UNIT: - 4

Processors, Memory, port and Computer buses

Topic Covered :-

- CPU organization: Registers, ALU, and Control Unit, execution of Instruction Primary Memory: RAM, ROM, Types of RAM and ROM

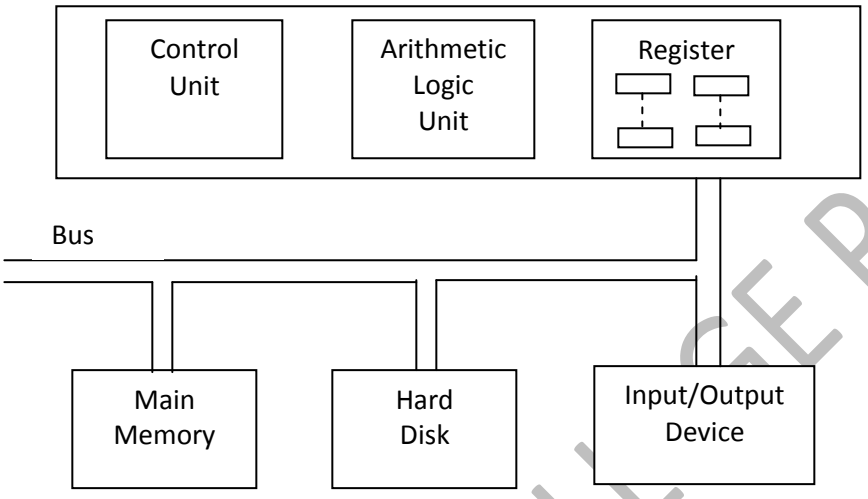
- Cache Memory: L1 cache and L2 cache

- Port: Parallel Port, Serial Port, USB Port and SCSI Port

- Introduction to buses, Read and write cycle, introduction to FSB, PCI Bus and USB.

CPU Organization:

- John von Neumann had given a model of the structure of digital computer processor that is still used in processor. This model is known as **Von Neumann model** or **simple organization of CPU,** and it is shown in following figure.



[Simple Computer Organization]

- CPU is a brain of your computer. It fetches instruction from main memory, examine it, and then execute it. After executing one instruction it executes another instruction. CPU is connected with other I/O devices such as monitor, keyboard, and storage devices such as hard disk, RAM through **Bus**.
- CPU contains mainly following *components*:

1) **Control Unit:**
   It is main controller of CPU. Main responsibility of Control Unit is:
   - Fetch the instruction from main memory.
   - Check the instruction whether it is arithmetic, relational, logical, or any other instruction.
   - Send to ALU to execute the instruction.

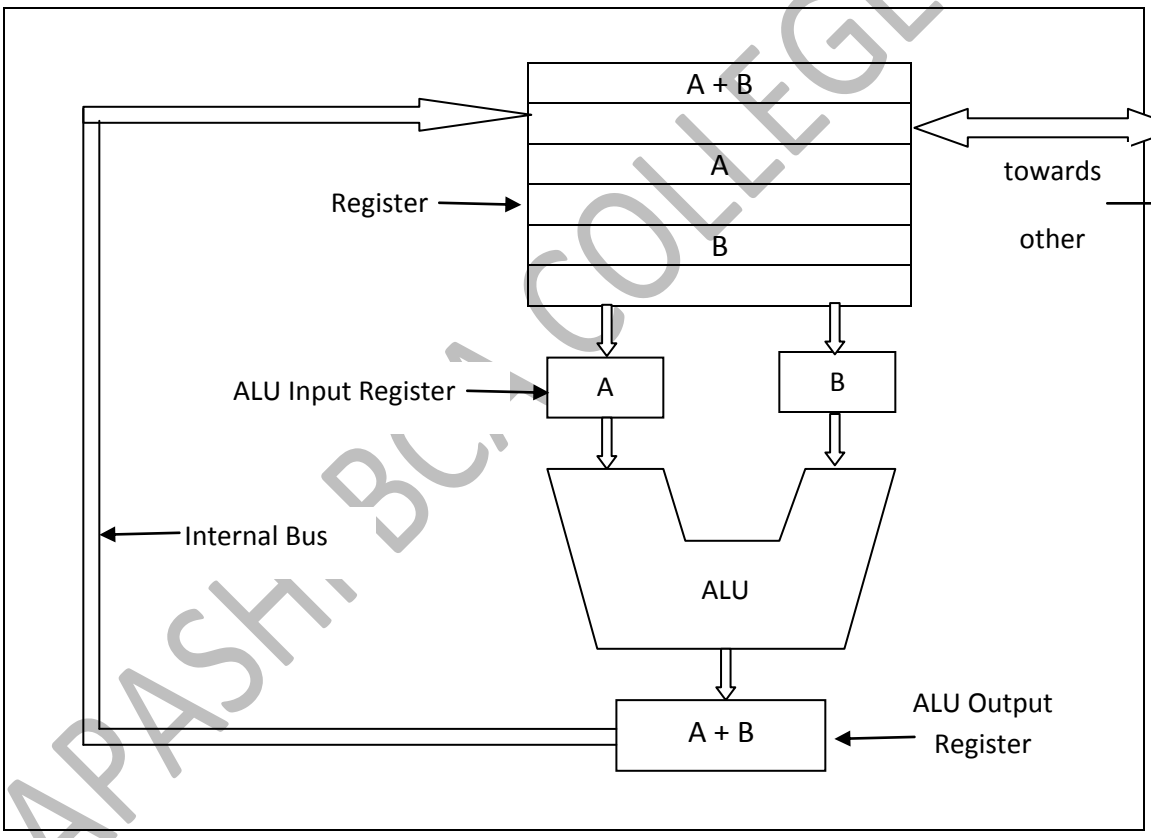
2) **Arithmetic Logic Unit:**
   It is a unit of CPU which performs various Arithmetic (Addition, Multiplication, subtraction, Division, etc), Relational (>, <, >=, <=, !=, ==), and Logical (and, or, not) operations.

3) **Register** :
   - Register is a small, high-speed memory used inside CPU to store temporary results and certain instruction. It is inside the CPU so read and writes operation from register and register is very fast. But it has limitation of size so you can store few instructions into register.

- The most important register is **Program Counter (PC)**, which points to next instruction to be fetched for execution.
- Another register is **Instruction Register (IR)**, which holds the instruction currently being executed.
- Also there is another important register that is **Accumulator**. Accumulator is a register in which arithmetic operations are performed and result is stored.

4) Bus :
Components are connected by collection of parallel wires for transmitting address, data and control information, is called Bus.
Buses can be **external** to the CPU, connecting it to memory and I/O device, and also **internal** to the CPU.

Internal Organization of CPU:



[Internal Architecture of CPU]

- Above diagram is also known as data path diagram. Data path is way for the instruction and it shows how instruction is pass from one component to another component in CPU. It consists register and ALU. These components are connected with each other through several internal buses.

- As shown in diagram control unit fetches the instruction from main memory and store into register. In diagram 'A' and 'B' in Input register indicate the fetched data value from the main memory.
- These register hold the ALU input while the ALU is performing some computation.
- ALU perform operation and yielding a result in the output register.
- This output register and again sends result (A+B) into a register, Later on the register can be written into memory if desired.

INTRODUCTION TO COMPUTER MEMORY

- Memory is one of the most important things that are incorporated into computers. The term "memory" identifies data storage that comes in the form of chips, and the word "storage" is used for memory that exists on tape or disks.

- Computer Memories are internal storage areas in the computer used to either temporarily or permanently store data or instructions to be processed.
- Memory in a computer system is required for storage and subsequent retrieval of the instructions and data. A computer system uses a variety of devices for storing instructions and data that are required for its operation.

- The basic objective of a computer system is to increase the speed of computation. Likewise the basic objective of a memory system is to provide fast, uninterrupted access by the processor to the memory such that the processor can operate at the speed it is expected to work.

- The capacity of the memory to hold data and program instructions varies in different computers.
- The original IBM PC could hold approximately 640000 characters of data or instructions only. But modern microcomputers can hold millions, even billions of characters in their memory.
- To locate the characters of data or instructions in the main memory, the computer stores them in locations known as addresses
- Addresses can be computers to post office mailbox. Their numbers stay the same, but contents continuously change.
- There are different types of memory in a computer that are assigned a task of storing several kinds of data. Each has certain peculiarities and capacities.

TYPES OF RAM AND ROM

- Memory units are the internal storage areas in computer. Memory – also known as the primary storage or main memory – is a part of the microcomputer that holds data for processing, instructions for processing the data and instructions.

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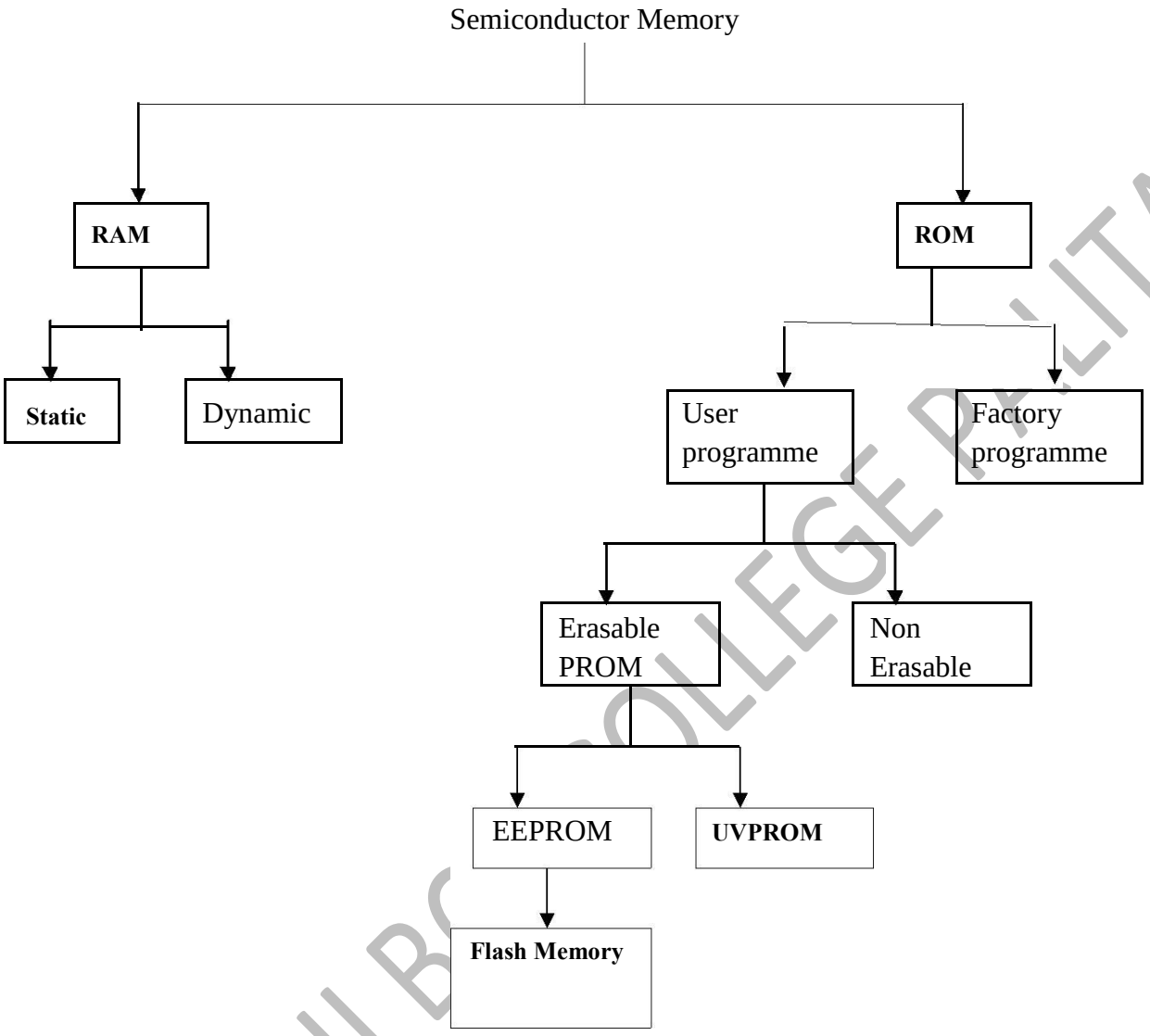


- Addresses can be computers to post office mailbox. Their numbers stay the same, but contents continuously change.
- A computer that has 1 MB of memory, can hold about 1 million bytes (or character) of information.
- Mainly there are two types of memory
- RAM - Volatile Memory(Primary) – This is the same as the main memory
- ROM - Non – Volatile Memory (Secondary)

1. **RAM - Volatile memory**
   - A type of computer memory that can be accessed randomly. That is any byte of memory can be accessed without touching the preceding bytes. RAM is main memory of CPU.
   - RAM refers to **read** and **write** memory, that is you can both write data into RAM and read data from RAM.
   - Data which is frequently changed, is stored in RAM, because time taken to read and write in it is approximately same.
   - It is volatile memory , it requires a steady flow of electricity to maintain its content. In this type of memory is lost data, when power is switched off.
   - RAM's are basically used to temporarily store data retrieved from the hard disk - or any other sources - so that the processor has faster access to the information required (RAMs are much faster than hard drives, floppy drives or CD-ROM drives).
   - Basically RAM is classified in two types

   1. Static RAM (SRAM)
      - The information which does not change frequently into static RAM
      - The term static derived from the fact that it does not need to be refreshed like dynamic RAM, so it does not require any refreshing circuitry.
      - SRAM is faster than DRAM
      - Many microcomputers use a SRAM as an external cache in addition to cache in the chip. Such SRAM is used as an external cache memory known as "L2 cache" (Level 2).SRAM is used in external use.

      - SRAM have the following advantages(strengths) over DRAM
        I. Simplicity : SRAM does not require external refresh circuitry.
        II. Speed : SRAM is faster than DRAM
        III. Cost : SRAM is several times more expensive than DRAM
        IV. Size : SRAM take up much more space than DRAM

      - Performance wise, SRAM is better than DRAM.

   2. Dynamic RAM
      - In a dynamic memory, the information stored has to be constantly refreshed using external circuitry or it will lose its contents.
      - DRAM is cheaper and consumes less power than SRAM
        DRAM is used as main memory.

2. ROM - Non Volatile Memory
- A computer memory on which data has been prerecorded.
- Once data has been written onto a ROM chip, it can not be removed and can only be read. It is used to store program which should not be lost when power is switched off.
- ROM is an example of non volatile memory.
- It is storing data permanently.
  In general purpose, ROM contains program to control peripherals and programs to load OS into main memory (RAM).

- In special purpose controllers ROM stores permanent programs and RAM stored data(BIOS).
- There are two main reasons that ROM is used for certain functions within the PC. Performance and Security.
- ROM is divided into 2 types. ○ Factory Programmed
  - User Programmed (PROM)

I. Factory programmed

- This type of ROM is developed by some standard industry and factory.
- It is reliable and less expensive.

II. User programmed (PROM – Programmable Read Only Memory)

- It is developed by not only user but some expert user. Once a program has been written onto a PROM, it remains there forever. To write data onto a PROM chip, you need a special device called a PROM programmer or PROM burner.
- It is not reliable and expensive
- It is used to store (application is) permanent programs and BIOS information.
- PROM is divided into two categories
  - Non Erasable
  - Erasable

1. Non Erasable

- The information which cannot be erased is known as Non Erasable Programmable ROM. This PROM is using fuse link. Once a fuse link is burnt it is permanent.

3. Erasable PROM (EPROM - Erasable Programmable Read Only Memory)

The information which is to be erased and reprogrammed by the user is known as erasable user programmable ROM.

There are 2 varieties of EPROM

a) EEPROM (EEPROM - Electrically Erasable Programmable Read Only Memory)

- It is a special type of PROM that can be erased by exposing it to an electrical charge.
- The information which stored in this type of memory can be erased by supplying / passing high voltage signal/pulse through this memory is known as EEPROM. It is not as fast as RAM.
- EEPROM requires data to be written or erased one byte at a time.

Flash Memory :

- These sizes are continuously increasing and their cost is also reducing.
- Flash memory up to 8 GB capacity are available they are used to store large programs and data.
- Flash memory can be erased and reprogrammed in blocks instead of one byte at a time. Many modern PCs have their BIOS (Basic Input Output System) stored on a flash

memory chip so that it can easily be updated if necessary. Such a BIOS is sometimes called flash BIOS.

b) UVPROM / UVEPROM – Ultraviolet Programmable Read Only Memory

- It is a special type of PROM that can be erased by shining intense ultraviolet light on it

Cache Memory

- Cache memory, also called CPU memory, is random access memory (RAM) that a computer microprocessor can access more quickly than it can access regular RAM. This memory is typically integrated directly with the CPU chip or placed on a separate chipthat has a separate bus interconnect with the CPU.

- The basic purpose of cache memory is to store program instructions that are frequently re-referenced by software during operation. Fast access to these instructions increases the overall speed of the software program.

- L1 and L2 are levels of cache memory in a computer. If the computer processor can find the data it needs for its next operation in cache memory, it will save time compared to having to get it from random access memory. L1 is "level-1" cache memory, usually built onto the microprocessor chip itself.

- L2 (that is, level-2) cache memory is on a separate chip (possibly on an expansion card) that can be accessed more quickly than the larger "main" memory. A popular L2 cache memory size is 1,024 kilobytes (one megabyte).

- **L1 (Level 1), L2 cache** are some specialized memory which work hand in hand to improve computer performance. When a request is made to the system, CPU has some set of instructions to execute, which it fetches from the RAM. Thus to cut down delay, CPU maintains a cache with some data which it anticipates it will be needed.**(L1) Level 1 Cache(2KB - 64KB) -** Instructions are first searched in this cache. L1 cache very small in comparison to others, thus making it faster than the rest.**(L2) Level 2 Cache(256KB - 512KB)** - If the instructions are not present in the L1 cache then it looks in the L2 cache, which is a slightly larger pool of cache.

Buses

- A collection of wires through which data is transmitted from one part of a computer to another. You can think of a bus as a highway on which data travels within a computer. When used in reference to personal computers, the term *bus* usually refers to *internal bus*. This is a bus that connects all the internal computer components to the CPU and main memory. There's also an expansion bus that enables expansion boards to access the CPU and memory.

- All buses consist of two parts -- an address bus and a data bus. The data bus transfers actual data whereas the address bus transfers information about where the data should go.
- The size of a bus, known as its *width,* is important because it determines how much data can be transmitted at one time. For example, a 16-bit bus can transmit 16 bits of data, whereas a 32-bitbus can transmit 32 bits of data.

➢ **Read Write Processor Bus Cycles**

- Thus a basic understanding of hardware operation is useful in developing software that interfaces directly with the hardware. In this article we will focus on some basic processor bus cycles. Understanding of bus cycle operations is useful in designing diagnostics and exception handlers.

✓ **Read Bus Cycle**

- Processor initiates a read bus cycle by floating the address of the memory location on the address lines.
- Once the address lines are stable, the processor asserts the address strobe signal on the bus. The address strobe signals the validity of the address lines.
- The processor asserts the data strobe signal. This signals to the memory that the processor is ready to read data.
- The memory subsystem decodes the address and places the data on the data lines.
- The memory subsystem then asserts the data acknowledge signal. This signals to the processor that valid data can now be latched in.
- This signals the end of the read bus cycle.

- **Write Bus Cycle**

- Processor initiates a write bus cycle by floating the address of the memory location on the address lines.
- Once the address lines are stable, the processor asserts the address strobe signal on the bus. The address strobe signals the validity of the address lines.
- The processor then places the data on the data lines.
- The memory subsystem decodes the address and writes the data into the addressed memory location.
- This signals to the processor that data has been written to the memory.
- Then the processor negates the data strobe, signaling that the data is no longer valid.
- signaling an end to the write bus cycle.

- **FSB (Front Side Bus, FSB**)

- is also known as the **Processor Bus, Memory Bus**, or **System Bus** and connects the CPU (chipset) with the main memory and L2 cache. The FSB can range from speeds of 66 MHz, 133 MHz, 100 MHz, 266 MHz, 400 MHz, and up. The FSB is now another important consideration when looking at purchasing a computer motherboard or a new computer.
- The FSB speed can be set either using the system BIOS or with jumpers located on the computer motherboard. While most motherboards allow you to set the FSB to any setting, ensure that the FSB is properly set unless you plan to overclock the computer. Keep in mind that improper settings may cause issues such as hardware lockups, data corruption, or other errors may arise with older hardware.

- **PCI (Peripheral Component Interconnect)**

- The PCI bus came in both 32-bit (133MBps) and 64-bit versions and was used to attach hardware to a computer. Although commonly used in computers from the late 1990s to the early 2000s, PCI has since been replaced with PCI Express.

- Revisions came in 1993 to version 2.0, and in 1995 to PCI 2.1, as an expansion to the ISA bus. Unlike ISA and other earlier expansion cards, PCI follows the PnP specification and therefore did not require any jumpers or dip switches. The picture below shows an example of what PCI slots look like on a motherboard. As you can see, there are three PCI slots: PCI4, PCI5, and PCI6, as well as a CNR slot.

- **USB**(**Universal Serial Bus**)
- An industry standard that defines cables, connectors and communications protocols for connection, communication, and power supply between computers and devices.
- USB was designed to standardize the connection of computer peripherals (including keyboards, pointing devices, digital cameras, printers, portable media players, disk drives and network adapters) to personal computers, both to communicate and to supply electric power. It has largely replaced a variety of earlier interfaces, such as serial portsand parallel ports, as well as separate power chargers for portable devices
- It is mostly used on personal computers. USB connects different devices using a standard interface.
- Most people use USB for computer mice, keyboards, scanners, printers, digital cameras, and USB flash drives. There are over six billionUSB devices around the world.

➢ Port

✓ Serial Port

- Used for external modems and older computer mouse
- Two versions: 9 pin, 25 pin model
- Data travels at 115 kilobits per second

- Serial port is used to communicate singles line or for completing the circuit.
- Data is transferred as bits from sender to receiver. The serial port takes 8, 16, or 32 parallel bits from the computer bus and converts it as an 8, 16, or 32 bit serial stream.

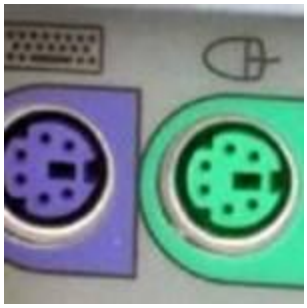
✓ **Parallel Port**

- Used for scanners and printers
- Also called printer port
- 25 pin model
- IEEE 1284-compliant Centronics port

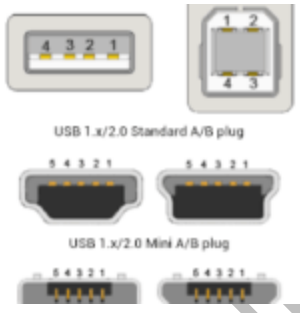
- Parallel ports are used to connect printers and other hardware. It is 25 pin port also named as IEEE 1284-compliant centronics port. Two variants of this port are ECP and EPP ports.
- These are 10 time faster than older port and support computer to handle data in two-ways.

✓ **PS/2 Port**

- Used for old computer keyboard and mouse

- Also called mouse port
- Most of the old computers provide two PS/2 port, each for the mouse and keyboard
- IEEE 1284-compliant Centronics port
- 

✓ **Universal Serial Bus (or USB) Port**

- It can connect all kinds of external USB devices such as external hard disk, printer, scanner, mouse, keyboard, etc.
- 

- It was introduced in 1997.
- Most of the computers provide two USB ports as minimum.
- Data travels at 12 megabits per seconds.
- USB compliant devices can get power from a USB port.

✓ **VGA Port:**

- This port is used to connect system's video card with monitor. This connector holds 15 holes and looks more like a serial port connector.
- Connects monitor to a computer's video card.
- It has 15 holes.
- Similar to the serial port connector. However, serial port connector has pins, VGA port has holes.

✓ **Power Connector**

- Three-pronged plug.
- Connects to the computer's power cable that plugs into a power bar or wall socket.

- This port is three pronged plug port which more looks like power plug. It is used to connect power cable in power socket.

✓ **DVI port:**

- DVI stands for digital video interface which is used to enhance video quality of flat LCD panel monitors.
- This connected high end video graphic card with monitor and is replacement for P&D plug and play display standard. It is becoming popular day by day.

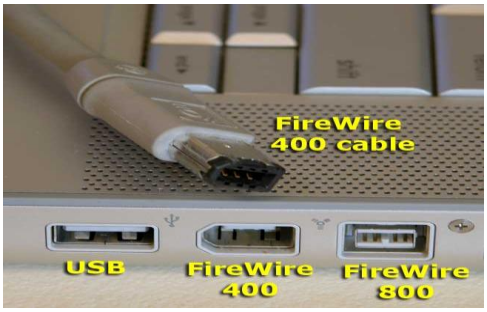
✓ **Game Port**

- Connect a joystick to a PC
- Now replaced by USB

- For all game lovers this port is favorite but this is now being replaced by USB port. This DB-15 connector comes with many input and small number of digital input and outputs.

✓ **Firewire Port**

- Transfers large amount of data at very fast speed.
- Connects camcorders and video equipment to the computer.
- Data travels at 400 to 800 megabits per seconds.

- 

- Invented by Apple.
- It has three variants: 4-Pin FireWire 400 connector, 6-Pin FireWire 400 connector, and 9-Pin FireWire 800 connector.

✓ **Modem Port**

- Connects a PC's modem to the telephone network.

✓ **Ethernet Port**

- Connects to a network and high speed Internet.
- Connects the network cable to a computer.

- This port resides on an Ethernet Card.

- Data travels at 10 megabits to 1000 megabits per seconds depending upon the network bandwidth.

✓ **Scsi**

- **SCSI** is most commonly used for hard disk drives and tape drives, but it can connect a wide range of other devices, including scanners and CD drives, although not all controllers can handle all devices.

- The **Small Computer System Interface** (**SCSI**) is a set of parallel interface standards developed by the American National Standards Institute (ANSI) for attaching printers, disk drives, scanners and other peripherals to computers.