Microprocessor Notes
Chapter no 01

CREATED BY

M BILAL & Arslan Ahmad Shaad

بسم الله الرحمن الرحيم

Short Questions

Chapter No 01

Fundamental Concepts

Q1: Define microprocessor?

Microprocessor is a program-controlled and semiconductor device, which fetches the instructions from memory, decodes and executes the instructions. Most Micro Processor are single- chip devices.

Q2: Define Accumulator?

It is a component of microprocessor which holds the whole data of microprocessor.

Q3: When was the microprocessor introduced?

The first microprocessor was introduced in 1971 by Intel Corporation. It was named Intel 4004, as it was a 4-bit processor.

Q4: What do you know about Intel 4004?

Intel 4004 was a 4-bit processor. It has low memory and slow in speed. To overcome the disadvantages of 4004 Intel produced another upgraded version called 4040, it was also 4bit.

Q5: Define Intel 8008?

In 1973, first 8-bit microprocessor was produced by Intel called 8008.

Q6: Differentiate between 4004 and 4040 processor?

4004	4040
First 4 bit microprocessor .It has low memory and slow in speed.	To overcome the disadvantages of 4004 Intel produced another upgraded version called 4040, it was also 4bit

Q7: Differentiate between 8085 and 8086 processor?

8085	8086
8085 was introduced in 1976 It has clock frequency 3 MHz with data rate of 8bit/s.	8086 processor was introduced In1978. It has clock frequency 5-10Mhz. It had 29,000 transistors.

Q8: Define bus?

Bus is a group of wires or lines that are used to transfer the addresses of Memory or I/O devices.

Q9: Define Address Bus?

This bus is used to carry the Address to the memory to fetch either instruction or data.

Q10: Define Data Bus?

This bus is used to carry the data from the memory to microprocessor.

Q11: Define Control Bus?

This bus is used to carry the control signals like RD/WR, Select etc.

Q12: Define Tristate device?

A device which has one input, one enable and one output line is called tristate device.

Q13: Define microcomputer?

A microcomputer is a small, relatively inexpensive computer with a microprocessor as its central processing unit (CPU). It includes a microprocessor, memory, and minimal input/output (I/O) circuitry mounted on a single printed circuit board.

Q14: Define ALU (arithmetic logic unit)?

An arithmetic logic unit (ALU) is a digital circuit used to perform arithmetic and logic operations. It represents the fundamental building block of the central processing unit (CPU) of a computer.

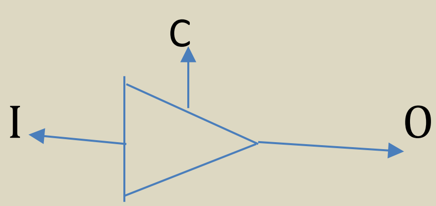
Q15: What are I/O ports?

The input/output port is what allows the software drivers to communicate with hardware devices on your computer.

Q16: Define microcontroller?

A microcontroller is a compact integrated circuit designed to govern a specific operation in an embedded system. A typical microcontroller includes a processor, memory and input/output (I/O) peripherals on a single chip.

Q17: Draw truth table of tristate device?



I	C	O
0	0	Z
0	1	Z
1	0	0
1	1	1

Q18: Define storage?

A storage device is any computing hardware that is used for storing, porting and extracting data files and objects. It can hold and store information both temporarily and permanently.

Q19: Define I/O devices?

An input device sends information to a computer system for processing, and an output device reproduces or displays the results of that processing. Depending on the interaction, a device can be both, referred to as an input/output device.

Q20: Define software programs?

A software program is commonly defined as a set of instructions, or a set of modules or procedures, that allow for a certain type of computer operation. The term is also often used interchangeably with terms like "software application" and "software product."

Q21: Define hardware?

Hardware is the collection of physical parts of a computer system. This includes the computer case, monitor, keyboard, and mouse. It also includes all the parts inside the computer case, such as the hard disk drive, motherboard, video card, and many others.

Q22: Define address decoding?

An address decoder is a binary decoder that has two or more inputs for address bits and one or more outputs for device selection signals. When the address for a particular device appears on the address inputs, the decoder asserts the selection output for that device.

Q23: Enlist the types of number system?

Basically there ae four types of number systems:

1. Binary number system.

2. Octal number system.

3. Decimal number system.

4. Hexa-decimal number system.

Q24: Enlist the types of memory devices?
There are two major types of memory devices:

1. Primary memory.

2. Secondary memory.

Q25: Define primary memory?
Primary storage, also known as main storage or memory, is the area in a computer in which data is stored for quick access by the computer's processor. E.g. RAM (random access memory).

Q26: Define secondary memory?
A secondary storage device refers to any non-volatile storage device that is internal or external to the computer. It can be any storage device beyond the primary storage that enables permanent data storage.

Q27: What is I/O read cycle?
In I/O read cycle, Data are read from an I/O device using the I/O address that appears on AD0–AD15. Burst reads are not supported for I/O devices.

Q28: What is I/O write cycle?
As with I/O read, this cycle accesses an I/O device, but writes data I/O address.

Q29: Define memory read cycle?
Data are read from a memory device located on the PCI bus.

Q30: Define memory write cycle?
As with memory read, data are accessed in a device located on the PCI bus. The location is written.

Q31: Define control signals?
This group of signals includes two control signals (RD and WR) three status signals (IO/M, S1 and S0) to identify the nature of the operation. And one special signal (ALE) to indicate the beginning of the operation.

Q32: What is the difference between microprocessor and microcontroller?

The major difference is microprocessor doesn't have inbuilt memory but micro-controller has inbuilt memory .In Microprocessor more op-codes, few bit handling instructions. But in Microcontroller: fewer op-codes, more bit handling Instructions. Micro-controller can be defined as a device that includes microprocessor, memory, & input / output signal lines on a single chip.

Q33: What is the disadvantage of microprocessor?

It has limitations on the size of data. Most Microprocessor does not support floating-point operations.

Q34: Difference between SRAM and DRAM?

Static RAM: No refreshing, 6 to 8 MOS transistors are required to form one memory cell, Information stored as voltage level in a flip flop.

Dynamic RAM: Refreshed periodically, 3 to 4 transistors are required to form one memory cell, Information is stored as a charge in the gate to substrate capacitance.

Q35: What is cache memory?

Cache memory is a small high-speed memory. It is used for temporary storage of data & information between the main memory and the CPU (center processing unit). The cache memory is only in RAM.

Q36: Why does microprocessor contain ROM chips?

Microprocessor uses ROM chips to store instructions, which are used to execute data.

Q37: What is fetch and execute cycle?

In general, the instruction cycle of an instruction can be divided into fetch and execute cycles. The fetch cycle is executed to fetch the opcode from memory. The execute cycle is executed to decode the instruction and to perform the work instructed by the instruction.

Q38: What is the need for Port?

The I/O devices are generally slow devices and their timing characteristics do not match with processor timings. Hence the I/O devices are connected to system bus through the ports.

LONG QUESTIONS

Chapter # 1

FUNDAMENTAL CONEPTS

Qno1: Describe historical background of microprocessor?

The first microprocessor was introduced in 1971 by Intel Corp. It was named Intel 4004, as it was a 4-bit processor.It has low memory and slow in speed. To overcome the disadvantages of 4004 Intel produced another upgraded version called 4040, it was also 4bit. Then in 1973 first 8-bit microprocessor was produced by Intel called 8008. The 8-bit processors were followed by 16-bit processors. They are Intel 8085 and 8086. 8085 has clock frequency 3 MHz with data rate 8bit/s and 8086 was introduced in 1978, has clock frequency 5-10 MHz it had 29,000 transistors.

Qno2: Describe the evaluation of different processors?

Evaluation of Microprocessors:

INTEL 4004

- The first microprocessor introduced in 1971 by Intel Corp.
- It could perform simple arithmetic and logic operations.
- It was a 4-bit µP.
- Its clock speed was 740 KHz.
- It had 2,300 transistors.

- It could execute around 60,000 instructions per second.

INTEL 4040

- Introduced in 1972.
- It was also 4 bit.
- Has 8 KB of program memory.
- It 640 bytes of addressable memory.
- Its Clock speed is between 500 KHz and 740 K

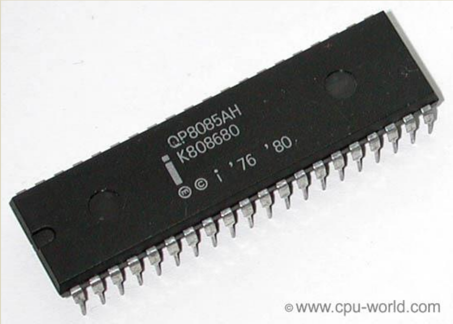
INTEL 8008

- Introduced in1973.
- It was first 8 bit *u*p.
- It’s clock speed was 500 KHz.
- It could execute 50,000 instruction per second.
- It had 3,500 transistors.

INTEL 8080

- Introduced in 1974.
- It was also 8 bit *u*p.
- It’s clock speed was 2 MHz
- It had 6,000 transistors.
- Was 10 times faster than 8008.

INTEL 8085



- Introduced in 1976.
- It was also 8-bit *u*p.
- It’s clock speed was 3 MHz
- Its data bus is 8 bit and address bus is 16-bit.
- It had 246 instructions.
- Could execute 7, 69,230 instructions per second.

INTEL 8086

- Introduced in 1978.
- It was first 16-bit *u*p.
- Its clock speed is 4.77 MHz, 8 MHz and 10 MHz, depending on the version.
- It had 29,000 transistors.
- Could execute 2.5 million instructions per second.
- It could access 1 MB of memory.
- It had 22,000 instructions.
- It had also multiply and Divide instructions.

Qno2: Define Address, Data and control bus?

ADDRESS BUS:

An address bus is a computer bus (a series of lines connecting two or more devices) that is used to specify a physical address. When a processor or DMA-enabled device needs to read or write to a memory location, it specifies that memory location on the address bus (the value to be read or written is sent on the data bus).

DATA BUS:

A data bus simply carries data. Internal bus carry information within the processor while external bus carry data between the processor and the memory. Data bus is used for both read/write operations.

CONTROL BUS:

The cup transmits a variety of control signals to components and devices to transmit control signals to the cpu using control bus. It is bidirectional. It is comprised of interrupt lines, byte enable lines, read/write signals lines. It determine data processing. It tells whether to read or write data to the data bus.

Qno3: Describe the functionality of Address, Data and Control bus?

Function of Address bus:

An address bus is a computer bus architecture used to transfer data between devices that are identified by the hardware address of the physical memory (the physical address), which is stored in the form of binary numbers to enable the data bus to access memory storage.

The address bus is used by the CPU or a direct memory access (DMA) enabled device to locate the physical address to communicate read/write commands. All address busses are read and written by the CPU or DMA in the form of bits... the width of the address bus is determined by the size of the memory that should be addressed by the system. It is unidirectional which means the addresses will travel in only one direction.

Function of Data bus:

Data bus is used for both read/write operation

When it is a write operation, the processor will put the data (to be written) on to the data bus.
When it is the read operation, the memory controller will get the data from the specific memory block and put it in to the data bus.

Data bus is bidirectional. The width of the data bus is determined by the size of the individual memory block.

Function of Control bus:

Microprocessor uses control bus to process data, that is what to do with the selected memory location. Some control signals are Read, Write and Opcode fetch etc. This is a dedicated bus, because all timing signals are generated according to control signal.

Qno4: Describe fundamental control bus?

A fundamental control bus consist of three bus terminals ,one is used to enable either memory or input devices, second terminal signal is used for reading data from enable device and the third terminal signal is used to write data towards enable device
These terminals are generally denoted as M/IO,$\overline{RD}$, $\overline{WR}$.

Q no 5: Define and Explain the use of tristate devices in bus-based system?

A device which has one input, one enable and one output line is called tri-state device, in a multiplexed bus system, many devices are connected to a common bus. If 2 or more devices attempt to use the bus at the same time, then data will be lost. Thus, only one device must be allowed to use the bus at a time. Only method is to connect the devices through tri-state devices, which when disabled will effectively disconnect devices from the bus. Tri-state buffer is a tri-state device.

Q6: What is difference between address bus and data bus?

ADDRESS BUS	DATA BUS
• Address bus carries the location to where it should be stored • Address bus is unidirectional • The width of the address bus is determined by the size of the memory that should be addressed by the system.	• The data bus carries the data to be stored • Data bus is bidirectional • The width of the data bus is determined by the size of the individual memory block

Q6: Define the basic different terms as such?

ALU

An arithmetic logic unit (ALU) is a digital circuit used to perform arithmetic and logic operations. It represents the fundamental building block of the central processing unit (CPU) of a computer. Modern CPUs contain very powerful and complex ALUs. In addition to ALUs, modern CPUs contain a control unit (CU).

Most of the operations of a CPU are performed by one or more ALUs, which load data from input registers. A register is a small amount of storage available as part of a CPU. The control unit tells the ALU what operation to perform on that data, and the ALU stores the result in an output register. The control unit moves the data between these registers, the ALU, and memory.

MICROPROCESSOR

Microprocessor is a semiconductor device consisting of electronics logics circuits. Microprocessor is capable of performing computing function and making decisions to change the sequence of program execution. The microprocessor includes all the logic circuit and control unit on one chip

MICROCOMPUTER

A microcomputer is a small, relatively inexpensive computer with a microprocessor as its central processing unit (CPU). It includes a microprocessor, memory, and minimal input/output (I/O) circuitry mounted on a single printed circuit board. Microcomputers became popular in the 1970s and 1980s with the advent of increasingly powerful microprocessors.

STORAGE

The device used to store data permanently or temporarily and provide to the user on his requirements is called memories or storage devices
Storage can be divided in to two groups
Primary storage
Secondary storage

INPUT AND OUTPUT PORTS

I/O port is an interface or a point of connection between the computer and its peripheral devices. Some of the common peripherals are mouse, keyboard, monitor or display unit, printer, speaker, flash drive etc. The main function of an I/O ports are to act as a point of attachment, where the cable from the peripheral can be plugged in and allows data to flow from and to the device. In your computer there are 65,535 ports that are numbered from 0000h to FFFFh.

SOFTWARE PROGRAM

Collection of specific instruction write to the microcomputer to perform a specific task is called software program.

HARDWARE

All those components take part in building a microcomputer system are called hardware of that system e.g. CPU, ram, rom etc.

ADDRESS DECODING

Address decoding is the process of generating chip select (CS*) signals from the address bus for each device in the system. Address decoding refers to the way a computer system decodes the addresses on the address bus to select memory locations in one or more memory or peripheral devices.

MICROCONTROLLERS

A microcontroller (or MCU for microcontroller unit) is a small computer on a single integrated circuit. ... A microcontroller contains one or more CPUs (processor cores) along with memory and programmable input/output peripherals.

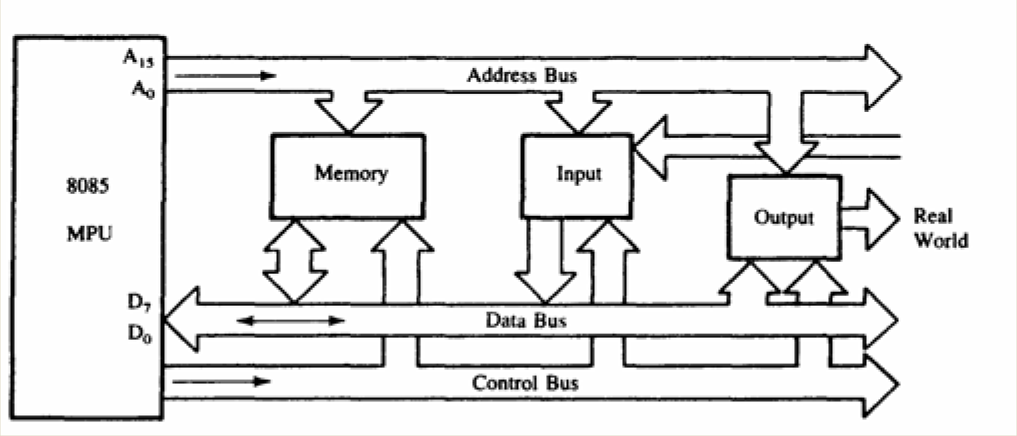
NUMBER SYSTEM

Number systems are the technique to represent numbers in the computer system architecture, every value that you are saving or getting into/from computer memory has a defined number system.

Computer architecture supports following number systems.

- Binary number system
- Octal number system
- Decimal number system
- Hexadecimal (hex) number system

Qno7: Sketch and explain the Microcomputer block diagram?



We can see there a microprocessor with three its busses going out: data bus, address bus and control bus. To these busses, the following devices are connected: operational memory composed of RAM (Random Access Memory) and ROM (Read Only Memory) memories, as well as input/output units to which peripheral devices are connected.

CPU: The CPU executes all the instructions and performs arithmetic and logic operations on data.
MEMORY: A memory unit stores both data and instructions. The memory section typically contains ROM and RAM chips.
INPUT: This is the process of entering data and programs in to the computer system.
OUTPUT: This is the process of producing results from the data for getting useful information.

Qno8: Describe the basic purpose and types of memory devices?

Memory devices:

A memory or storage devices are used in computers to store the data temporarily or permanently and provide it as output to the user on his demand.

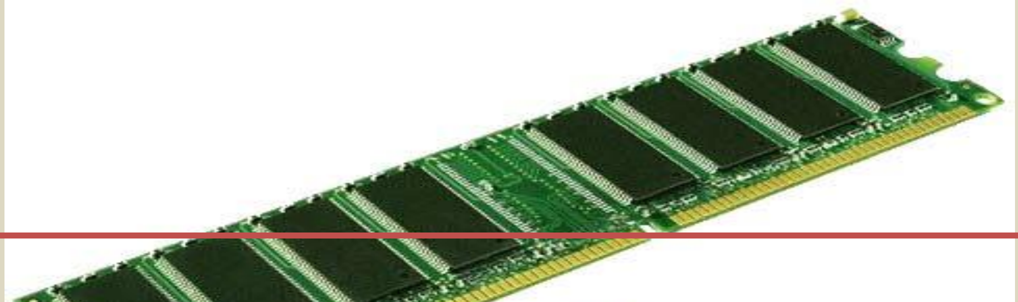
There are two types of memories

- PRIMARY MEMORY
- SECONDARY MEMORY

PRIMARY MEMORY:

Also known as main memory. Primary memory is computer memory that a processor or computer accesses first or directly. It allows a processor to access running execution applications and services that are temporarily stored in a specific memory location. E.g. RAM, ROM, Cache

RAM

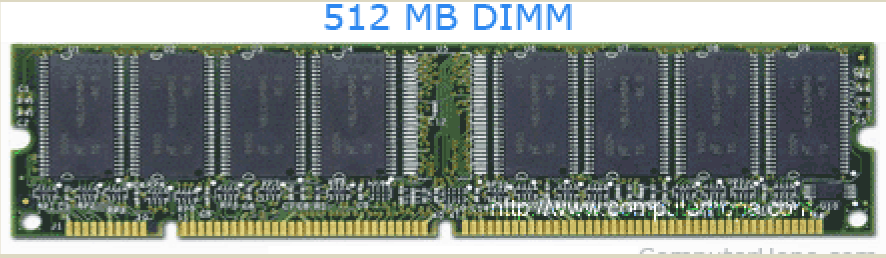


Stands for random access memory. It is volatile memory, all information that was stored in RAM is lost when the computer is turned off. RAM stores data randomly and the processor accesses these data randomly from the RAM storage.

Types of Ram

SRAM

- Short for Static RAM
- SRAM is computer memory that requires a constant power flow to hold information.
- SRAM uses bi stable latching circuitry (flip-flop) to store each bit.
- SRAM needs a lot more transistors in order to store a certain amount of memory.
- SRAM does not have to be periodically refreshed.
- It provides faster access to data.
- It is expensive.
- It is more commonly used in cache and video card memory only.
- Their storage is in kilobytes or bytes.



DRAM

- Short or Dynamic RAM
- DRAM is used for a computer's main memory.
- DRAM is one of the most commonly found RAM modules in PC compatible personal computers and workstations.
- It stores its information in a cell containing a capacitor and transistor.
- A DRAM module only needs a transistor and a capacitor for every bit of data.
- DRAM need to be refreshed in order to retain the data.
- It is cheap.
- It is slower than SRAM.
- Its storage is in Megabytes or Gigabytes.

ROM

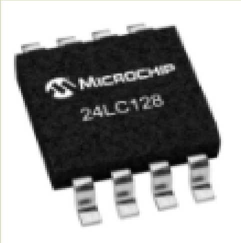
ROM stands for Read Only Memory. The memory from which we can only read but cannot write on it. This type of memory is non-volatile. The information is stored permanently in such memories during manufacture. ROM is used for the BIOS which tells the computer how to start, or important programs like the firmware of certain devices, which usually does not need to be modified.e.g. EROM, PROM, EEPROM

PROM

- PROM, or programmable read-only memory, is a subclass of ROM the data to be stored in PROM are recorded by the manufacturer of the computer using special high-current devices to burn fuses on the devices.
- It can be programmed only once and is not erasable.
- A good example of a PROM is a computer BIOS in early computers.

EPROM

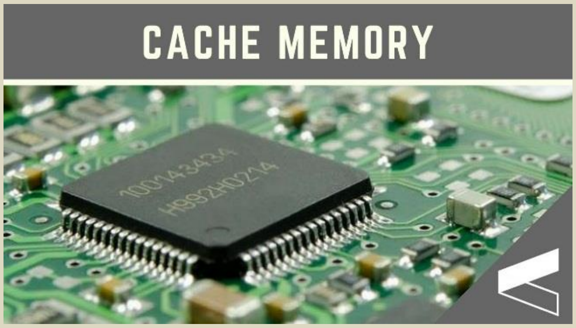
- EPROM, or erasable programmable read-only memory, is a special kind of PROM. EPROM allows the user to erase the data stored in this memory device by using special ultraviolet devices and then reprogram it.
- An example of where EPROM is used is in the field of robotics.



EEPROM

- EEPROM stands for Electrically Erasable and Programmable Read Only Memory.
- The EEPROM is programmed and erased electrically.
- It can be erased and reprogrammed about ten thousand times.
- Both erasing and programming take about 4 to 10 ms (millisecond).
- In EEPROM, any location can be selectively erased and programmed.
- EEPROMs can be erased one byte at a time, rather than erasing the entire chip. Hence, the process of re-programming is flexible but slow.
- The microcontroller on the Arduino based board has EEPROM:

Cache:

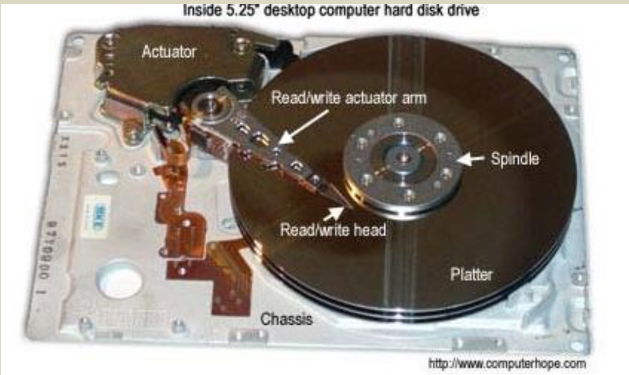


Cache memory is a very high speed semiconductor memory which can speed up CPU. It acts as a buffer between the CPU and main memory. It is used to hold those parts of data and program which are most frequently used by CPU.
Cache memory is faster than main memory. It is very expensive. Most computers today come with L3 cache or L2 cache, while older computers included only L1 cache

SECONDARY MEMORY:

Secondary memory is where programs and data are kept on a long-term basis. It cannot be processed directly by the CPU. It must first be copied into primary storage (also known as RAM). They need more access time and thus are much slower .e.g. hard disk, floppy disk, optical storage, USB

HARD DISK



- The hard disk drive is the main, and usually largest, data storage device in a computer.
- It can store anywhere from 160 gigabytes to 2 terabytes.
- Disk access time is measured in milliseconds.
- A hard drive is a secondary storage device that consists of one or more platters to which data is written using a magnetic head

FLOPPY DISK

- A floppy disk is a magnetic storage medium for computer systems.

- The floppy disk is composed of a thin, flexible magnetic disk sealed in a square plastic carrier.
- Floppies are cheap
- Floppies don't have much storage capacity.
- Floppies can get affected by heat.

OPTICAL STORAGE

➢ Optical storage - such as the compact disk (CD) - are storage media that hold content in digital form and that are written and read by a laser

USB

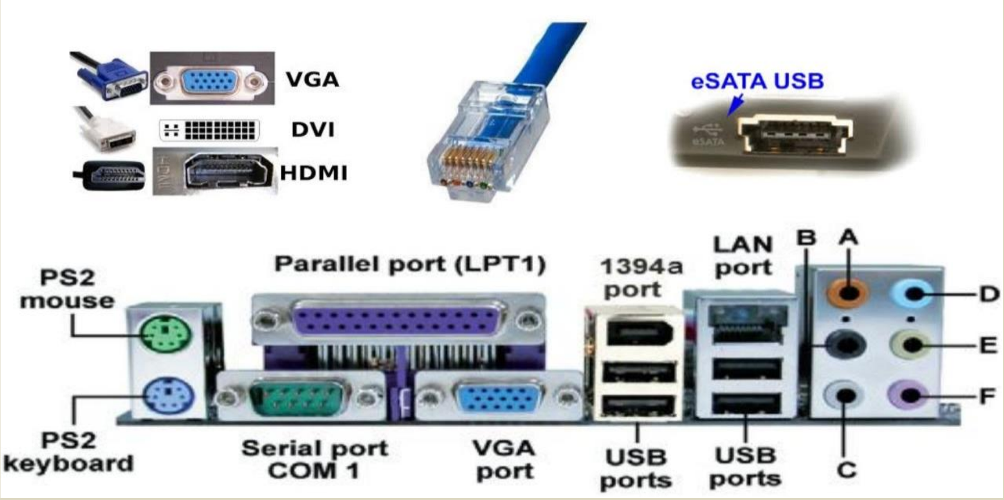
✪ USB Storage devices are portable devices that hold user data and files. USB storage devices include external hard drives and flash drives.

✪ USB storage devices can be used to hold files ranging from video and audio files to documents and program files.

Qno9 describe the basic purpose and types of I/O ports?

I/O Ports

Input/output (I/O) devices enable us to control the computer and display information in a variety of ways. They are used to take data from the outside world or send data to the outside world from computer. The well-known ports are USB port, keyboard port printer port etc.



Types of I/O ports

Serial I/O ports

These types of ports can transfer data bit by bit inside the microcomputer. Data rate is slow. COM1, COM2 are example of serial I/O ports.

Parallel I/O ports

These ports can transfer data in group formats of bit. 16 bit data segment.

Qno10: how instruction fetch and execute?

Instruction fetch:

The fetch cycle begins with retrieving the address stored in the Program Counter (PC). The address stored in the PC is some valid address in the Memory holding the instruction to be executed. The Central Processing Unit completes this step by fetching the instruction stored at this address from the memory and transferring this instruction to a special register – Instruction Register (IR) to hold the instruction to be executed. The program counter is incremented to point to the next address from which the new instruction is to be fetched.

Instruction Execution:

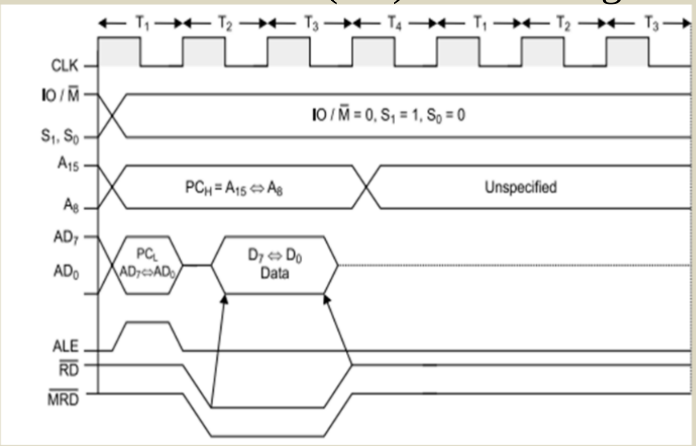
Before instruction execution a fetched instruction is decoded. The decoded instruction is sent to ALU for process, after the completion of process result is transfer to the specific place. This action is called execution of an instruction.

Qno 11: define and describe memory read cycle and memory write cycle?

MEMORY READ CYCLE

OPERATION:

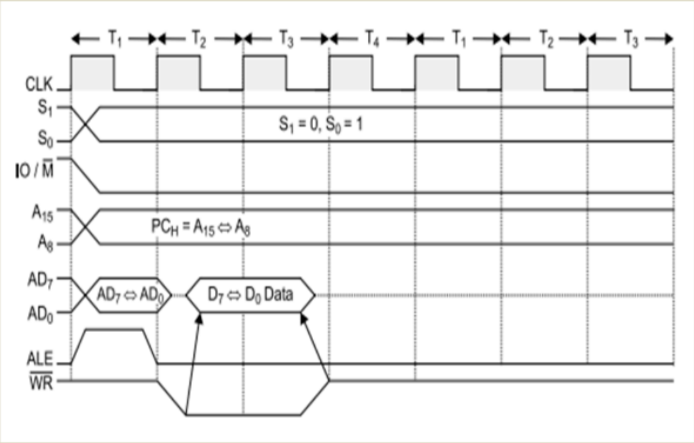
- It is used to fetch one byte from the memory.
- It requires 3 T-States.
- It can be used to fetch operand or data from the memory.
- During T1, A8-A15 contains higher byte of address. At the same time ALE is high. Therefore Lower byte of address A0-A7 is selected from AD0-AD7.
- Since it is memory ready operation, IO/M (bar) goes low.
- During T2 ALE goes low, RD (bar) goes low. Address is removed from AD0-AD7 and data D0-D7 appears on AD0-AD7.
- During T3, Data remains on AD0-AD7 till RD (bar) is at low signal.



MEMORY WRITE CYCLE

OPERATION:

- It is used to send one byte into memory.
- It requires 3 T-States.
- During T1, ALE is high and contains lower address A0-A7 from AD0-AD7.
- A8-A15 contains higher byte of address.
- As it is memory operation, IO/M (bar) goes low.
- During T2, ALE goes low, WR (bar) goes low and Address is removed from AD0-AD7 and then data appears on AD0-AD7.
- • Data remains on AD0-AD7 till WR (bar) is low.

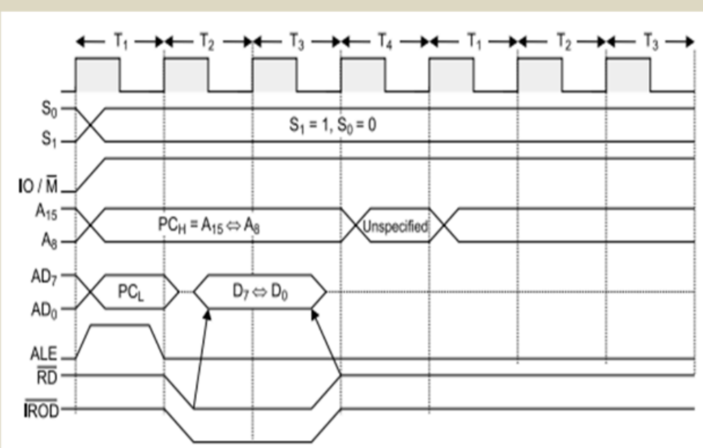


Qno 12: define and describe I/O read cycle and I/O write cycle?

I/O READ CYCLE

OPERATION:

- It is used to fetch one byte from an IO port.
- It requires 3 T-States.
- During T1, The Lower Byte of IO address is duplicated into higher order address bus A8-A15.
- ALE is high and AD0-AD7 contains address of IO device.
- IO/M (bar) goes high as it is an IO operation.
- During T2, ALE goes low, RD (bar) goes low and data appears on AD0-AD7 as input from IO device.
- During T3 Data remains on AD0-AD7 till RD (bar) is low.



I/O WRITE CYCLE

OPERATION:

- It is used to writ one byte into IO device.
- It requires 3 T-States.
- During T1, the lower byte of address is duplicated into higher order address bus A8-A15.
- ALE is high and A0-A7 address is selected from AD0-AD7.
- As it is an IO operation IO/M (bar) goes low.
- During T2, ALE goes low, WR (bar) goes low and data appears on AD0-AD7 to write data into IO device.
- During T3, Data remains on AD0-AD7 till WR (bar) is low.