MODULE 4.2

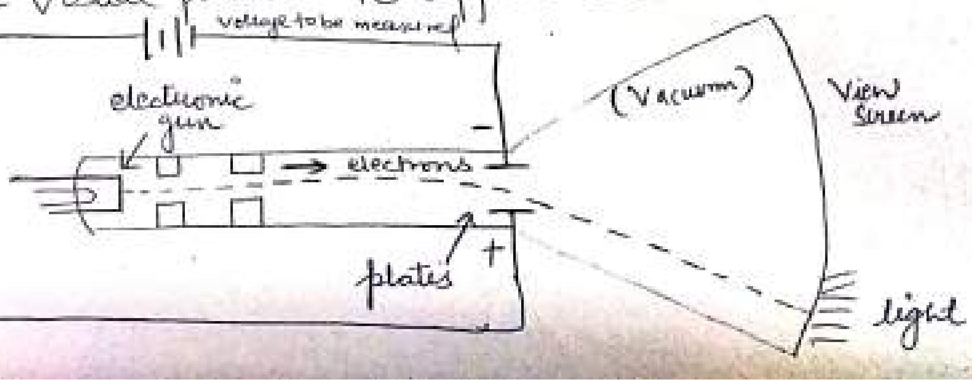
[Peripheral Device, Input-Output Interface, Asynchronous Data Transfer, Modes of Transfer, Priority Interrupt, DMA, I/O Processor]

PERIPHERAL DEVICE

The input-output subsystem of a computer, referred to as I/O, provides an efficient model of communication between the central system and the outside environment.

Devices that are under the direct control of the computer are said to be connected on-line. These devices are designed to read information into or out of memory unit upon command from the CPU and are considered to be part of the total computer system. Input or output devices attached to the computer are also called peripherals. Among the most common peripherals are keyboards, display units and Printers. Peripherals that provide auxiliary storage for the system are magnetic disks and tapes. Peripherals are electromechanical and electromagnetic devices of some complexity.

Video Monitors are the most commonly used peripherals. They consist of a keyboard as the input device and a display unit as the output device. There are different types of video monitors but the most popular is cathode ray tube (CRT)
The CRT contains an electronic gun that sends an electronic beam to a phosphorescent screen in front of the tube. The beam can be deflected horizontally and vertically. To produce a patter on screen, a grid inside the CRT receives a variable voltage that causes the beam to hit the screen and make it glow at selected spots. Horizontal and vertical signal deflect the beam to make the sweep across the tube, causing the visual pattern to appear on the screen.



Printers provide a permanent record on paper of computer o/p data or text. There are three basic types of character printers:
1. Daisywheel 2. Dot Matrix 3. Laser Printers.

The Daisywheel printer contains a wheel with the character placed along the circumference.
The Dot Matrix printer contains a set of dots along the printing mechanism.
The Laser Printer uses a rotating photographic drum that is used to imprint the character images.

Magnetic tapes are used mostly for storing files of data: for example, a company's payroll record. Access is sequential and consists of records that can be accessed one after another as the tape moves along a stationary read-write mechanism. It is cheapest & slowest method for storage

Other Input and Output devices encountered in computer systems are digital incremental plotters, optical and magnetic character readers, and various data acquisition equipment

The input-output organization of a computer is a function of the size of the computer and the devices connected to it

ASCII Alphanumeric Characters :-
Input and output devices that communicate with people and the computer are usually involved in transfer of alphanumeric information to and from the device and the computer. The standard binary code for the alphanumeric character is ASCII. It uses seven bits to code 128 characters. The ASCII code contains 94 characters that can be printed and 34 non-printing characters used for various control functions. The printing characters consist of 26 uppercase letters A to Z, the 26 lowercase letters, the 10 numerals 0 to 9, and 32 special printable characters such as %, *, / and $.
The 34 control characters are used for routing data and arranging the printed text into a prescribed format.

There are three types of control characters:

FORMAT EFFECTORS
INFORMATION SEPARATORS
COMMUNICATION CONTROL CHARACTERS

Format effectors are characters that control the layout of printing. They include controls such as backspace (BS), carriage Return (CR).
Information seperators are used to separate the data into divisions like Paragraphs and pages. They include character such as record separator (RS) and file seperator (FS).
The communication control characters are useful during the transmission of text between remote terminals. Example are STX (start of text) and ETX (end of text).

INPUT-OUTPUT INTERFACE

Input-Output interface provides a method for transferring information between internal storage and external Input output devices. Peripherals connected to a computer need special communication links for interfacing them with the CPU. The purpose of communication link is to resolve the difference that exist b/w the central computer and each peripheral.

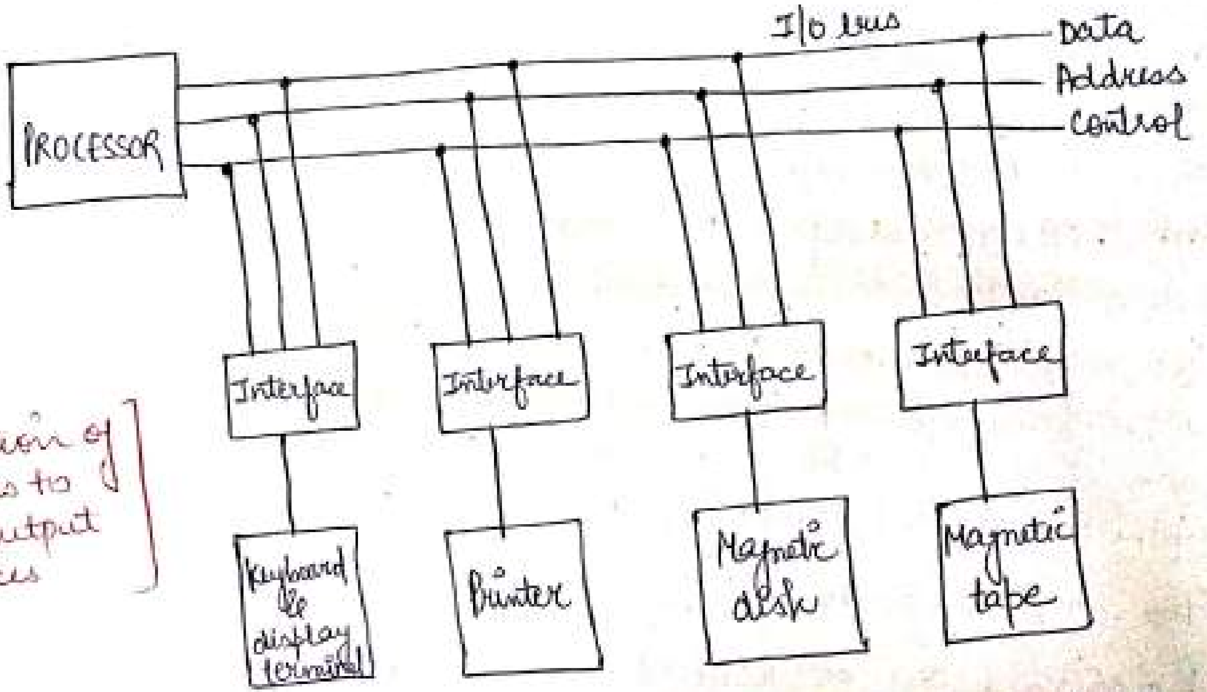
The differences are:

1. Peripherals are electromechanical and electromagnetic devices and their manner of operation is different from operation of CPU and memory and ∵ conversion of signal values may be required.
2. The data transfer rate of peripherals is slower than the transfer rate of CPU and synchronization mechanism may be needed.
3. Data codes and formats in peripheral differ from the word format in CPU and memory.
4. The operating modes of peripherals are different from each other and each must be controlled so as not to disturb the operation of other peripherals connected to CPU.

To resolve these differences, computer system includes special hardware components b/w the CPU and peripherals to supervise and synchronize all input and output transfers. These components are called INTERFACE UNITS because they interface b/w the processor bus and the peripheral device. In addition each device may have its own controller that supervises the operations of particular mechanism in peripheral.

I/O BUS AND INTERFACE MODULES

A communication link between the processor and several peripherals is shown:



[connection of I/O bus to input output devices]

The I/O bus consists of data lines, address lines and control lines. The magnetic disk, printer, terminal are employed in general purpose computer. The magnetic tape is used in computer for backup storage. Each peripheral device has associated with it an interface unit. Each interface decodes the address & control received from the I/O bus, interprets them for the peripheral and provides signals for the peripheral controller. It also synchronizes the data flow and supervises the transfer between the peripheral and processor. Each peripheral has its own controller that operates the particular electromechanical device. Example, the Printer controller control the paper motion, the print timing. A controlled may be housed seperately or integerated with peripheral.

The I/O bus from the processor is attached to all peripheral interfaces. To communicate with particular device the processor places a device address on the address line. Each interface attached to the I/O bus contains an address decoder that monitors the address line. When the interface detects its own address, it activates the path b/w the bus lines and the device that it controls. All the peripherals whose address does not correspond to the address in the bus are disabled by their interface.

At the same time that the address is made available in the address line, the processor provides a function code in the control lines. The interface selected responds to the function code and proceed to execute it. The function code is referred to as an I/O command. The interpretation of the command depends on the peripheral that the processor is addressing.

There are four types of commands that interface may receive.

1. CONTROL COMMAND :- It is issued to activate the peripheral and to inform it what to do.
Example: Magnetic tape unit may be instructed to backspace the tape by one record, to rewind the tape. The particular control command issued depends on the peripheral.

2. STATUS COMMAND :- It is used to test various status condition in the interface and the peripheral.
Example: The computer may wish to check the status of the peripheral before the transfer is initiated. During the transfer one or more error may occur which are detected by the interface. These errors are designated by setting bits in a status register that the processor can read at certain intervals.

3. OUTPUT COMMAND :- It causes the interface to respond by transferring data from the bus into one of its registers. Consider an example with a tape unit.

The computer starts the tape moving by issuing a control command. The Processor then monitors the status of the tape by means of a status command. When tape is in correct position, the processor issues a data output command.

4. Input Command: It is opposite of the data output. In this case the interface receives an item of data from the peripheral and places it in its buffer register. The processor checks if data are available by means of a status command and then issues a data input command. The interface places the data on the datalines, when they are accepted by processor.

I/O VERSUS MEMORY BUS

In addition to communicating with I/O, the processor must communicate with the memory unit. Like the I/O bus, the memory bus contains data, address, and read/write control lines. There are three ways that computer buses can be used to communicate with memory and I/O:

1. Use two seperate buses, one for memory and the other for I/O.
2. Use one common bus for both memory and I/O but have seperate control lines for each. (Isolated I/O method)
3. Use one common bus for memory and I/O with common control lines. (Memory mapped I/O)

① In first method, the computer has independent set of data, address and control buses, one for accessing memory and other for I/O. This is done in computers that provide a seperate I/O processor (IOP) in addition to CPU. The memory communicates with both the CPU and the IOP through memory bus. The IOP also communicates with the input and output devices through a seperate I/O bus with its own address, data and control line. The purpose of IOP is to provide an independent pathway for transfer of information b/w external devices & internal memory. The I/O processor is also called as data channel.

2) Isolated VERSUS MEMORY-MAPPED I/O

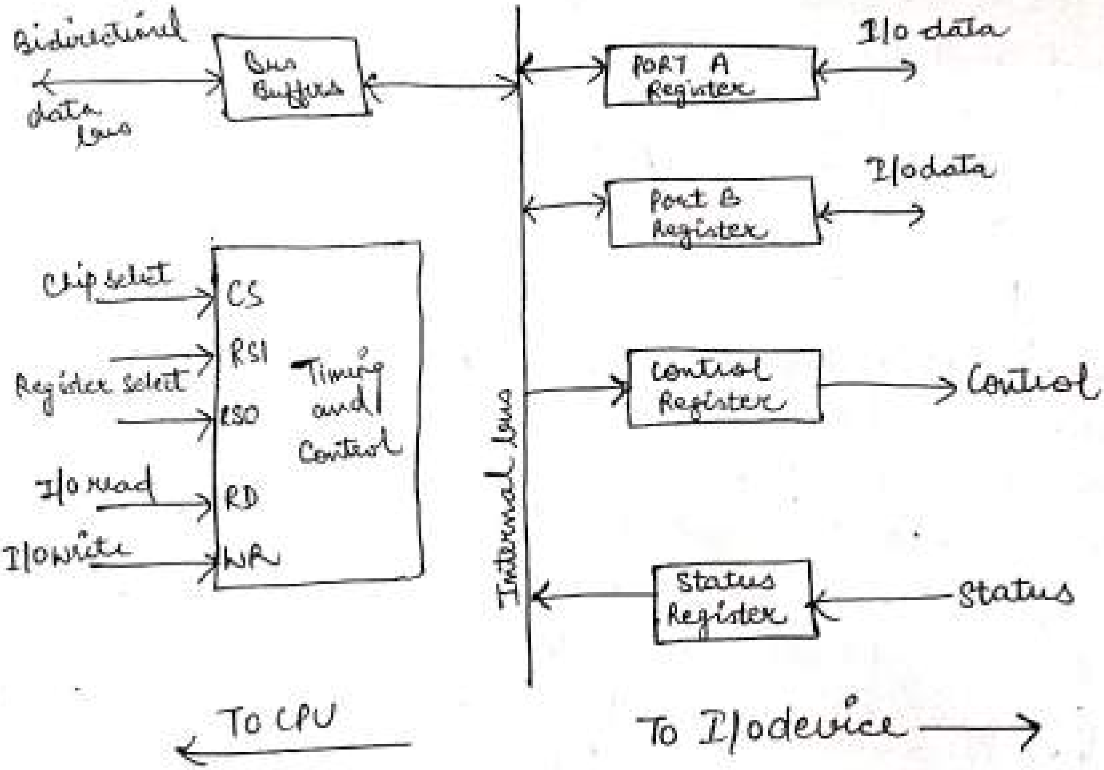
Many computers use one common bus to transfer information b/w memory or I/O and the CPU. The distinction b/w a memory transfer and I/O transfer is made through seperate read and write lines. The CPU specifies whether the address on the address line is for a memory word or for an interface register. The I/O read and I/O write control lines are enabled during an I/O transfer. The memory read and memory write control lines are enabled during memory transfer. This configuration isolates all I/O interface address from the address assigned to memory and is refered to as isolated I/O method.

In isolated I/O configuration, the CPU has distinct input & output instructions and each of these instructions is associated with the address of an interface register. When CPU fetchs and decodes the operation code of an input and O/P instruction, it places the address associated with the instruction into the common address lines. At same times it enables the I/O read (for input) or I/O write (for output) control lines. This informs the external component that are attached to the common bus that the address in the address line is for the interface register & not for memory word. On other hand when CPU is fetching an instruction or an operand from memory, it places the memory address on the address lines & enables the memory read or memory write control line. This informs the external component that the address is for memory word & not for I/O interface.

2) The other alternative is to use the same address space for both memory and I/O. This is the case in computer that employ only one set of read and write signals and not distinguish b/w memory and I/O address. This configuration is referred to as memory-mapped I/O. In a memory-mapped I/O organization there are no specific input or O/P instruction. The CPU can manipulate I/O data residing in interface register with the same instructions that are used to manipulate memory words. Each interface is organized as a set of registers that responds to read and write requests. Computers with memory-

mapped I/O can use memory-type instructions to access I/O data. It allows the computer to use the same instructions for either input-output transfers or for memory transfers.

Example of I/O Interface An example of an I/O interface unit is shown.



CS	RS1	RS0	Register selected
0	x	x	None: data bus in high impedence
1	0	0	Port A Register
1	0	1	Port B Register
1	1	0	Control Register
1	1	1	Status Register

It consists of two data registers called ports, a control register, a status register, bus buffers and timing and control circuits. The interface communicates with the CPU through the data bus. The chip select and register select inputs determine the address assigned to the interface. The I/O read and write are two control lines that specify an input or output respectively. The four registers communicate directly with the I/O device attached to the interface.

The I/O data to and from the device can be transferred into either port A or port B. The interface may operate with an output device or with a input device or with a device that requires both input and output. If the interface is connected to printer, it will only output data, and if it services a character reader, it will only input data.
A magnetic disk unit transfers data in both directions but not at the same time, so the interface can use bidirectional lines.

The control register receives control information from the CPU. By loading appropriate bits into the control register, the interface and the I/O device attached to it can be placed in a variety of operating modes. For example, port A may be defined as an input port and port B as an output port. A magnetic tape unit may be instructed to rewind the tape or to start the tape moving in the forward direction.
The bits in the status register are used for status conditions and for recording errors that may occur during the data transfer. For example, a status bit may indicate that port A has received a new data item from the I/O device. Another bit in the status register may indicate that a parity error has occured during the transfer.

The interface registers communicate with the CPU through the bidirectional data bus. The address bus selects the interface unit through the chip select and two register select inputs. A circuit must be provided externally (usually a decoder) to detect the address assigned to the interface registers. This circuit enables the chip select (CS) input when the interface is selected by the address bus. The two register select inputs RS1 and RS0 are usually connected to the two least significant lines of address bus. These two inputs select one of the four registers in the interface as specified in table. The content of selected register is transfer into the CPU via the data bus when the I/O read signal is enabled.