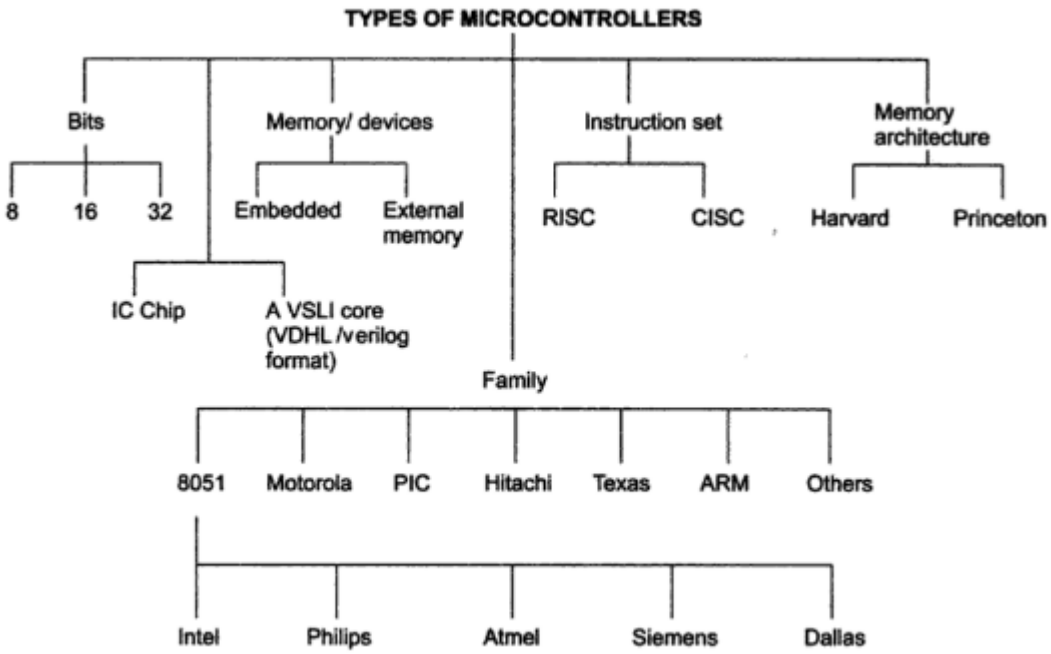
1) Explain different Types of Microcontrollers



The microcontrollers are characterized regarding bus-width, instruction set, and memory structure. The types of microcontroller is shown in figure, they are characterized by their bits, memory architecture, memory/devices and instruction set

Classification According to Number of Bits

The bits in microcontroller are 8-bits, 16-bits and 32-bits microcontroller.

- In **8-bit** microcontroller, the point when the internal bus is 8-bit then the ALU is performs the arithmetic and logic operations. The examples of 8-bit microcontrollers are Intel 8031/8051, PIC1x and Motorola MC68HC11 families.

- The **16-bit** microcontroller performs greater precision and performance as compared to 8-bit. For example 8 bit microcontrollers can only use 8 bits, resulting in a final range of 0×00 – 0xFF (0-255) for every cycle. 16 bit microcontrollers with its 16 bit data width has a range of 0×0000 – 0xFFFF (0-65535) for every cycle. Some examples of 16-bit microcontroller are 16-bit MCUs are extended 8051XA, PIC2x, Intel 8096 and Motorola MC68HC12 families.

- The **32-bit** microcontroller uses the 32-bit instructions to perform the arithmetic and logic operations. These are used in automatically controlled devices including

implantable medical devices, engine control systems, office machines, appliances and other types of embedded systems. Some examples are Intel/Atmel 251 family, PIC3x.

Classification According to Memory Devices

The memory devices are divided into two types, they are

- Embedded memory microcontroller
- External memory microcontroller

Embedded memory microcontroller: When an embedded system has a microcontroller unit that has all the functional blocks available on a chip is called an embedded microcontroller.For example, 8051 having program & data memory, I/O ports, serial communication, counters and timers and interrupts on the chip is an embedded microcontroller.

External Memory Microcontroller: When an embedded system has a microcontroller unit that has not all the functional blocks available on a chip is called an external memory microcontroller. For example, 8031 has no program memory on the chip is an external memory microcontroller.

Classification According to Instruction Set

CISC: CISC is a Complex Instruction Set Computer. It allows the programmer to use one instruction in place of many simpler instructions.

RISC: The RISC is stands for Reduced Instruction set Computer.This type of instruction sets reduces the design of microprocessor for industry standards. It allows each instruction to operate on any register or use any addressing mode and simultaneous access of program and data.RISC systems shorten execution time by reducing the clock cycles per instruction and CISC systems shorten execution time by reducing the number of instructions per program. The RISC gives a better execution than the CISC.

Classification According to Memory Architecture

Memory architecture of microcontroller are two types, they are namely:

- Harvard memory architecture microcontroller
- Princeton memory architecture microcontroller

Harvard Memory Architecture Microcontroller:

Many years ago, in the late 1940's, the US Government asked Harvard and Princeton universities to come up with a computer architecture to be used in computing distances of Naval artillery shell for defense applications.

Princeton suggested computer architecture with a single memory interface.It is also known as Von Neumann architecture after the name of the chief scientist of the project in Princeton University John Von Neumann.
Harvard suggested a computer with two different memory interfaces, one for the data / variables and the other for program / instructions.
Although Princeton architecture was accepted for simplicity and ease of implementation, Harvard architecture became popular later, due to the parallelism of instruction execution.The point when a microcontroller unit has a dissimilar memory address space for the program and data memory, the microcontroller has Harvard memory architecture in the processor.

Princeton Memory Architecture Microcontroller: (Single memory interface)

Example: An instruction "Read a data byte from memory and store it in the accumulator" is executed as follows: -
Cycle 1- Read Instruction
Cycle 2- Read Data out of RAM and put into Accumulator

The point when a microcontroller has a common memory address for the program memory and data memory, the microcontroller has Princeton memory architecture in the processor.

2.. What are Criteria for selecting a microcontroller-

The below resources are needed:

Ports with network interface and network processing related instructions processing CPU.
Ports with mobile or wireless interface and related processing instructions capable CPU.
USB/ PCI/ I^2C/ CAN/ JTAG/ GPIB interface devices.

The following resources are checked:-

1. Internal EEPROM Flash/ROM/EPROM.
2. Serial synchronous communication full duplex or half.
3. Serial UART.
4. Timer 1, 2, or 3.
5. Watchdog, timer 0 or 1.
6. Out-compares 0 or 1 or 2 or 3 or 4 or 5.
7. Input captures 0 or 1 or 2 or 3.
8. PWM 0 or 1 or 2 or 3 or 4.
9. Single or multi-channel ADC with or without programmable voltage reference
10. Modem device.
11. Digital signal processing (DSP) ports with DSP instructions processing CPU.
12. Ports with non-linear controller instructions processing CPU.

Features taken into consideration while selecting an MCU.

Factors for on-chip feature
8-bit or 16-bit or 32-bit ALU
Power dissipation (maximum limit)
Clock speed need (lowest limit)
RISC or CISC or RISC core with the CISC instruction set
Program storage architecture—Harvard or Princeton memory
Total external and internal memory up to or more than 64 kB
DMA controller
Cache, memory management unit, or DSP calculations
Intensive computations at fast rate

Additional factors needed:

Cost when single chip and when MCU interfaces to circuit with some features externally added
Major building blocks of hardware cost and availability
Major building blocks of software cost and availability
Hardware–software tradeoff
Integration ease
Design team expertise availability
Development software and hardware tools availability and cost
Testing and debugging facilities ease and availability

Also we need to select suitable processor and its family.

On-chip resources base selection, Selection of development tool base and selection of software building blocks are also needed.

3. What are the applications of microcontroller?

Microcontrollers are intended for embedded devices, in comparison to the micro-processors which are used in PCs or other all-purpose devices. Microcontrollers are employed in automatically managed inventions and appliances like- power tools, implantable medical devices, automobile engine control systems, , office machines, remote controls appliances, toys and many more embedded systems. By dipping the size and expenditure in comparison to a design that make use of a different micro-processor, I/O devices and memory, micro-controllers formulate it inexpensive to digitally control more & more appliances and

operations. Mixed signal micro-controllers are general; putting together analog constituents required controlling non-digital electronic structures.

Application of Microcontroller in Day to Day Life Devices:

- Light sensing & controlling devices
- Temperature sensing and controlling devices
- Fire detection & safety devices
- Industrial instrumentation devices
- Process control devices

Application of Microcontroller in Industrial Control Devices:

- Industrial instrumentation devices
- Process control devices

Application of Microcontroller in Metering & Measurement Devices:

- Volt Meter
- Measuring revolving objects
- Current meter
- Hand-held metering systems