* In the following diagram, the system bus connects all the supporting devices to the CPU.
* The system bus consists of an 8 bit data bus, a 16 bit address bus and bus control signal.
* All other devices like program memory ports, data memory, serial interface, interrupt control, timers, and the CPU are all interfaced together through the system bus.
* It contains the CPU that acts as a brain of any processing machine. The CPU synchronizes and manages all processes that are carried out in microcontroller.

* Pin 1 to 8 → These pins are known as port 1. This port doesn't serve any other function. It is internally pulled up bi-directional I/O port.
* Pin 9 It is a RESET pin which is used to reset the microcontroller to its initial value.
* pins 10 to 17 These pins are known as port 3. This port serves some functions like interrupt, timer, inputs control signal, serial communication signal RXD and TXD etc.
* PIN 18, 19 : These pins are used for interfacing an external crystal to get the system clock.
* Pin 20: This pin provide the power supply to the circuit.
* Pins 21 to 28 : These pins are known as PORT 2. It serves as I/O port. Higher order address bus signals are also multiplexed using this port.
* Pin 29 This is PSEN pin which stands for program store enable. It is used to read a signal from the external program memory.
* Pin 30 : This is a EA pin which stands for external access input.
* PIN 31 : This is ALE pin. which stands for Address latch enable. It is used to demultiplexed the address data signal of the port.
* Port 32 to 39 : These pin are known as port 0. It is served as I/O port. Lower order address and data bus signals are multiplexed using these signal.
* Port 40 : These pin used to provide power supply to the circuit.

8051 Memory organization :

The 8051 microcontroller memory is devided into
→ program memory
→ Data memory

Program memory :

Program memory is used for permanent saving program being executed. The memory is read only. Depending on the setting mode in compiler program memory may also used to store a constant variable

External Data memory :

up to 256 bytes of external data memory available depending on the 8051 derivative. Locations available to the user occupy addressing space from 0 to FFh

* Science external data memory used for CALL stack also and there is only 256 bytes splited over two diffrent memory areas time utilizing of this memory is crucial for fast and compact code.

External Data memory :

Access to External data memory is slower than access to external data memory. There may be upto 64K bytes of external data memory.

SFR Memory :

* The 8051 provides 128 bytes of memory for Special function Registers. SFRs are bit, byte, or word sized registers that are used to control timers counters, serial I/O, port I/O and peripherals

Addressing mode of 8051 microcontroller

Addressing modes are an aspect of the instruction set architecture in most central processing unit designs.

Different addressing mode are

- → immediate addressing mode
- → Register addressing mode
- → Direct addressing mode
- → Indirect addressing mode
- → Register indirect addressing mode
- → Implied Addressing mode

Immediate addressing mode

In this immediate Addressing mode, the data is provided in the instruction itself.

Eg: MOV A #0AFH ;
MOV R3, #45H ;
MOV DPTR, #FE0CH ;

Register addressing mode:

In the Register addressing mode the source or destination data should be present in a Register.

Eg: MOV A, R5 ;
MOV R2, #45H
MOV R0, A ;

Direct Addressing mode:

In the direct addressing mode, the source or destination address is specified by using 8 bit data instructions only the internal data memory can be used in this mode.

Eg: MOV 80H, R6 ;
MOV R2, 45 ;
MOV R0, 05H

* The vector address of T_1/R_1 is 0023H
  vector address of TF_0 is 000BH
  vector address of TF_1 is 001BH
  vector address of INT0 is 0003H
  vector address of INT1 is 0013H

* There is a Interrupt enable Register IE which is used to enable / disable interrupt sources.

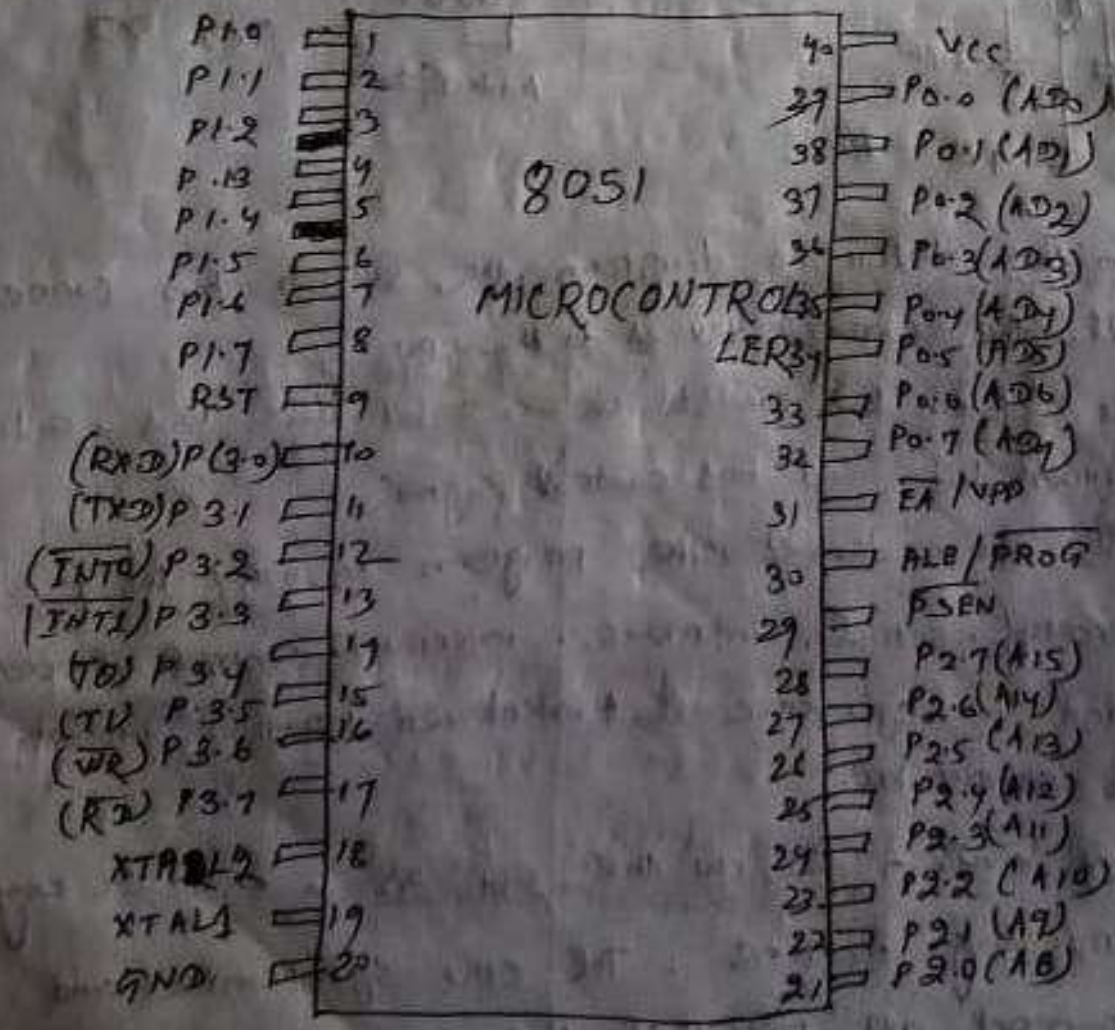
Serial Communication

* Microcontroller need to communicate with external devices such as sensors, computers and so on to collect data for processing. Data communication is generally done by means of two method.
  - → Parallel mode
  - → serial mode

* In parallel mode data bits are transferred faster using more data pins. But when comes to a microcontroller, we cannot afford to dedicate many pins for data transfer.
* UART or serial communication in 8051 microcontroller will allow the controller to send and receive data's just by using two pins
* Serial communication used only two pins to establish communication between microcontroller and external devices.
* So this mode of communication data is transferred one bit at a time

* It contain interrupts that is a sub-routine call, that given by microcontroller when some other program with high priority is request for acquiring the system buses the 5 interrupts occur in current running program.
* It contain memory for operation of various program and stored data
* Bus: Bus is a group of wires which used as a communication canal or act as means of data transfer
* Oscillators: As microcontroller is digital circuit therefore it needs timer for their operation.
→ To perform timer operation inside microcontroller it required externally connected on-chip oscillator

PIN Description of 8051 Microcontroller:



Register Indirect addressing mode

In this mode, the source or destination address is given in the Register.

exa : MOV 0E5H, @R0;
MOV @R1, 80H

Indexed Addressing mode:

In the indexed addressing mode, the source memory can only be accessed from program memory only. The destination operand is always the Register.

exa : MOVC A, @A+PC;
MOVC A, @A+DPTR;

Implied Addressing mode:

In the implied addressing mode there will be a single operand. These type of instruction can be ~~used only~~ work on specific Register only.

8051 Microcontroller Interrupt:

Interrupt is an event that temporarily suspends the main program, passes the control to a special code section, execute the event related function and resumes the main program flow where it had left off.

-> The 8051 Microcontroller can recognize five different events that cause the main program to interrupt from the normal execution.

The five interrupt are

1) Timer 0 overflow interrupt - TF0
2) Timer 1 overflow interrupt - TF1
3) External hardware interrupt - INT0
4) External hardware interrupt - INT1
5) Serial communication interrupt - RI/TI