Installation Technician Computing and Peripherals

(Job Role)

Sector: Electronics and Hardware

Textbook for Class XI

Contents

Do You Know ?

According to the 86th Constitutional Amendment Act, 2002, free and compulsory education for all children in 6-14 year age group is now a Fundamental Right under Article 21-A of the Constitution.

EDUCATION IS NEITHER A PRIVILEGE NOR FAVOUR BUT A BASIC HUMAN RIGHT TO WHICH ALL GIRLS AND WOMEN ARE ENTITLED

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Basic Electronics and Computer Fundamentals

Introduction

Computer is an electronic equipment that works on electricity. Every component of a computer needs electrical power to run and this power can come from a wall outlet in the form of alternating current or from a battery in the form of direct current. Internal components of a computer receive the power from the internal power supply known as SMPS (switched mode power supply). A computer installation technician must understand the basic principles of electrical and electronics, and also be aware of the computer fundamentals, its internal components, and working.

This Unit explains the basic concept of electricity and energy foundation, electrical quantities—current, voltage, and resistance; the electronic components — active and passive, integrated circuits (IC), and semiconductor memory. Further, the Unit also describes the basic components of a computer system, hardware and software, functional units of a computer, primary and secondary memory of a computer, different types of computers along with their capacity. Various input and output devices are used to enter the data in the computer as well as to produce output. The variety of input and output devices, their functionality and connectivity to the computer system are also discussed in this Unit.

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CHAPTER 1

BASIC ELECTRONICS

INTRODUCTION

Electricity has an important place in modern society. In the current age, most of the electronic devices work on electricity. Computer is also an electronic device which works mainly on electricity. The peripheral devices attached to the computer also work on electricity. It is necessary to provide proper and continuous power to the electronics equipment to work properly. For this purpose, the surge protector and uninterrupted power supply (UPS) are used, which also work on electricity. Hence, electricity has an important place in the world of computing and computer. In this Chapter, you will understand the basic concept of electricity, electrical quantities, and various electronic components.

ELECTRICITY

Electricity is the set of physical phenomena associated with the presence and flow of electric charge. It has a wide range of well-known effects, such as lightning, static electricity, electromagnetic induction, and electrical current.

ENERGY FOUNDATION

Electric charge is a fundamental physical property of matter. The forms of matter are—solid, liquid, and gases which are made up of atoms. Atoms are the fundamental building blocks of all molecules. The centre of an atom is called the nucleus. Atoms consist of three subatomic particles—protons, electrons, and neutrons. Electrons spin around the nucleus in shells, at a great distance from the nucleus. Protons carry a positive (+) charge, electrons carry a negative (-) charge, neutrons are neutral and have no net charge. One coulomb of charge is equal to 6×1018 (6,250,000,000,000,000,000) electrons.

Protons are found in the center of the atom, with a charge of +1 and a mass of 1 atomic mass unit, which is approximately equal to 1.66×10. Electrons are found in the periphery of the atom and have a charge of -1. They are much smaller than protons and their mass is 1/1836 amu.

The steady flow of electrons is called current. Current is what flows through electrical wires and powers electronics items, from light bulbs to televisions.

The positively charged protons attract negatively charged electrons, hence holding the atomic structure as shown in Figure 1.1.

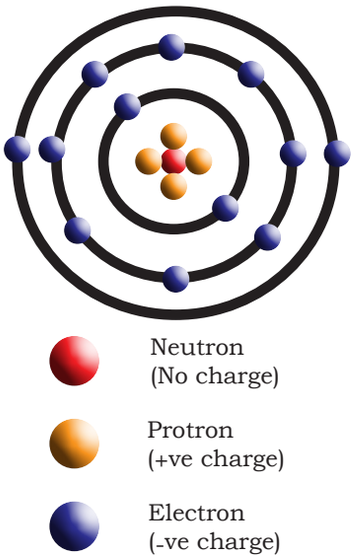


Fig. 1.1: Atomic structure

Conductors and Insulators

The materials can be categorised as insulators or conductors based on its physical property known as resistivity. In an insulator, the electric charge does not flow freely from one atom to another due to high resistivity. In a conductor, the electric charge flows freely from one atom to another due to low resistivity. This flow of charge is electric current.

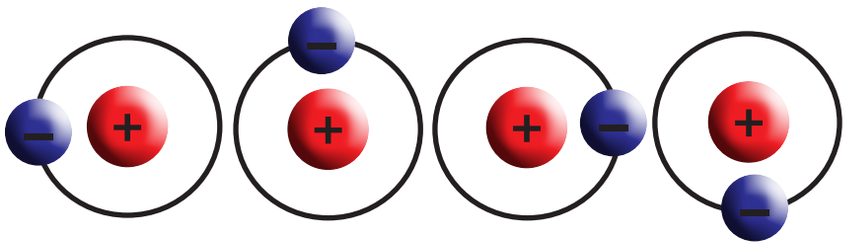


Fig. 1.2: Atoms in a wire, showing electrons travelling from one atom to another atom

Conductors

The material in which the electrons are loosely held can move very easily. These are called conductors. Metals like copper, aluminium, and steel are good conductors of electricity.

Insulators

The materials which hold their electrons very tightly do not allow the movement of the electrons through them very well. These are called insulators. Rubber, plastic, cloth, glass, and dry air are good insulators and have very high resistance.

Fig. 1.3: Conductor and insulator in a wire

The conductors are used to carry electrical current through wires. Insulators are commonly used as coating for the wires as shown in Figure 1.3. This wire consists of a core of copper (a conductor) and a coating of polyethylene (an insulator). The copper allows current to flow through the wire, while the polyethylene resists the flow of the current.

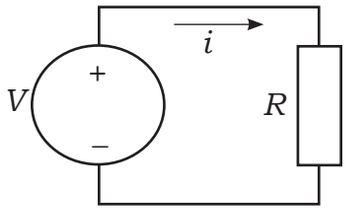


Fig. 1.4: A simple electric circuit made up of a voltage source and a resistor

Electrical Quantities

Current, voltage, and resistance are the three basic building blocks of electrical and electronics. They are called electrical quantities.

Voltage

This is the potential difference between two points. It is also the amount of work required to move one coulomb charge from one point to another point. Mathematically it can be written as V=W/Q where, 'V' is the voltage, 'W' is the work in joule, 'Q' is the charge in coulomb.

Value of voltage is measured in volt or joules per coulomb. Symbolic representation of voltage is 'V' or 'v'.

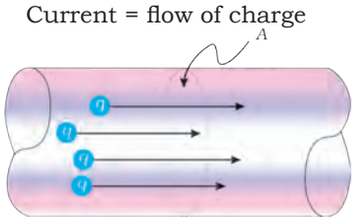


Fig. 1.5: Flow of charge through a cross section 'A'

Electric Current

This is the movement of electric charge through a conductive medium. In equation form, electric current 'I' is defined to be I=ΔQ/ΔT where, 'Q' is the amount of charge passing through a given area in time 'T'. The SI unit for current is the ampere (A), named after the French physicist André-Marie Ampère (1775–1836). Since, I=ΔQ/ΔT, we see that an ampere is one coulomb per second, 1 A=1 C/s.

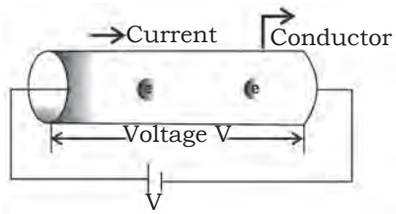


Fig. 1.6: Flow of electrons in the conductor

The flow of electricity requires a conductive medium for the flow of charge known as a conductor. The material's ability to conduct charge is called electrical conductance. The SI unit for conductance is siemens (S).

Resistance

It resists the flow of electrons and hence electric current in the circuit. Conceptually, the resistance controls the flow of electric current. An object or medium that has high electrical resistance is called a resistor. The

resistance is represented by the symbol 'R'. The SI unit of electrical resistance is ohm (Ω). Figure 1.7(a) and (b) show the resistor and its symbol.

To understand how to measure current and voltage in a circuit, you must also have a general understanding of how a circuit works and how its electrical measurements are related.

An electrical circuit is a type of network that has a closed loop, which provides a return path for the current. A simple circuit consists of a voltage source and a resistor.

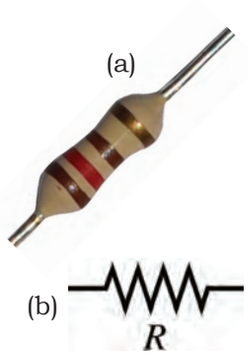


Fig. 1.7: (a) Resistor, (b) Resistor symbol

According to Ohm's law, the electrical current 'I', or movement of charge, that flows through most substances is directly proportional to the voltage 'V' applied to it. The electric property that impedes current is called resistance 'R'. Collisions of moving charges with atoms and molecules in a substance transfers the energy to the substance and limits the current. Resistance is inversely proportional to current. Ohm's law can therefore be written as follows: I=V/R where 'I' is the current through the conductor in amperes, 'V' is the potential difference measured across the conductor in volts, and 'R' is the resistance of the conductor in ohms (Ω). More specifically, Ohm's law states that 'R' in this relation is constant, independent of the current. Using this equation, we can calculate the current, voltage, or resistance in a given circuit.

For example, if we had a 1.5 V battery that was connected in a closed circuit to a light bulb with a resistance of 5 Ω, what is the current flowing through the circuit? To solve this problem, we would just substitute the given values into Ohm's law: I = 1.5V/5Ω; I = 0.3 amperes. If we know the current and the resistance, we can rearrange the Ohm's law equation and solve for voltage 'V' where V=IR

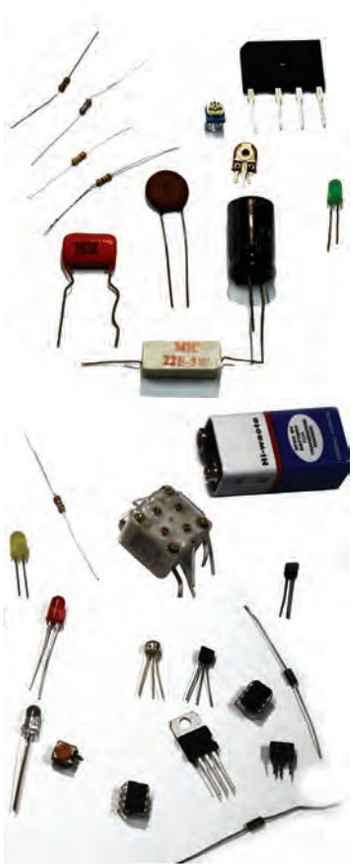


Fig. 1.8: Different types of components used in electrical and electronics

Components—Active and Passive

An electronic circuit is composed of various components. Electronic components usually have two or more leads, which can be fitted into the PCB to form a working electric

circuit. Electronic components are mainly classified into two classes— active and passive components.

Fig. 1.9: (a) Active components

Fig. 1.9: (b) Passive components

Active components

They produce energy in the form of voltage or current. These components require an external source for their operation. An active component has an analog electronic filter with the ability to amplify a signal or produce a power gain. Examples of active components are—diode, transistors, as shown in Figure 1.9(a).

Passive components

These do not produce energy in the form of voltage or current. They do not require external energy to operate. They cannot generate energy of their own and depend on the power provided from the AC circuit. Examples of passive components are resistors, capacitors, inductors, sensors, and transducers as shown in Figure 1.9(b).

Active components

The basic material used to manufacture active components is a semiconductor. Let us first understand the basics of semiconductors.

Semiconductor

These are materials whose conductivity is between that of conductors and insulators. Electronic devices are made up of semiconductor material. In semiconductor industry, silicon and germanium are used. Semiconductors are of two types, which are as follows:

Intrinsic (pure)

It is the pure form of semiconductor. The 'pure' word here represents that this semiconductor does not contain any other impurity atom.

Extrinsic (impure)

It is an impure form of semiconductor. When impurity atoms are added in the pure (intrinsic) form of semiconductor, then that semiconductor is known as extrinsic semiconductor. The extrinsic semiconductors are also known as impure semiconductors.

P-type semiconductor: When pentavalent impurity atom is added, an extrinsic semiconductor is formed which is known as P-type semiconductor.

N-type semiconductor: When trivalent impurity atom is added, an extrinsic semiconductor is formed which is known as N-type semiconductor.

Diode

It is an electronic device which allows current to flow easily in circuit. The most common form of diode is P-N junction diode, which is formed when two semiconductors, that is, P-type semiconductor and N-type semiconductor are combined to form a new component which is known as diode. The diode and its symbol are shown in Figure 1.10 (a) and (b). The silver ring in a diode represents the cathode.

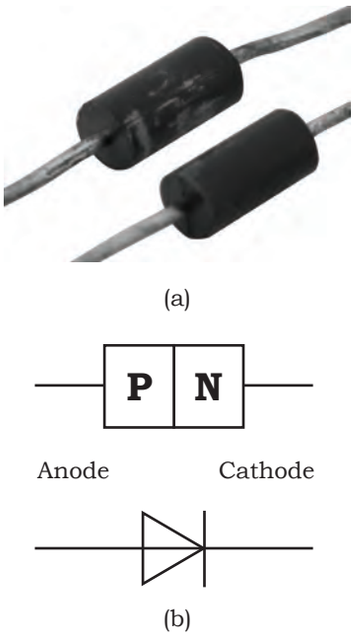


Fig. 1.10: (a) Diode (b) Diode symbol

Diode passes current only in one direction, therefore it is also known as unidirectional. The P-side is called anode and the N-side is called cathode. When the anode and cathode of a P-N junction diode are connected to external voltage source, such that, the positive end of a battery is connected to the anode and negative end of the battery is connected to the cathode, diode is said to be forward biased or we can say that diode will act as a close switch (it will be turned 'on'). In a forward biased condition, diode will pass the current through it.

When the P-side of the diode is connected to the negative terminal of the battery and N-side of the diode is connected to the positive terminal of the battery, diode is said to be reverse biased or we can say that diode will act as an open switch (it will be turned 'off'). In a reverse biased condition, diode will not pass the current through it.

Diode can be connected in forward bias and reverse bias as shown in Figure1.11(a) and (b).

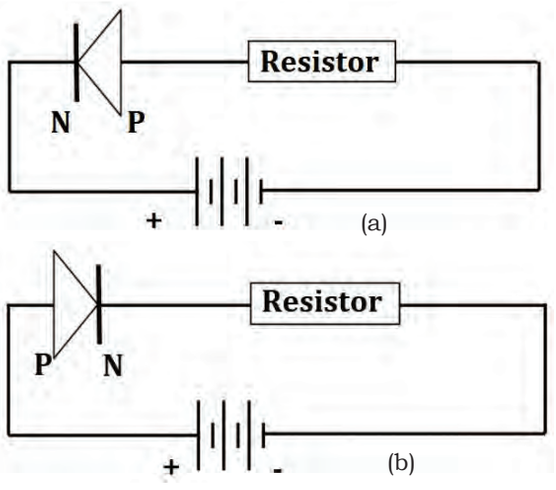


Fig. 1.11: (a) Diode connected in forward bias, (b) Diode connected in reverse bias

There are various types of diodes such as avalanche diode, crystal diode, light emitting diode (LED), photodiode, varactor diode, and zener diode.

Transistor

It is an active semiconductor device that has two P-N junctions which amplify electric current and voltage. It is a three layer semiconducting device. These three layers have three terminals—emitter, base, and collector respectively. It has two junctions and where the two layers touch each other is called a junction. Junction where emitter and base layer touch each other is known as an emitter base (EB) junction. Whereas junction where collector and base layer touch each other is known as a collector base (CB) junction.

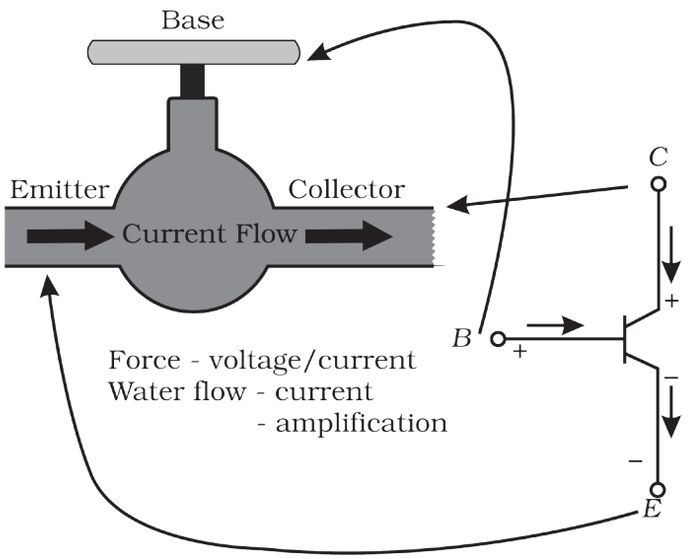


Fig. 1.12: Analogy showing a tap as the base of the transistor

To understand the functioning of a transistor, we can relate it with the water supply system in our home. Storage tank which is kept at the roof of the building is similar to an emitter in a transistor which acts as a source of charge carrier, that is, electrons and holes in a semiconductor. The tap at the ground is similar to the base of the transistor, this tap controls the flow of the water like base controls the flow of the charge carrier. Like the bucket at the ground collects the water coming from the storage tank, similarly the collector of the transistor collects the charge carriers coming from emitter.

Identifying BJT Terminals

Keep the transistor such that the flat surface faces you, as shown in the below Figure 1.13(a).

The bipolar junction transistor has three terminals namely—

1. Emitter (E)
2. Base (B)
3. Collector (C)

The bipolar junction transistor (BJT) and its symbol are shown in Figure 1.13(a) and (b).

Figure 1.14 shows the details junctions of BJT.

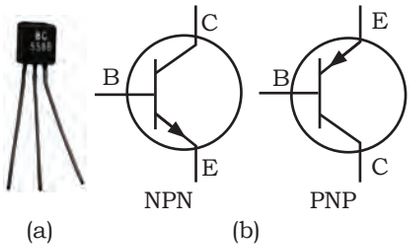


Fig. 1.13: (a) Bipoloar Junction Transistor (b) Symbol of BJT

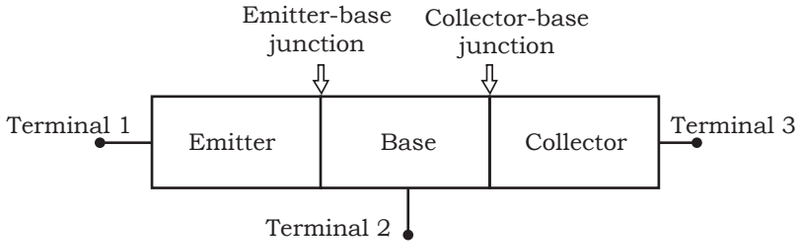


Fig. 1.14: EB and CB junction of bipolar junction transistor

Passive Components

Resistor

It is the basic component in an electronic circuit, which is used to calculate voltage and current in the circuit. It opposes movement of electrons or it controls the amount of current flow in the circuit. This opposition is known as resistance. Resistance is measured in ohms (Ω).

Colour bands on a resistor are used to represent the resistance values. There are 4-band, 5-band, and 6-band resistors.

In a 4-band resistor as shown in Figure 1.15, the first and the second band represent the numerical value of the resistor, the third band is a multiplier to the power of ten, and the fourth band is the tolerance level. In a 5-band resistor, first three bands represent significant digit, fourth band represents multiplier, and fifth band represents tolerance.

Each colour on the colour coded resistor has the specific value as per the colour scheme shown in Table 1.1.

The tolerance gives an upper and lower value of resistor. Take the following example for a 100Ω resistor as shown in Table 1.2.

The resistance of the resistor in Table 1.2 is calculated as: resistance of resistor is the value of the first band, succeeded by value of the second band, succeeded by number of zeros as per the value of colour code mentioned Table 1.1 and the fourth band represents the tolerance value to be taken from Table 1.2.

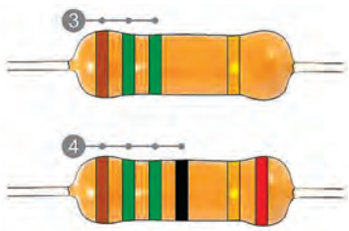


Fig. 1.15: 4-band and 5-band colour coded resistor

Table 1.1 Colour code

Code	Number
Black	0
Brown	1
Red	2
Orange	3
Yellow	4
Green	5
Blue	6
Violet	7
Grey	8
White	9

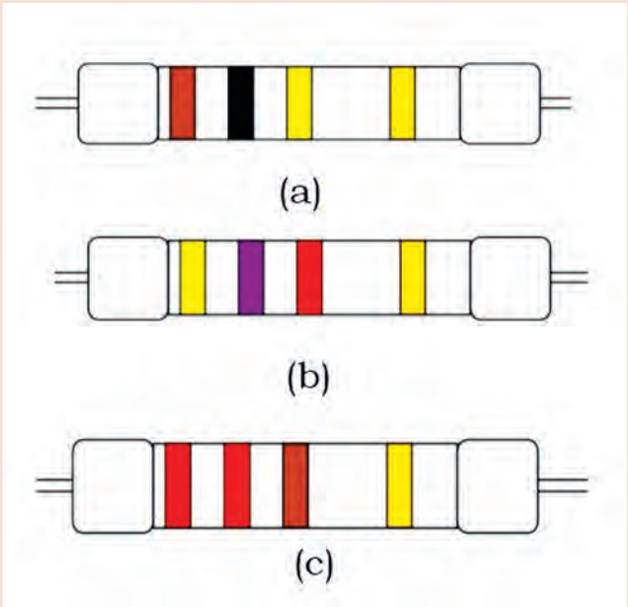
Table 1.2 Tolerance value

Tolerance	Colour	Stated Resistor Value	Allowed Upper Value	Allowed Lower Value
+/- 1%	Brown	100 Ω	101 Ω	99 Ω
+/- 2%	Red	100 Ω	102 Ω	98 Ω
+/- 5%	Gold	100 Ω	105 Ω	95 Ω
+/- 10%	Silver	100 Ω	110 Ω	90 Ω

For example, resistance of the four band resister with colours yellow, violet, orange, and gold is calculated as: yellow = 4, violet = 7, orange = 3 number of zeros, gold = 5% tolerance, resistance = 47000 Ω (or 47 kΩ), 5% tolerance.

According to Ohm's law, power is calculated as the product of voltage and resistance.

Assignment: Calculate the value of resistors by using the color code.



(a) Brown-black-yellow-yellow
(b) Yellow-violet-red-yellow
(c) Red-red-brown-yellow

Alphanumerically coded (surface mounted) resistors

These are rectangular in shape as shown in Figure 1.16. They have leads, which come out from the resistor, these leads are used for mounting of resistor on the printed circuit board (PCB). Some surface mount resistors use plates on the bottom side of the resistor.

Fig. 1.16: Surface mount resistor

The first two or three numbers printed on the surface mount resistor represent significant digits and the last digit represents the number of zeros that should follow. For example, as shown in Figure 1.16, a resistor reading 1252 indicates a value of 12,500 ohms. For tolerance value, one must refer to the letter at the end of the code. Compare this letter at the end of the code with the tolerance. There are two types of resistors—fixed resistor and variable resistor.

Fixed resistor

The resistors made up of ceramic body and cylindrical in shape with definite or fixed resistance values are fixed resistors. The resistive element could be either carbon film, thick film, or a wound wire element. The properties of fixed resistors depend upon the type of fixed resistor used.

Fig. 1.17: (a) Fixed resistor

Based on the type of material used in constructing a resistor, it is classified into — carbon composition, carbon pile, carbon film, metal film, and metal oxide film.

(i) Carbon composition is made up of carbon clay composition with plastic coating around it.

(ii) Carbon pile is made up of a stack of carbon disks compressed between two metal contact.

(iii) Carbon film is deposited on an insulating substrate and cut into thin resistive path.

(iv) Metal film is cylindrically shaped and coated with nickel chromium.

(v) Metal oxide film is made up of tin oxide.

For example, a carbon film resistor has 5% tolerance, power rating of 0.125W–2W, temperature coefficient of 250–450 ppm/k.

A metal film resistor has 1% tolerance, power rating of 0.1–5W and temperature coefficient of 10–250 ppm/K.

Fig. 1.17:(b) Variable resistor

Variable Resistor

These are the resistors whose resistance value can be changed. They have three terminals out of which two are connected to the ends of the track and a third terminal is connected to the wiper. The motion of the wiper allows increase and decrease of resistance. Potentiometer, rheostat, and trimpot are variable resistors.

Capacitor

Fig. 1.18: Capacitor showing capacitance value 4700 micro farad and maximum voltage value of 10 V

It is a passive electronic component used to store electric charge. The unit for measuring capacitance is farad (F). In a capacitor, energy is stored in the form of an electric field. It has two parallel plates and between these plates, energy is stored. It is also marked with colour bands to denote value. The first two bands are the first and second digits whereas the third band denotes the multiplier. The capacitor is indicated by the symbol ⊣⊢.

The capacitance of capacitor can vary from –20% to +80% of actual capacitance.

The parameters of capacitor are maximum voltage, capacitance, and tolerance. Maximum voltage defines the maximum voltage value of a capacitor. The Figure 1.18 shows the various parameters which are mentioned on a capacitor.

The capacitor is marked with the value of capacitance and voltage. You can calculate the amount of charge in capacitor by using equation Q = C x V where, Q = charge in coulomb, C = capacitance in farad, V = voltage in volt.

Types of capacitors

There are various types of capacitors based on the type of material used between plates of capacitor. They are ceramic capacitors, film power capacitors, super capacitors, electrolytic capacitors, and variable capacitors, etc.

Ceramic capacitors: They are made up of ceramic and metal where metal acts as the electrode and ceramic

is the dielectric. This type of capacitor is used in applications of high frequency and high current pulse loads.

Film power capacitors: In these, the dielectric films are drawn to a thin layer surrounded by metallic electrodes on a cylindrical wiring. Polypropylene is used as the dielectric.

Super capacitors: These are electrochemical capacitors with no specific dielectric in it. The storage of charge is obtained by either separation of charge or redox reaction.

Fig. 1.19: Different types of capacitors

Electrolytic capacitor: An electrolytic capacitor is a type of capacitor that uses an electrolyte to achieve a larger capacitance than other capacitor types. An electrolyte is a liquid or gel containing a high concentration of ions.

Variable capacitors: Above mentioned capacitors are fixed capacitors which cannot vary their capacitance. A variable capacitor can vary its capacitance through mechanical motion.

Inductor

It is a two terminal electrical component which resists changes in electric current. The value of inductance is measured in henry. Inductive tolerance is usually in the range of -5% to +20%.

In an inductor, copper wire is used which is wound on a plastic or ferromagnetic material in the form of a coil. The inductor is shown in Figure 1.20 and it is indicated by the symbol  .

Fig. 1.20: Inductor

When current flows through the coil, a magnetic field is set. This field restricts the flow of current. Once the field is created, then current passes normally through it thus resisting any change in the flow of current.

The types of inductors are—air core inductor, ferromagnetic core inductor, and variable inductor.

Air core inductor

It has its coil wound on non-magnetic material like plastic or ceramic and there is only air present in between the windings.

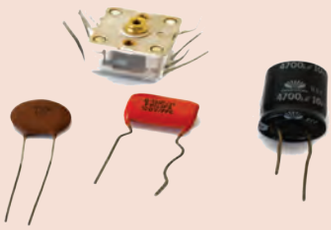
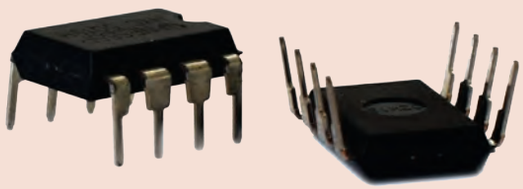
Ferromagnetic inductor

It has its coil wound on a magnetic core made up of ferromagnetic material.

Variable inductor

It is made up of ferrite magnetic core which can be slid or screwed to change inductance.

Assignment: Identify the components used in electrical and electronics.

Pictorial representation of the component	**Write down the name of the components and identify which category they belong to—active or passive.**
	Name of the components: _____ Category: Active ☐ Passive ☐
	Name of the components: _____ Category: Active ☐ Passive ☐
	Name of the components: _____ Category: Active ☐ Passive ☐
	Name of the components: _____ Category: Active ☐ Passive ☐

Transformer

It is an electric unit that transfers energy between two circuits using electromagnetic induction. It is a static unit that simply transforms the voltage level of an AC signal. It either steps-up or steps-down the AC voltage. It does not change the frequency of applied AC signal.

It consists of a core made up of ferromagnetic or ceramic material and a coil made up of some insulating magnetic material or copper wires. Transformer oil is used for cooling of transformer.

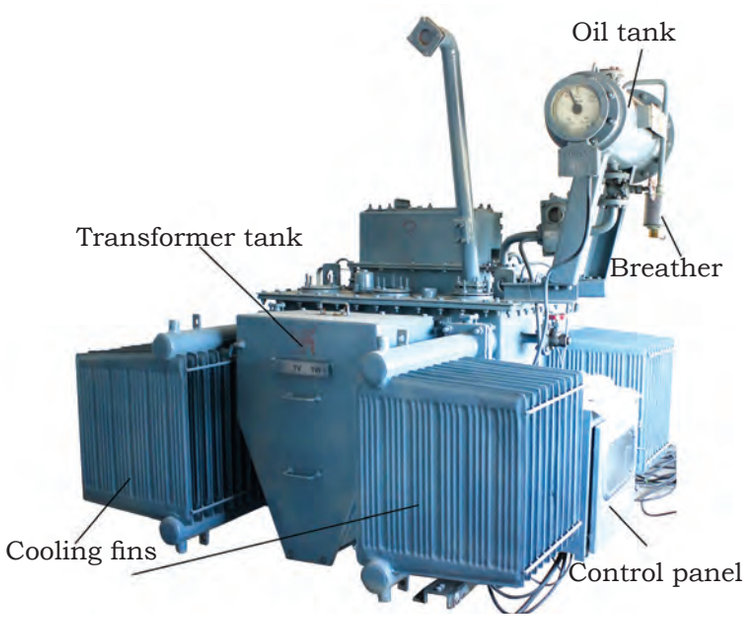


Fig. 1.21: Transformer parts

Based on the purpose, there are different types of transformers such as power transformers, instrument transformers, RF transformers, and audio transformers. However, in computers the step-down, center tap, and high frequency transformers are used. A center tapped transformer is shown in Figure 1.22.

Fig. 1.22: Center tapped transformer

Integrated Circuit (IC)

Digital ICs are used in computers and computer networks. An integrated circuit is a combination of electronic components on a single piece (or 'chip') of semiconductor material as shown in Figure 1.23. It has a large number of tiny transistors on a small chip and results in circuits that are smaller, cheaper, and faster. It also has a number of pins.

Fig. 1.23: Integrated circuit

Semiconductor Memory

It is an electronic data storage device, which is fabricated on integrated circuits (IC). As we have discussed, semiconductors have conductivity which is in between that of conductors and insulators. Electronic devices are made up of semiconductor material. In

Fig. 1.24: RAM

Fig. 1.25: ROM

semiconductor industry, silicon and germanium are widely used. Computer memory is a physical electronic device. Semiconductor memories are used to store applications and data. This storage can be temporary or permanent, as required by a computer and/or its user. There are two types of memory—primary and secondary. Primary memory includes RAM, ROM, and secondary memory is—hard disk drive, CD/DVD, magnetic tape, pen drive, etc. Primary memory is classified into two types—read-only memory (ROM) and random access memory (RAM).

Power Supply

It is an electrical device which provides operating voltage to the computer. It is used to provide power to a personal computer. It requires a minimum load of 7A at 5V and 2.5A at 12V. Modern PC requires power in the range of 60W–250W. The electronic components inside the computer require very low DC voltage.

The various types of power supply used in computing are DC power supply, AC power supply, linear regulated power supply, batteries, uninterrupted power supply, and switched mode power supply (SMPS).

Rectifier

AC power supply takes voltage from the mains and converts it to DC before transmitting it to any device. To convert AC into DC, a rectifier circuit is used which ensures that the current does not reverse its direction. Rectifier circuits can be classified as single phase and three phase circuits. Again, every phase has half wave rectifiers and full wave rectifiers.

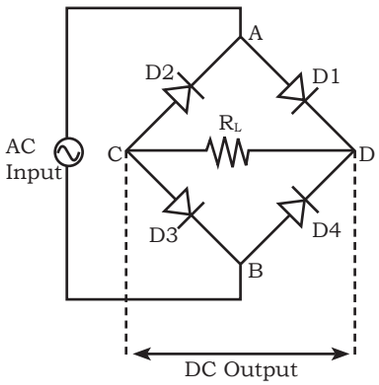


Fig. 1.26: Construction of bridge rectifier circuit

Full wave bridge rectifier

A bridge rectifier is a type of full wave rectifier which uses four or more diodes in a bridge circuit configuration.

Bridge rectifier construction

The bridge rectifier is made up of four diodes namely D1, D2, D3, D4, and load resistor RL. The input AC signal is applied across two terminals A and B and

the output DC signal is obtained across the load resistor RL, which is connected between the terminals C and D.

During the positive half cycle, the terminal A becomes positive while the terminal B becomes negative. This causes the diodes D1 and D3 to become forward biased and at the same time, it causes the diodes D2 and D4 to become reverse biased. The current flow direction during the positive half cycle is shown in the Figure 1.27 (that is A to D to C to B).

During the negative half cycle, the terminal B becomes positive while the terminal A becomes negative. This causes the diodes D2 and D4 to become forward biased and at the same time, it causes the diodes D1 and D3 reverse biased. The current flow direction during negative half cycle is shown in the Figure 1.28 (that is B to D to C to A).

From the Figure 1.27 and Figure 1.28, we can observe that the direction of current flow across load resistor RL is same during the positive half cycle and negative half cycle. Therefore, the polarity of the output DC signal is same for both positive and negative half cycles.

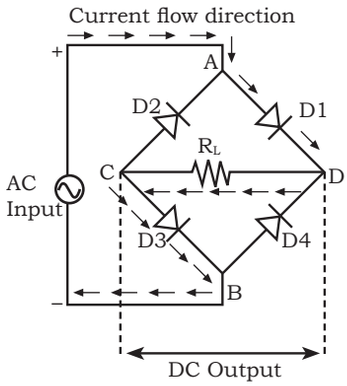


Fig. 1.27: Bridge rectifier circuit during positive half of the input cycle

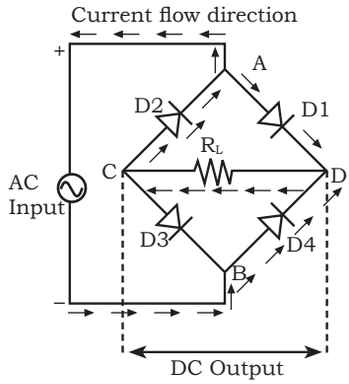


Fig. 1.28: Bridge rectifier circuit during negative half of the input cycle

Battery

This is a device that converts chemical energy directly to electrical energy. It consists of a number of voltaic cells connected in series by a conductive electrolyte containing anions and cations. One half-cell includes electrolyte and the anode or negative electrode; the other half-cell includes electrolyte and the cathode or positive electrode.

Batteries are convenient sources of electricity that can be easily stored and utilised.

Battery is shown in the Figure 1.29(a). The positive terminal is cathode and negative is anode. It is important to show the correct flow of electrons in the circuit diagrams by indicating the positive and negative terminal as shown in Figure 1.29(b).

Batteries can be broadly classified into two types—primary and secondary.

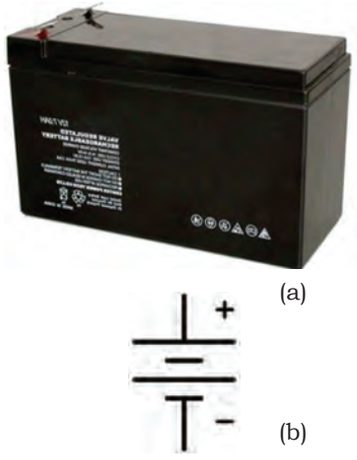


Fig. 1.29: (a) Battery used in UPS (b) Battery symbol in a circuit diagram

Primary batteries

They are non-rechargeable. They convert chemical energy to electrical energy irreversibly.

Secondary batteries

They are rechargeable. Their chemical reactions can be reversed by supplying electric energy to the cell.

Switched Mode Power Supply (SMPS)

It is used to achieve voltage regulation and conversion of power. SMPS functions in three stages—input rectifier, where AC is converted to DC; inverter phase, where again the DC is converted into inverted AC; and output rectifier stage, where the inverted AC is given to the high winding transformer.

Fig. 1.30: SMPS

SMPS is the board on which electronic components are assembled for the regulation of electric power. In it, input AC voltage is converted into low DC voltage. It is used in PCs so that every part of the PC gets proper power supply separately. It helps split the power to motherboard, hard disk, floppy drive, CD drive, etc.

It contains several wires of multiple colour. Each wire carries different amount of voltage value, which will pass to different hardware parts of the computer. The Table 1.3 shows the different colour cables and amount of voltage they carry.

Table 1.3

Yellow	12 V
Blue	12 V
Black	Common [0]
Red	5 V
White	5 V
Green	Power supply ON
Orange	3.3 V
Purple	+5 SB (Standby)

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Uninterrupted Power Supply (UPS)

It is an electronic device which supplies power to a load when the mains supply or input power source fails. Any UPS has a power storage element which stores energy in the form of chemical energy, for example, the energy is stored in batteries. A UPS uses double conversion method of accepting AC input, rectifying to DC, passing this through a string of batteries, and inverting it to AC again.

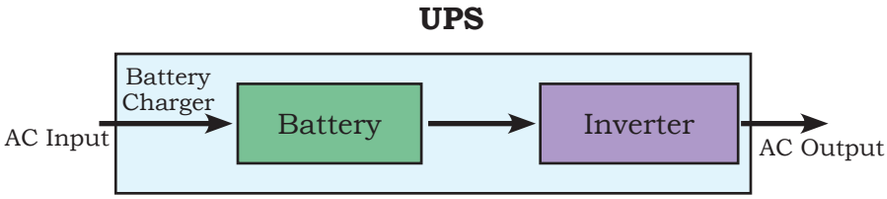

Fig. 1.31: Block representation of an UPS

Classification of UPS

It plays a vital role in maintaining the regularity of electric power. There are a variety of UPS used in power system. Some of them are discussed below—

Online UPS

In an online UPS, the batteries are always connected to the inverter, so that, no power transfer switches are necessary. In case of a power cut, there will be no momentary power breaks.

Standby or offline UPS

A system where normally AC input (utility power) is output, as it is to connected devices and when a power outage or abnormal voltage is detected, inverter starts feeding using power from the batteries. In the event of a power outage, a few milliseconds of momentary break occurs in the AC output.

Printed Circuit Board

This is used to electrically connect various components using tracks, pads, etc. Internally, all the components are connected, which reduces the complexity of the circuit. It can be found in many electronics devices

like—TV, mobile, digital camera, computers parts like—graphic cards, motherboard, etc.

Types of PCB

There are several types of PCBs available. Out of these types of PCB, we have to choose the appropriate type of PCB according to our application—

Single-layer PCB

Single sided consisting of one layer of copper on a rigid base material.

Double-layer PCB

Double sided consisting of two layers of copper on a rigid base material.

Multi-layer PCB

They are boards with more than three copper layers on double-sided boards which are stuck to each other with a particular glue.

Flexible PCB

It consists of a single conductor layer on a dielectric film.

Soldering

It is the process of melting a metal onto other metal components in order to bind them. It differs from welding. In welding, the component pieces are melted together; in soldering, a softer metal with a lower melting point is used to connect them. Because soldering does not melt components, it is useful for delicate applications, such as electronics works. The purpose of soldering is to bind two other components. Solder can be thought of as a sort of 'metal glue'. It can be used to fill in gaps or hold pieces in place, but does not serve any more complicated purpose. Since solder is metallic, it conducts electricity, which is another reason for it being widely used for connecting electronic components.

Fig. 1.32: Soldering kit

The soldering process is classified into soft soldering, silver soldering, and brazing.

Soldering techniques

There are various types of soldering techniques. The following are the most commonly used soldering techniques in PCB:

Conduction soldering

It is basically the traditional hand soldering technique.

Induction soldering

Uses induction heat to melt the solder.

Laser

This method is used at a power of 30–50W for electrical connection joints.

Desoldering

It is the process of removing the solder and components from PCB for troubleshooting, repair, or replacement.

Check Your Progress

A. Multiple choice questions

1. Which of the following components is used to provide resistance?
   (a) Heat (b) Energy
   (c) Product (d) Resistor
2. A diode _____.
   (a) is the simplest of semiconductor devices
   (b) has characteristics that closely match those of a simple switch
   (c) is a two-terminal device
   (d) All of the above
3. Which of the following is a semiconductor material?
   (a) Silicon
   (b) Germanium
   (c) Both A and B
   (d) None of these
4. Transformer works on _____.
   (a) AC
   (b) DC
   (c) Both AC and DC
   (d) None of these

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5. Transistor has _____layers and _____ junctions.
   (a) two, three (b) three, two
   (c) three, three (d) two, two
6. Diode is reverse biased when _____.
   (a) cathode is connected to the positive and anode is connected to the negative terminal of the battery
   (b) cathode is connected to the negative and anode is connected to the positive terminal of the battery
   (c) no specific polarity is required
   (d) None of these
7. What is the ohmic value for the colour code of orange, orange, orange?
   (a) 22 k Ω
   (b) 33 k Ω
   (c) 3300 Ω
   (d) 44000 Ω
8. Which of the following will be the correct value of resistance for the colour code of brown, brown, red, gold and for what ohmic value?
   (a) 1.2k Ω 5%
   (b) 1.1k Ω 5%
   (c) 1.3k Ω 5%
   (d) 1.5k Ω 5%
9. Which of the following will be the correct value of resistance for the colour code of black, brown, green, gold, and for what ohmic value?
   (a) 1x105 Ω 5%
   (b) 1x104 Ω 5%
   (c) 1x105 Ω 10%
   (d) 1x104 Ω 10%

B. Fill in the blanks

1. Electrons have _____ charge.
2. The SI unit for measuring the rate of flow of electric charge is _____.
3. Transformers work on _____ voltage.
4. Extrinsic semiconductor is _____ form of semiconductor.
5. Intrinsic semiconductor is _____ form of semiconductor.
6. Capacitor stores energy in the form of _____ field.
7. Inductor stores energy in the form of _____ field.
8. Diode has _____ terminals.
9. Silicon is _____ material.
10. Transistor has _____ terminals.
11. A three terminals semiconducting device is _____.

C. State whether the statements given below are True or False

1. Transformer is used to step up the voltage.
2. Transistor is used as an amplifier and switch.

3. The electromagnetism in a transformer is the energy source for the transformer.
4. Transformer changes the frequency of the applied signal.
5. The junction where emitter layer and base layer touch each other is named as emitter base junction.
6. Amplification is the process of increasing the level of voltage and current.
7. The base unit of capacitance is farad.
8. Green, orange, orange, violet colour coded resistor is 62kΩ 5%.
9. Violet, green, orange, silver colour coded resistor is 75kΩ 10%.
10. Blue, red, orange, gold colour coded resistor is 62kΩ 5%.
11. Orange, orange, yellow, gold colour coded resistor is 330kΩ 5%.

D. Short answer questions

1. Describe the relationship between the electrical current, voltage, and resistance in a circuit.
2. Explain the difference between a conductor and insulator.
3. List the name of conductors and insulators which are used in our day-to-day life.
4. What does 10 A define?
5. Write short notes on—
   (a) Diode
   (b) Transistor
   (c) LED, capacitor
   (d) Inductor
6. Explain the types of semiconductors.
7. What are the applications of a transistor?
8. Write down the specifications of a capacitor.
9. Describe the functions and identify the major components of a battery.
10. What is the role of active and passive components in an electric circuit?

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Chapter 2 Computer System Fundamentals

Introduction

Computers are an essential tool of information technology (IT). They are multi-purpose machines that are used to solve a variety of problems in different fields. The basic working principle of a modern computer is based on the analytical engine designed by Charles Babbage in the 19th century. Computers have changed our daily routine as the entire task performed by us in our daily routine is automated. Our lives are directly or indirectly affected by the computers. It was in the past era where computers were used in industries. In this era of information, we are dependent on the storage, flow, and processing of data and information which can only be possible with the help of computers. This is the reason a computer is called a multi-purpose machine. The purpose of this Chapter is to introduce you to a computer.

Computer System

Fig. 2.1: Computer system

The term 'computer' is derived from the word 'compute', meaning 'to calculate'. A computer is a programmable electronic machine that accepts data from the user, processes it by performing calculations and operations on it, and generates the desired output results. Computer performs both simple and complex operations, with speed and accuracy.

Computing is not restricted to only mathematical computing but to a variety of logic-based tasks. Computer, process the data as per the given set of instructions. It can perform operations like generating bills, reserving tickets, printing mark-sheets, printing business reports, or communicating messages. Data can be text, number, audio, video, graphs, or animations.

Characteristics and Limitations of a Computer

As we know, computers can execute millions of instructions per second. The computer gives a correct result only if the data and instructions given are correct.

The term garbage in, garbage out (GIGO) is used to refer to this feature. Computers are very useful because of their characteristics like speed, accuracy, automation, programming ability, storage, diligence, versatility, and ability to retain data.

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Characteristics

Speed: The speed of computer data processing is measured in terms of instructions per second. Modern computers can process the data very fast that is at the rate of millions of instructions per second. It means the calculations which otherwise require hours and days to compute manually, can be completed in a few seconds using computers.

Accuracy: Computers can perform complex arithmetic and logical computations with 100% accuracy. For example, the computer can accurately give the result of division of any two numbers up to ten decimal places.

Automation: Computers can automatically perform a given task based on the given instructions. Once data and necessary instructions are stored in the computer memory, human intervention is not required.

Programability: Computers can be programmed to execute predefined set of instructions. The program once written can be modified later for the revised task.

Storage: Computers can store large volumes of data permanently in secondary storage for a long time. The stored content can be retrieved whenever required. A limited amount of data can be stored, temporarily, in the primary memory.

Diligence: Computers are machines and hence they can operate consistently for long hours without any break. They can perform long and complex calculations with the same speed and accuracy from the start till the end.

Versatility: Computers are versatile in nature. They can perform different types of tasks with the same ease. At one moment, you can use the computer to prepare a letter document and the next moment you may play music or print a document.

Limitations

Computers also have some limitations. Computers do not have emotions, knowledge, experience, and feelings. They can only perform tasks as per the instructions given by the user and do not take their own decisions.

Generations of Computer

The computer has evolved from a large simple calculating machine to a smaller but much more powerful machine. The evolution of the computer to the current state is defined in terms of generations of the computer. Each generation of the computer is designed based on a new technological development, resulting in better, cheaper, and smaller computers that are more powerful, faster, and efficient than their predecessors. There are five generations of the computer.

Table 2.1 Generations of computer

Generations	Hardware Technology	Systems Examples
First Generation (1942–1954)	Main electronic component: vacuum tubes Input/Output device: punch card	ENIAC, EDVAC, EDSAC, UNIVAC, IBM 701
Second Generation (1955–1964)	Main electronic component: transistors Input/Output device: floppy disk and tape	IBM 7030, IBM 7094, IBM 1400 series, CDC 164, UNIVAC series
Third Generation (1964–1975)	Main electronic component: integrated circuits (IC) Input/Output device: keyboard and mouse as input device, high capacity disk for secondary storage	IBM 360/370, UNIVAC 1108, UNIVAC AC 9000, PDP 11, CDC 6600
Fourth Generation (1975–Present)	Very large scale integrated circuits (VLSI) technology, microprocessor Input/Output device: keyboard and mouse as input device, high capacity disk for secondary storage	STAR 1000, CRAY-X-MP (super computer), DEC 10, PDP 11 CRAY-1, IBM 4341, ALTAIR 8800, Apple computers, VAX9000
Fifth Generation (Present–Future)	These machines will incorporate bio-chip and VVLSI (very very large scale integration) or ultra-large scale integration (ULSI) artificial intelligence (AI)	IBM notebooks, Pentium PCs, SUN workstations

Hardware and Software

A computer needs both hardware and software to function properly.

Hardware: It consists of mechanical and electronic devices which we can see and touch. CPU, keyboard, mouse, and monitor are examples of hardware.

Software: It consists of programs, operating systems, and the data that resides in the memory and storage devices. Windows, Microsoft Office, LibreOffice, and Photoshop are some examples of software.

A computer system is useful only if it consists of both hardware and software.

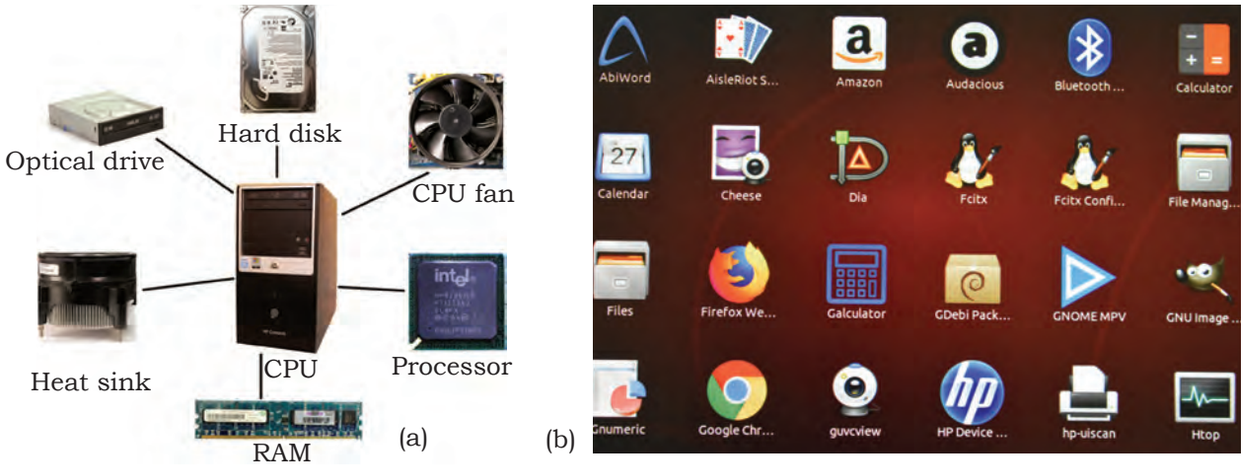

Fig. 2.2: (a) Hardware and (b) Software

Practical Exercise

Identify whether the following are a part of the computer hardware or software.

Component	Hardware/Software
Motherboard	
Monitor	
DVD drive	
Hard disk	
Microphone	
MS Office	
Keyboard	
CorelDraw	
LibreOffice	
RAM	

The Input-Process-Output Concept

A computer is an electronic device that accepts data, processes data, generates output, and stores data. A computer mainly performs the following four functions:

Input

The computer accepts input data from the user via an input device like keyboard. The input data can be characters, word, text, sound, images, document, etc.

Process

The computer processes the input data. It performs arithmetic or logic calculation, editing, modifying a document, etc. During processing, the data, instructions, and the output are stored temporarily in the computer's main memory.

Output

It is the result generated after the processing of data. The output may be in the form of text, sound, image, document, etc. The computer may display the output on a monitor and send the output to the printer for printing.

Storage

The input data, instructions, and output are stored permanently in the secondary storage devices like hard disk. The stored data can be retrieved, whenever needed.

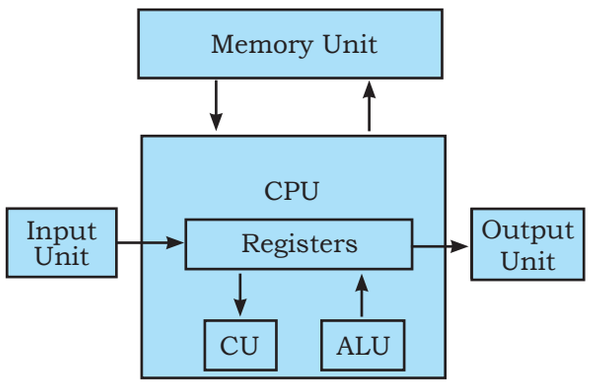

Fig. 2.3: John von Neumann architecture

Main Components of the Computer System

The internal design of a computer differs from one model to another but the basic components of all computers remain the same. The basic working model of a computer is based on the John von Neumann architecture. The interconnection diagram for a simple computer is shown in the Figure 2.3. John von Neumann proposed the first

usable draft of a working computer. It consists of some functional units namely input/output unit, central processing unit (CPU), and memory.

A computer has the following three main components—

(i) input/output unit
(ii) central processing unit
(iii) memory unit

Input and output unit

The user interacts with the computer via the I/O unit. The input unit accepts data from the user and the output unit provides the processed data that is the information to the user. The input unit accepts data from the user, converts it into computer understandable form. Similarly, the output unit provides the output in a form that is understandable by the user. The input is provided to the computer using input devices like keyboard and mouse. The commonly used output devices are monitor and printer.

Fig. 2.4: Input and output devices

Central Processing Unit (CPU)

It is the main component of the computer. It performs all the processing of input data and is responsible for activating and controlling the operations of other units of the computer. In microcomputers, the CPU is built on a single chip or integrated circuit (IC) and is called microprocessor. Internal architecture of a CPU consists of the following parts—

(i) arithmetic logic unit (ALU)
(ii) registers
(iii) control unit (CU)
(iv) buses
(v) clock

Arithmetic logic unit (ALU)

It consists of two units—arithmetic unit and logic unit. The arithmetic unit performs arithmetic operations such as addition, subtraction, multiplication, and division. Logic unit performs comparisons of numbers, letters, and special characters. Logic operations include

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testing for greater than, less than or equal to condition. ALU performs arithmetic and logic operations and uses registers to hold the data that is being processed.

Registers

They are high speed but have low storage in the CPU. They are referred to as the CPU's working memory and are directly accessed and manipulated by the CPU during instruction execution. They store data, instructions, addresses, and intermediate results of processing. The data and instructions are brought in the registers processing. For example, if two numbers are to be added, both numbers are brought in the registers and added and the result is also placed in a register. There are different registers for different specific purposes. Some of the important registers in CPU are as follows—

- Accumulator (ACC): stores the result of arithmetic and logic operations.
- Instruction register (IR): contains the most recently fetched instruction.
- Program counter (PC): contains the address of next instruction to be processed.
- Memory address register (MAR): contains the address of next location in the memory to be accessed.
- Memory buffer register (MBR): temporarily stores data from memory or the data to be sent to memory.
- Data register (DR): stores the operands and any other data.

The number of registers and the size (number of bits) of each register in a CPU helps to determine the power and the speed of a CPU. The overall number of registers can vary from about ten to many hundreds, depending on the type and complexity of the processor. The size of the register also called word size, indicates the amount of data with which the computer can work at any given time. The size of a register may be 8, 16, 32, or 64 bits. In 32-bit CPU, each register is 32 bits wide and it can manipulate 32 bits of data at a time. The modern PCs have 32-bit or 64-bit registers and are

referred to as 32-bit processor and 64-bit processor. A 64-bit processor can process the data twice as much as a 32-bit processor.

Control unit (CU)

It controls the input, output, and processing activities inside the computer. It maintains the order and controls the operation of the entire system. The control unit interprets the instructions given to the computer, determines the data to be processed, where to store the results (output), and sends the control signals to the devices required for the execution of the instructions. It directs the computer to carry out stored program instructions by communicating with the ALU and the registers. CU uses the instructions in the instruction register (IR) to decide which circuit needs to be activated. It also instructs the ALU to perform the arithmetic or logic operations. When a program is run, the program counter (PC) register keeps track of the program instruction to be executed next. CU tells when to fetch the data and instructions, what to do, where to store the results, the sequencing of events during processing, etc. CU also holds the CPU's instruction set, which is a list of all operations that the CPU can perform.

Buses

Data is stored as a unit of 8 bits in a register. Each bit is transferred from one register to another by means of a separate wire. This group of eight wires which is used as a common way to transfer data between registers is known as a bus. Bus is a connection between two components to transmit signals between them. Bus is of three major types namely—data bus, control bus, and address bus.

Clock

It is an important component of CPU which measures and allocates a fixed time slot for processing each and every micro operation. CPU executes the instructions in synchronisation with the clock pulse. The clock speed of a CPU is measured in terms of mega

hertz or millions of cycles per second. The clock speed of a CPU varies from one model to another.

Memory unit

It stores the data, instructions, intermediate results and output, temporarily during the processing of data. The memory unit consists of cache memory and primary memory. Primary memory or main memory of the computer is used to store the data and instructions during execution of the instructions. Random access memory (RAM) and read-only memory (ROM) are the primary memory. The input data that is to be processed is brought into the main memory before processing. The instructions required for processing of data and any intermediate results are also stored in the main memory. The output is stored in memory before being transferred to the output device. CPU can work with the information stored in the main memory. In addition to the main memory, there is another kind of storage device known as the secondary memory. It is non-volatile memory and is used for permanent storage of data and programs. A program or data that has to be executed is brought into the RAM from the secondary memory. Magnetic disks, optical disks, and magnetic tapes are examples of secondary memory.

Cache memory

During processing, data and instructions are brought to RAM from secondary storage devices. For processing, the data and instructions are accessed from the RAM and stored in the registers. The time taken to move the data between RAM and CPU registers is large. This affects the speed of processing of a computer and results in decreasing the performance of CPU. Cache memory is a very high speed memory placed in between RAM and CPU. It increases the speed of processing and it is a storage buffer that stores the data that is used more often temporarily and makes it available to the CPU at a fast rate. During processing, CPU first checks cache for the required data. If

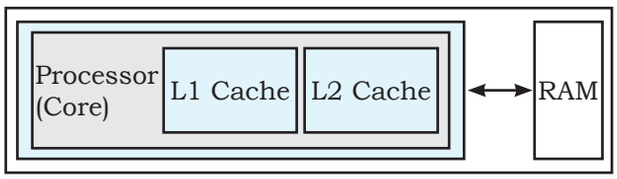

Fig. 2.5: Illustration of cache memory

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data is not found in cache, then it looks in the RAM for data. To access the cache memory, CPU does not have to use the motherboard's system bus for data transfer.

Cache memory is built into the processor and may also be located next to it on a separate chip between the CPU and RAM. Cache built into the CPU is faster than separate cache, running at the speed of the microprocessor itself. However, separate cache is roughly twice as fast as RAM.

The CPU has a built-in level 1 (L1) cache and level 2 (L2) cache, as shown in Figure 2.5. In addition to the built-in L1 and L2 cache, some CPUs have a separate cache chip on the motherboard. This cache on the motherboard is called level 3 (L3) cache. Modern processor comes with built-in L3 cache, like in Intel core i7. The L1, L2, and L3 cache store the most recently run instructions, the next ones and the possible ones, respectively. Typically, CPUs have cache size varying from 256KB (L1), 6 MB (L2), to 12MB (L3) cache. Cache memory is very expensive, so it is smaller in size. Generally, computers have cache memory of sizes 256 KB to 2 MB.

Primary memory

It is the main memory of a computer. It is used to store data and instructions during the processing of data. It is semiconductor memory and is of two kinds—random access memory (RAM) and read-only memory (ROM).

Read-only memory (ROM)

It is an essential memory unit in every computer. It holds the boot up program called BIOS (Basic Input Output System) required to boot the computer. This memory is permanent and is not erased when the system is switched off. The memory capacity of ROM varies from 64 KB to 256 KB depending on the model of the computer.

Random access memory (RAM)

It is used to store data and instructions during the execution of programs. CPU accesses the data and the

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instructions from RAM, as it can access them at a faster speed than the storage devices connected to the input and output unit. The input data that is entered using the input unit is stored in RAM, to be made available during the processing of data. Similarly, the output data generated after processing is stored in RAM before being sent to the output device. Any intermediate results generated during the processing of program are stored in RAM. RAM is volatile meaning it is temporary and is erased when the computer is switched off. It is a read/write type of memory and thus can be read and written by the user. As it is possible to randomly use any location of this memory, it is known as random access memory. The memory capacity of RAM starts from 640 KB and the present computers have 4 GB to 16 GB RAM.

Memory representation

In a computer, data is stored as a machine code. The machine code has only two states either 0 or 1. Binary digit or bit is the basic unit of memory. A bit is a single binary digit that is 0 or 1. A bit is the smallest unit of representation of data in a computer. The storage capacity of memory is measured in bytes. A group of 8 bits form a byte. One byte can store 2^8 that is 256 different combinations of bits and thus can be used to represent 256 different symbols. In a byte, the different combinations of bits fall in the range 00000000 to 11111111.

Binary digit = 1 bit = 0 or 1
1 Nibble = 4 bits
1 Byte (B) = 8 bits
1 Kilobyte (KB) = 2^{10} = 1024 bytes
1 Megabyte (MB) = 2^{20} = 1024KB
1 Gigabyte (GB) = 2^{30} = 1024 MB = 1024*1024 KB
1 Terabyte (TB) = 240 = 1024 GB = 1024*1024*1024 KB

A computer with 2GB of RAM can hold 2 billion bytes of data and instructions at any time.

Secondary memory

It stores data and instructions permanently. The information can be stored in secondary memory for

a long time (years), and is generally permanent in nature unless erased by the user. It is a non-volatile memory. It provides backup storage for data and instructions. Hard disk drive and optical disk drives are some examples of storage devices.

The data and instructions that are currently not being used by CPU, but may be required later for processing are stored in secondary memory. It has a higher storage capacity and is also cheaper than the primary memory. But it takes a longer time to access the data and instructions stored in secondary memory than in primary memory.

Magnetic Storage Devices

These use plastic tape or metal or plastic disks coated with magnetic materials. Data is recorded magnetically in these devices. Read/write heads are used to access data from these devices. Hard disk drive is the most popular magnetic storage device now.

Hard disk drive (HDD): This consists of metal disks coated with magnetic material concealed in dust free containers. Hard disks have a very high storage capacity, high data transfer rates, and low access time. They are more durable, less error prone, and are the most common secondary storage device used in computers.

Fig. 2.6: Hard disk drive

Optical storage devices: This is a data storage medium which uses a low power laser beam to read from and write data into it. The laser beam reads the pits and lands (all optical media have pits and lands which are microscopic) as 0s and 1s. It is very cheap to manufacture optical disks in large quantities and it is a popular secondary storage medium. The main types of optical disks are—CD, DVD, and Blu-ray.

Fig 2.7: CD, DVD, and Blu-ray disc

Compact disc (CD): This is an optical storage medium capable of storing up to 700 MB of data. A CD drive uses red laser beams for reading from and writing data into CDs. There are two types of CDs—CD-R and CD-RW. In CD-R (compact disc recordable), data can be written once and read many times whereas in CD-RW (compact

disc rewritable) disks, it can be erased and rewritten at any time.

Digital versatile disk (DVD): This is an optical storage media similar to CD-ROM but with a higher storage capacity. This is achieved by using smaller spots to record data. Recording and reading of data is done using a DVD drive. Here also, red laser beam is used for these operations. The capacity of a DVD varies from 4.37 GB to 15.9 GB. DVDs also come in the form of DVD-ROM and DVD-RW.

Blu-ray DVD: This is an optical disk format developed to enable recording, rewriting, and playback of high definition (HD) video as well as storing huge amounts of data. CD and DVD technologies use red laser to read and write data while Blu-ray format uses a blue-violet laser. The benefit of using a blue-violet laser is that it has a shorter wavelength than a red laser, which makes it possible to focus on the laser spot with greater precision. This allows data to be packed more tightly. Therefore, it is possible to store more data on the disk even though it is the same size as that of a CD or DVD. The format offers more than five times the storage capacity of traditional DVDs and can hold up to 25 GB on a single layer disc and 50 GB on a dual layer disc.

Fig. 2.8 (a): Flash drive

Fig. 2.8 (b): Flash memory cards

Semiconductor storage (flash memory)

Flash drives use EEPROM chips for data storage. Flash memory is faster and durable as compared to other types of secondary memory. USB flash drive and flash memory cards are the examples of flash memory.

USB flash drive: This is a small external storage device. It is portable and rewritable. The storage capacity of an USB drive currently varies from 2 GB to 128 GB.

Flash memory card: This is of size about 1 inch × 0.75 inches with a thickness of about 2 mm. It has storage capacities in the range of 1 GB–32 GB. It also has a smaller version which is used within cell phones and tablets. These smaller cards are

about 6 mm × 3 mm in size and are less than 1 mm thick. These cards have various speed levels as per their usage.

Table 2.2 summaries the characteristics of the various kinds of data storage in the storage hierarchy. Modern computers are designed with this hierarchy due to the characteristics listed in the table.

Table 2.2 Comparison of different types of memory

Storage	Speed	Capacity	Relative Cost	Volatile
Registers	Fastest	Lowest	Highest	Yes
Cache	Faster	Low	Very high	Yes
RAM/ ROM	Fast	Low/ Moderate	High	Yes
Hard Disk	Moderate	Very high	Very low	No

Practical Activity

Identify the computer hardware and software.

Material required

Computer, RAM, hard disk drive, CD, DVD, pen drive

Procedure

1. Identify the RAM chip and note its memory capacity.
2. Identify the hard disk drive and note its memory capacity.
3. Insert the CD in the CD drive and note its memory capacity.
4. Insert the DVD in the DVD drive and note its memory capacity.
5. Insert the pen drive in the USB slot and note its memory capacity.
6. Categorise all of the above memory into primary and secondary memory.

Classification of Computers

Generally, the word computer refers to a personal computer such as a desktop or laptop. However, we

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see different types of computers in our daily lives performing various tasks, for example while operating an ATM, purchasing groceries at the store, etc.

Purpose

According to purpose, computers can be classified into two types:

General purpose computers

These computers are used for general use such as office applications, banking, invoice, sales analysis, and financial accounting. They are used at home, offices, and educational institutions.

Fig. 2.9: Digital and analog signals

Special purpose computers

These computers are designed to perform scientific applications, weather forecasting, space applications, etc.

Working principle

According to the technology used, computers can be classified into three types—analog, digital, and hybrid computers.

Analog computers

These deal with analog data which represents the continuously varying physical quantities, such as current, voltage, or frequency. They are used to measure physical quantities like pressure, temperature, speed, etc., and to perform computation on these measurements. Examples are thermometer and speedometer.

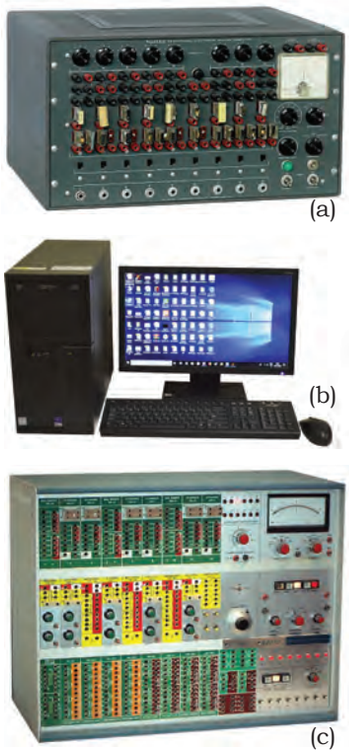

Fig. 2.10: (a) Analog computer, (b) Digital computer, (c) Hybrid computer

Digital computers

These operate on digital data. Input and output is in the form of on/off type (digit 1 and 0). Digital computers are based on counting operation. Any data to be manipulated by a digital computer must be converted to a discrete (1,0) representation. The digital computers are mainly used in office, home, and industry.

Hybrid computers

These use the combination of digital and analog computers. These computers use digital-to-analog

(DAC) and analog-to-digital (ADC) technology to deal with both types of data. They store and process both analog and digital data. Hybrid computers are mainly used in artificial intelligence. The ECG machine used in hospitals is an example of hybrid computer. ECG machine reads the heart beat as an analog signal and then converts it into digital signal to print the graph.

Fig. 2.11: Supercomputer

Classification of computers according to size and storage capacity

Supercomputer: This is designed by interconnecting a number of processors. It has the highest processing speed with multiprocessing technology. It is mainly used in weather forecasting, biomedical research, aircraft design, remote sensing, and other areas of science and engineering. A supercomputer focuses on executing a few programs as fast as possible. Examples of supercomputers are CRAY YMP, CRAY2, NEC SX-3, CRAY XMP, and PARAM.

Fig. 2.12: Mainframe computer

Mainframes: These are slower than the supercomputers in speed and processing power. They can support hundreds of users simultaneously. In one way, mainframes are more powerful than supercomputers because they support more programs simultaneously, while the supercomputer can execute a single program faster than a mainframe. Mainframes have a very large storage capacity and can handle large database systems, such as patient information system in a big hospital or student information system in an university. Example of mainframes are DEC, ICL, and IBM 3000 series. The capacity of a mainframe can be a hundred or even a thousand times that of a modern PC.

Fig. 2.13: Mini computer

Mini computer: This uses multiprocessing. It is capable of supporting hundreds of users simultaneously. It has a large storage capacity and operates at a higher speed. The minicomputer is used in multi-user system where various users can work at the same time. This type of computer is generally used for processing a large volume of data. It is also used as a server in Local Area Networks (LAN).

Fig. 2.14: Micro Computer

Micro computer: This has the lowest speed and storage capacity. Its CPU is a microprocessor. The 4 bit microprocessor chip was invented first. The 8 bit microprocessor chip was used in the first microcomputer. The microprocessor chip continues to improve 16 bit, 32 bit, and 64 bit chips. Examples of microcomputer are IBM PC, PC-AT. The PC supports a number of input and output devices. Today's microcomputer is so powerful that it can serve the purpose of a server, or sometimes that of a minicomputer that can be used as a server. The microcomputer can be categorised as below—

Fig. 2.15: All in one computer

Desktop computers

Desktop computers are also known as personal computer (PC). They are intended for use at a fixed location. They consist of CPU, monitor, speaker, keyboard, and mouse. Desktop computers are easy to upgrade and expand. They are also less expensive.

All in one computer

All in one computers are the new form of desktop PC. They have inbuilt CPU and monitor like that of a laptop. They can also have a touch screen monitor and are mounted on a desk like a standard monitor. CPU is mounted on the back side of the monitor. It has a USB port for connection of a mouse and keyboard.

Fig. 2.16: Laptop computer

Laptop computers

A laptop has a built-in monitor, keyboard, touch-pad, and speakers to make a fully functional computer. The modern laptops also have touch screen, which minimises the use of a keyboard or mouse. They are called laptops because of their small size and being light enough to be used while being placed on one's lap. A laptop can perform almost all jobs of a desktop. The main components of laptop are—touchpad, battery, AC adapter and ports. A user can work on a fully charged laptop without connecting it to a power supply for three to seven hours. A laptop has a power cable and AC adapter designed to be used with

specific type of laptop. The laptop also have 3–4 USB ports to connect peripheral devices, a VGA or HDMI port to connect the projector and a slot to insert a memory card.

Mobile computers

Many mobile devices work as specialised computers. These are normally used for internet, e-mail, photography, capturing and storing images and videos. These devices are portable and consume very less space. The various mobile computers are categorised as—tablets, smartphones, wearable devices, vehicle-mounted, handheld computers, e-book readers, etc. The most common are tablets and smartphones, which are discussed here.

Tablets

They are handheld computers and are more portable than laptops. They use a touch sensitive screen for typing and navigation. The size of a tablet is about 7 to 10 inches. They work on specialised operating systems such as Android, Windows, and iOS. The iPad is an example of a tablet.

Smartphones

In addition to providing telephone services, a smartphone is designed to run a variety of applications (apps). They are small tablet computers and can be used for web browsing, watching videos, reading e-books, and playing games. Many apps can be installed on the smartphone which we use in our daily lives for booking tickets, bill payment, etc.

Fig. 2.17: Smartphone

Personal Digital Assistants (PDAs)

They are just like a mobile phone with a touch screen and keypad. They have bigger screens than mobile phones. They use handwriting recognition software to enter text and are extremely portable and fit into pockets. They are a powerful computer that includes satellite navigation facilities (GPS), mobile phone capability, and versions of application software that have a limited range of functions.

Fig. 2.18: PDA

Fig. 2.19: IBM computer

Fig. 2.20: Apple computer

Types of computers on the basis of brand

There are two types of PCs—IBM/IBM compatible Intel PC and Mac PC.

IBM PC

IBM PC began with the original IBM PC that was introduced in 1981. Other companies began manufacturing similar computers which were called IBM Compatible.

Apple/Macintosh

Macintosh introduced the first personal computer with graphical user interface (GUI) in 1984. Macs are made by Apple Inc., and use Mac OS X (an operating system).

Practical Exercise

Look through the list of computer types and state where they are being used. Discuss which computer should be used for what purpose. State three reasons to choose a laptop computer rather than a general purpose desktop computer.

Check Your Progress

A. Multiple choice questions

1. The computer system is used to _____.
   (a) compute the result
   (b) process the data
   (c) produce result
   (d) All of these
2. The data and information can be stored in _____.
   (a) primary storage
   (b) secondary storage
   (c) Both (a) and (b)
   (d) None of these
3. Which of the following are components of central processing unit (CPU)?
   (a) Arithmetic logic unit, mouse, control unit
   (b) Arithmetic logic unit, control unit, memory
   (c) Arithmetic logic unit, integrated circuits, memory
   (d) Control unit, monitor, memory

4. The device through which data and instructions are entered into a computer is _____.
   (a) software
   (b) output device
   (c) input device
   (d) memory
5. The measurement of storage capacity of memory is in_____.
   (a) bite
   (b) bytes
   (c) kilobytes
   (d) megabytes
6. The 'heart' of the processor which performs many different operations—
   (a) arithmetic and logic unit
   (b) motherboard
   (c) control unit
   (d) memory
7. Unit of computer which is capable of performing arithmetic, logical, and data manipulation operations on binary numbers is called _____.
   (a) CU
   (b) ALU
   (c) I/O Unit
   (d) processing unit
8. Operations of computer arithmetic and logic unit are directed by _____.
   (a) ALU itself
   (b) program
   (c) control unit
   (d) memory unit
9. CPU consists of _____.
   (a) ALU, control unit and registers
   (b) ALU and control unit
   (c) ALU, control unit, and hard disk
   (d) ALU, control unit, and monitor
10. The output of a computer is sent to _____.
    (a) input device
    (b) output device
    (c) Both (a) and (b)
    (d) None of these
11. Which among the following was found in the first generation of computers?
    (a) Vacuum tubes and magnetic drum
    (b) Integrated circuits
    (c) Magnetic tape and transistors
    (d) All of above

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12. Which of the following refers to the fastest, biggest, and most expensive computer?
    (a) Personal computer
    (b) Supercomputer
    (c) Laptop
    (d) Notebook

B. Fill in the blanks

1. The _____ unit is used to perform the arithmetic operations.
2. The input, output, and processing activities are controlled by the _____
3. The _____ unit acts as central nervous system of the computer.
4. The _____ unit presents the results to the user.
5. The different parts of the CPU are _____, _____, and _____.
6. _____ and _____ are the main memory.
7. The fastest memory in a computer is _____.
8. ALU consists of the _____ unit and _____ unit.
9. The _____ memory is placed between the RAM and the CPU.
10. The result of input given to computer is called as _____.
11. The _____ is the physical part of the computer system which one can see, feel, or touch.
12. The _____ is also called the brain of the computer.
13. The wrong results produced by computer on wrong input are _____.
14. According to its size and memory capacity, the digital computer is categorised into _____ types.
15. A bit is a single binary digit _____ or _____.
16. One byte can store _____ different combination of bits.
17. 1 Byte = _____ bits
18. 1 Kilobyte (KB) = _____ bytes
19. 1 Megabyte (MB) = _____ KB
20. 1 Gigabyte (GB) = _____ MB = _____ KB
21. 1 Terabyte (TB) = _____ GB
22. The registers are located inside the _____.

C. State whether the statements given below are True or False

1. The random access memory is used to hold the boot up program.
2. Control unit is used to present the result to the user.
3. For entering data and instruction to a computer, an input device is used.

4. Control unit decides where to store processed data.
5. A computer can do anything without data and instruction.
6. A computer is a high speed calculator.
7. CPU is a microprocessor with high speed processing power.
8. Minicomputer uses microprocessor having large storage capacity.
9. Supercomputer has highest processing speed after mainframe with multiprocessing technology.
10. The output of the digital computer is in the form of 0 or 1 type.
11. Digital computers are used for measuring physical quantities like pressure, temperature, etc.

D. State the long form of the following acronyms—

1. CPU
2. ALU
3. CU
4. RAM
5. ROM
6. HDD
7. ENIAC
8. EDVAC
9. EDSAC
10. UNIVAC
11. GIGO
12. IBM
13. PDA
14. LSI
15. VLSI

E. Short answer questions

1. What is a computer?
2. Explain input and output with examples.
3. List the important characteristics of computers.
4. List the limitations of the computer.
5. Distinguish between software and hardware.
6. Explain the input-process-output cycle.
7. What are the main components of the computer system?
8. Define analog, digital, and hybrid computers.
9. Give an example of analog computer and digital computer.
10. Give names of different types of computers.
11. How is a computer a versatile machine?
12. Explain how a computer is diligent?
13. Draw a labeled diagram of a basic model of a computer system.

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14. List the functions of a computer.
15. List the components of central processing unit.
16. Name the functional units of a computer.
17. What is the function of ALU?
18. What is the function of control unit?
19. What is primary memory?
20. List five important registers of the CPU and state the purpose of each register.
21. Why are registers used in the CPU?
22. Define word size.
23. Explain the meaning of 64-bit processor.
24. List the key features of the internal memory.
25. List the key features of the main memory.
26. Which is the fastest memory?
27. Arrange the memories in increasing order of speed—register, RAM, hard disk drive, magnetic tape, cache memory.
28. Give the approximate speed and size of the registers, cache memory, RAM, and magnetic disk.
29. List the different memories available in the computer in order of their hierarchy with respect to the CPU.
30. Why is primary memory faster than the secondary memory?
31. What is the meaning of volatile memory? Also give an example of volatile memory. Differentiate between RAM and ROM.

Chapter 3 Input and Output Devices

Introduction

Input and output devices are required to communicate with the computer. These devices are connected to the CPU through various ports or with the help of wireless technologies. Input devices feed data and instructions into the computer, and output devices present information from a computer system. Output generated by the output devices may be hardcopy or softcopy output. Hardcopy outputs are permanent outputs which can be used later when required. They produce a permanent record on paper. Printer is a common output device, that produces hardcopy outputs. Softcopy outputs are electronic and are available on the screen in a digital form. They do not produce a permanent record. Monitor is a common softcopy output device.

Input Devices

An input device is used to feed data into a computer. It is also defined as a device that provides communication between the user and the computer.

Text Input Devices

Keyboard

This is the most common input device. It is designed just like a conventional typewriter. It allows the user to input alphabets, numbers, and other characters. It provides keys for additional functions. It detects the key being pressed and generates the corresponding ASCII code which can be recognised by the computer. The standard US keyboard introduced in 1986 has 101 keys. It has a keyboard layout called the QWERTY design. QWERTY gets its name from the first six letters across in the upper left hand corner of the keyboard

Fig. 3.1: Keyboard

as shown in Figure 3.1. Normally, keyboards come in two sizes—one with integrated numeric keypad and other with a separate numeric keypad. Keyboards can be classified into wired and wireless. Wired keyboards are connected to the CPU through a serial, PS/2 port, or USB port. Wireless keyboards are connected to the computer through infrared (IR), radio frequency (RF), or bluetooth connections. Portable flexible keyboards are also available now. New generation keyboards like laser keyboards that project the keyboard layout to any surface are being developed.

Fig. 3.2: Numeric keypad

Numeric keypad

It is a small keyboard having only numbers. It is used to enter only numeric data such as those in ATMs. The computer keyboards also have a numeric keypad.

Fig. 3.3: PIN pad

PIN pad

This is a device with a numeric keypad used to enter a personal identification number (PIN) of debit card or credit card while doing the transaction.

Pointing Devices

These devices are used to move an onscreen pointer or cursor (usually an arrow). They are commonly used with graphical user interfaces (GUIs).

Mouse

It is a small handheld device used to indicate the position of a cursor or its movement on a computer's screen by rolling it over a mouse pad or flat surface. A mouse has one or more buttons and possibly a scroll wheel. This scroll wheel is used to scroll the screen vertically or horizontally. The different types of mouse are ball, optical, and laser mouse. Ball mouse works on the principle of the movement of the ball, whereas optical mouse uses LED and laser mouse uses laser beams for sensing the movement. Laser mouse has more precise movement when compared to other types of mouse. Wired mouse uses serial, PS/2, and USB ports, to communicate, whereas a wireless mouse comunicates with the computer via radio waves.

Fig. 3.4: Mouse

Light pen

It is a pointing device shaped like a pen. The tip of the light pen contains a light-sensitive element which when placed against the screen detects the light from the screen, enabling the computer to identify the location of the pen on the screen. Light pens have the advantage of drawing directly on the screen. They are used by engineers, artists, fashion designers for Computer Aided Designing (CAD) and other drawing purposes.

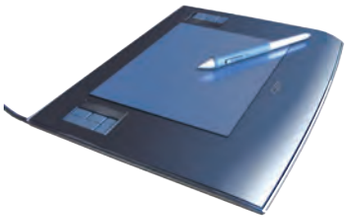


Fig. 3.5: Light pen

Touch screen

It is an input device that allows the user to operate by simply touching on the display screen. Some computers, tablets, smartphones, etc., have touch-sensitive display screens. It can also be operated using a stylus which gives more precision. Information kiosks at railway stations and bank ATMs also use touch screens as input device. Nowadays, touch screens is the most common hardware interface for electronic gadgets.

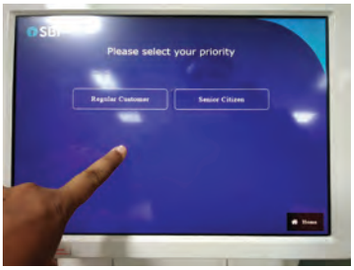


Fig. 3.6: Touch screen

Graphic tablet

This consists of an electronic writing area and a special pen that works with it. It allows artists to enter natural hand movements to create graphical images with motions and actions similar to traditional drawing tools. A stylus is used like a pen and moved over the surface of the tablet. Stylus' movement data is then sent to the computer. The pen of the graphics tablet is pressure sensitive. Hard or soft pressure on the tablet using the pen can result in brush strokes of different widths in an appropriate graphics program.

Fig. 3.7: Graphic tablet

Touchpad

This is a pointing device found on the laptop computers in place of a mouse to control the pointer. It allows the user to move the finger across the touchpad just as a mouse pointer does and this movement in the form of data is sent to the computer. Touchpad is operated with fingers and dragging it across the flat surface, as the finger moves on the surface, the mouse cursor will move in that same direction. The touchpad also has two buttons below the touch surface that enables clicking.

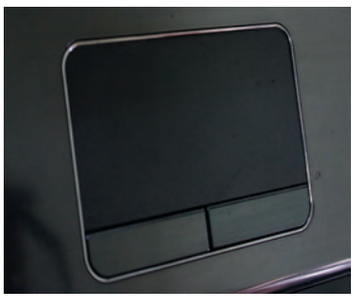


Fig. 3.8: Touchpad

Fig. 3.9: Joystick

Joystick

This is an input device used for playing video games, controlling training simulators and robots. Joysticks and other game controllers can also be used as pointing devices. The joystick has a vertical stick which can move in any direction. It can be used to control objects in a video game or to make menu selections by the movement of a cursor displayed on the screen. It has a button on the top that is used to select the option pointed by the cursor.

Audio Visual Input Devices

Scanner

Fig. 3.10: Flatbed scanner

Scanning is a process of taking a close-up photograph. Scanner is an input device which functions like a photocopying machine. It has a glass plate to place the paper which is to be scanned. Scanners can capture information, like pictures or text, and convert it into a digital format that can be edited using a computer. The scanned image or document is captured by the laser beams and converted to digital data. The scanned picture or document can be saved in the computer. The quality of the image depends on the resolution of the scanner. The resolution of the image scanned is expressed in dots per inch (DPI). The higher the DPI, the better will be the resolution of the scanned image.

The different variants of scanners are flat bed, sheet feed, and hand held scanner. A sheet feed scanner can scan a single sheet, whereas a flat bed can scan even from a book but they are not portable. A hand held scanner is portable but the scanning action is not smooth as the scanner is moved manually.

Fig. 3.11: Microphone

Microphone

This is used to input human voice into the computer. It is attached to a computer for the input of sound. It accepts sound which is analogue in nature as input and converts it to digital format. The digitised sound can be stored in the computer for processing or playback. The headphones come with microphones to use chat applications. A computer loaded with speech recognition

software like the one pre installed in Windows 7 can convert what a person has said into text, which can be saved for word processing. A voice recognition program can process the input and convert it into machine recognisable commands.

Digital camera

This can take pictures and videos and convert them into digital format. Pictures or videos taken using a digital camera are stored inside its memory and can be transferred to a computer by connecting the camera to it. It is a kind of small computer that controls camera focus, stores images, etc. It runs a very simple operating system (stored on ROM) and usually provides a menu-based GUI for the user.

Fig. 3.12: Digital Camera

The quality of the lens, the density of charge coupled device (CCD), resolution (measured in megapixel), optical zoom, and the software used in the camera determines the quality of the picture. Each picture is made up of thousands of tiny pixels (picture elements) and the camera stores the data on the colour of each dot. The quality of the picture is determined by the number of pixels in each picture. Digital cameras have resolutions ranging from 2 mega pixel to 24 megapixels and optical zoom ranging from 3x to 60x.

Webcam

It is a compact and less expensive version of a digital camera. It is used in computers for video chatting. It does not have an internal memory. It is a very basic video camera used to feed live video into a computer. The video data from a web cam is low quality compared to a full video camera. It is positioned on top of the laptop monitor and for desktop computers it can be connected externally. Applications like Skype, Yahoo Messenger, etc., use webcam to capture images. Now, laptops also come with an inbuilt web camera.

Fig. 3.13: Webcam

Closed circuit TV (CCTV)

CCTV captures the images and videos fed as input to the computers. (Figure 3.14). CCTVs are commonly used to maintain road safety and the security on premises.

Fig. 3.14: CCTV

Input card Readers

Smart card or chip reader

Fig. 3.15: Smart card reader

This is a plastic card that stores and transacts data. It has a tiny 'chip' of computer memory embedded inside. Data can be stored in the chip's memory and read back using a 'chip' reader. The data card may contain a memory or a microprocessor. Memory cards simply store data, while a microprocessor card on the other hand can add, delete, and manipulate information in its memory. The smart card is used in most banking, healthcare, telephone calling, electronic cash payments, and other applications.

Smart card readers are used to access data in a smart card. It can be contact type or contact less. A contact type of reader requires physical contact with the cards, which is made by inserting the card into the reader. A card is inserted into the reader where metal contacts connect to the metal pads on the front face of the card. The reader can access the data stored on memory chip. A contact less type of reader works with a radio frequency that communicates when the card comes close to the reader. Many contact less readers are designed specifically for toll gate payment in transportation applications and person identity applications. Satellite TV decoders use smart cards to store data regarding subscription of channels by the user. The data is encrypted so that it is not easy to alter. Many types of cards—ID cards, phone cards, credit cards, and door security cards use this system.

Magnetic strip reader

The credit cards have a magnetic strip. This strip stores the user's data in the form of magnetised dots (for example, the credit card number, card expiry date, and customer name). The strip allows inputting of this data to a computer system faster and more accurately than typing. A magnetic strip reader is used to read the data by swiping the card through a slot on the reader.

Input-reading Text or Codes

Entering the data in a computer using a keyboard may be a slow process and it is prone to mistakes. Sometimes speed and accuracy may be essentially required. In such cases, the following input devices are used to read and input the data.

Barcode or Quick Response (QR) code reader

It is a set of vertical lines of different thickness and spacing that represent a number. These lines are read by a barcode reader or scanner. Barcode readers are devices that are used to input data from such set of barcodes (Figure 3.16 (b)). This code is converted to an alphanumeric value and is fed to the computer connected to it. The bar code reader reads and enters the value quickly and accurately than entering the data by using a keypad. Barcode is used to code items in a shop and books in a library. Handheld scanners are commonly seen in shops to scan codes and price information for each of the items to make billing easier. Mobile phones with camera and special software can also be used as a barcode reader.

Fig. 3.16: (a) Bar code, (b) its reading using BCR

QR codes are similar to barcodes. Barcodes are single dimensional, whereas QR codes are two dimensional as shown in Figure 3.17. The two dimensional way of storing data allows QR code to store more data than a standard barcode. This code can store website URLs, plain text, phone numbers, email addresses, and any other alphanumeric data. The QR code can be read using a barcode reader or a mobile phone which has a camera and special software installed.

Fig. 3.17: QR code

Optical Mark Reader (OMR)

It is an input device that recognises marks made by a pencil or pen in a multiple-choice type form. It is commonly used to check forms filled with pen or pencil and to correct MCQs of exam papers. It can read the marks and feed that data to a computer (Figure 3.18).

Fig. 3.18: Optical mark recognition

Fig. 3.19: Optical mark recognition

OMR technology scans a printed form and reads predefined positions and records the marks on the form. This technology is useful for applications in which large number of forms needs to be processed quickly with great accuracy, such as objective type tests and questionnaires.

OMR sheets are normally used to evaluate multiple choice questions in competitive exams. It consists of bubble shaped options to mark the answers. Candidates are required to darken the correct bubble option using a pen or pencil (refer to Figure 3.19). For accuracy of results, good quality paper and accurate alignment of printing is essential.

Fig. 3.20: MICR

Magnetic Ink Character Reader (MICR)

It reads the data written by the magnetic ink. The cheque number is printed at the bottom of each bank cheque by special magnetic ink using a special font. It can be detected by a MICR reader. MICR reads this data and feeds it to the computer quickly and accurately (Figure 3.20).

Optical Character Recognition (OCR)

This is a software technology that converts images of text into an actual text file. To use this technology, first scan the document using the scanner. Then the scanned image is analysed by the OCR software. The result is such that it seems the text has been typed by hand.

Input Sensors

A sensor is a device that senses the real world data (for instance, temperature) and converts it into digital data to be processed by the computer. A computer system cannot sense the real world data such as light or dark, hot or cold, quiet or noisy. We use our senses (eyes, ears, mouth, nose, and skin) to read such data. In the same way, the sensor reads this kind of data and converts it into its digital equivalent. The sensors are connected to a computer.

Remote control

This is a very commonly used input device. It sends data signals each time a button is pressed using

infrared light or radio signals. The signals can control the system from some distance. It is also used to control a presentation slide show.

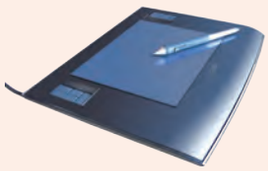
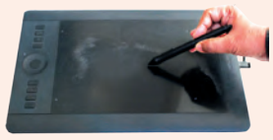
Biometric sensor

It is a device that identifies unique human physical features with high accuracy. It is an essential component of a biometric system which uses physical features like fingerprints, retina, iris patterns, etc., to identify, verify, and authenticate the identity of the user. The three major types of biometric sensors are semiconductor sensor, optical sensor, and ultrasound sensor. Figure 3.21 shows a biometric sensor.

Fig. 3.21: Biometric sensor

Practical Exercise

Identify the following input devices and list their features.

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Output Devices

These can be categorised into three types based on the output produced by the computer in the following form:

1. soft copy
2. hard copy
3. sound output

Soft copy output device

The output on the screen is called a soft copy. The soft copy output can be provided on the following devices.

Visual Display Unit (VDU)

This is an output device that visually conveys text, graphics, and video information. Information shown on a display device is called softcopy because the information exists electronically and is displayed for a temporary period of time.

Display devices include Cathode Ray Tube (CRT) monitors, Liquid Crystal Display (LCD) monitors, Thin Film Transistor (TFT) monitors, Light Emitting Diode (LED) monitors, and gas plasma monitors.

Some of the characteristics of a VDU are size, resolution, pixel pitch, and response time. VDUs are available in different sizes. The size of a monitor is measured diagonally across the screen in inches. The resolution of the monitor is the maximum number of pixels it can display horizontally and vertically (such as 800 x 600 or 1024 x 768 or 1600 x 1200). The pixel spacing on the screen is called the dot pitch. A screen with smaller dot pitch produces sharper images. Response time refers to the time taken for a pixel to turn from a state of brightness to a state of darkness and then back again. Monitors with lesser response time provide better movie viewing experience.

The CRT monitors were used earlier. Nowadays they are not being used, as flat LCD monitors are available at the same cost. But it is essential to know the old technology also. The CRT monitor looks like a television set from the past. It is large in size,

heavy, and consumes more electricity because it contains a large cathode ray tube. It is available in two forms—monochrome and color. A monochrome monitor displays characters and images in a single color on a dark background. Another variation of monochrome monitor is capable of displaying different shades of gray and is called a gray scale monitor. A color monitor uses three different basic colours such as red, blue, and green to display 16 to 1 million different colours. These monitors are preferred by graphic artists for their accurate colour rendering and by gamers for faster response to rapidly changing graphics.

Flat panel monitor

These are very thin, lightweight, and need very less power. Flat panel displays are thinner, lighter in weight, consume less power, and emit less heat as compared to CRT monitors. They are most commonly used in computers, especially in laptops. Different types of flat panel monitors are LCD (Liquid Crystal Display), LED (Light Emitting Diode) and OLED (Organic LED). LCD uses liquid crystal molecules for display, LED uses light emitting diodes for display, and OLED uses a special organic compound for display. LED displays have better brightness.

Fig. 3.22: CRT monitor

Liquid crystal display (LCD): This displays consists of liquid crystals sandwiched between two plastic plates. These crystals rearrange to form an image when an electric current passes through them. A light source at the back of this plate makes the picture visible. This light source can be a fluorescent lamp or LED.

Light emitting diode (LED) monitor: This uses LED directly behind the liquid crystal display (LCD) in order to light up the screen. This technique is very effective and gives each area of the screen its own light, which can be on or off. LED screens can produce massive contrast ratios resulting in better color quality and clarity. Further, wider viewing angle, faster refresh rates, and power saving are its other advantages, making this technology expensive.

Fig. 3.23: LCD and LED display

Fig. 3.24: Plasma monitors

Plasma monitors: A flat panel display consists of sandwiching neon or xenon gas between two sealed glass plates with parallel electrodes deposited on their surfaces. When a voltage pulse is passed between two electrodes, the gas lights up as different colours creating images on a monitor. Plasma monitors provide high resolution but are also expensive.

Organic light emitting diode (OLED) monitors: The panel of OLED is made up of millions of tiny LEDs. The 'O' in OLED stands for organic which means there is carbon in the light emitting layer of the panel. OLED screens are thinner and lighter than LCDs and LEDs. They can produce better quality images and have a better viewing angle. OLEDs consume less power but are again very expensive.

Fig. 3.25: Multimedia projector

LCD projector

This is a type of video projector used for displaying videos, images, or computer data on a large screen or any other flat surface. Several people in a classroom can view the output on a wide screen at the same time. It is a modern equivalent of the slide projector or overhead projector. A beam of high-intensity light travels through thousands of shifting pixels in a LCD display. This beam of light then passes through a lens which projects and focuses the image on the surface.

Hard copy output devices

Hard copies are tangible computer outputs. Printer and plotter are used to get a hard copy output.

Printer

This is used to produce a hard copy output. There are different kinds of printing technology. Two factors that determine the quality of a printer are its resolution and speed. Resolution is measured in terms of DPI. Speed is measured in terms of number of characters printed in a unit of time and is represented as characters per second (CPS), lines per minute (LPM), or pages per minute (PPM). Based on the technology used, they can be classified as impact or non-impact printers.

Impact printers

These use the typewriting or printing mechanism where a head or needle strikes against an ink ribbon to make a mark on the paper. The ink ribbon used in this printer is not very expensive. It is used in banks and shops for printing receipts, etc. Dot matrix printers fall under this category.

Fig. 3.26: Dot matrix printer

Dot matrix printers: Use small electromagnetically activated pins in the print head and an inked ribbon to produce images by impact. The most commonly used printer heads consists of nine pins. Certain printers use 24 pins for better print quality. A dot matrix printer prints a letter in a grid or matrix pattern of dots. It forms the letters by hitting the print on the ribbon and then both the papers. Its print quality is poor and also produces noise while printing. But its running cost is very less and one can also print multiple copies in one go using the carbon paper between the papers. These printers are slow and noisy and are not commonly used for personal use. The dot matrix printers are widely used at cash counters in shops due to their low printing cost and because we can get carbon copies from them.

Line Printer: The line printer also uses the similar technology but it is a fast printer which prints one row at a time. This means it can print upto 3,000 lines per minute (Figure 3.27).

Fig. 3.27: Line printer

Non-impact printers

These do not touch the paper while printing. And since they don't strike the printer head, they are not noisy. They use different technologies to print characters on paper. Inkjet, laser, and thermal printers fall under this category. Running cost of these printers is more expensive than impact printers.

Inkjet printers: These form the image on the page by spraying tiny droplets of ink from the print head. The four colour ink (cyan, yellow, magenta, and black) is used to produce colour printouts. The droplets of ink come from tiny holes (the jets). Each droplet creates

Fig. 3.28: Inkjet printer

Fig. 3.29: Laser printer

Fig. 3.30: Laser printer's toner

Fig. 3.31: Thermal printers

a tiny dot on the paper. Since the dots are so small, the quality of the printout is excellent (1200 dots per inch are possible). They are used to print photographs. They are inexpensive, but the cost of ink cartridges makes it a costly affair in the long run.

Laser printers: These produce a good quality output. It utilises a laser beam to produce an image (through a mirror) on a drum. The light of the laser alters the electrical charge on the drum and applies toner (dried ink) in the cartridge. The toner powder from the toner cartridge is then sprayed onto the drum. The toner powder sticks onto the portions traced on the drum by the laser beam. It is transferred to a paper by rolling the paper over the drum. Through heating, the powder is fused onto the paper. There are laser printers which print about four A4 size papers per minute. These printers produce clear and quality printouts. They are also faster and their speed is rated in pages per minute (PPM). Monochrome and colour laser printers are available. Colour laser printers use multiple colour toner cartridges to produce colour output and are expensive.

Thermal printers: These produce a printed image by selectively heating heat sensitive thermal paper when it passes over the thermal print head. The coating turns black in the areas where it is heated, producing an image. These printers are less noisy and faster than dot matrix printers. They are also smaller, lighter, and consume less power, making them ideal as portable printers. They are commonly used in business to print receipts in devices such as an ATM and in printing labels.

The features of all the above printers are summarised in the Table 3.1.

Table 3.1

Comparison of printers

Features	Laser Printers	Inkjet Printers	Thermal Printers	Dot Matrix Printers
Printing material used	Ink powder	Liquid ink	Heat sensitive paper	Ink soaked ribbon
How does it print?	It fuses the powder on the paper through heating.	It sprays liquid ink on paper through microscopic nozzles.	Thermal paper is passed over the thermal print head.	Pins are pushed against ribbon on paper.
Printing speed	20 pages per minute	6 pages per minute	150 mm per second	30550 characters per second
Quality	Printing quality is good. Best for black and white.	Printing quality is good, especially for smaller fonts.	Poor quality printing of images. Good quality text printing.	Poor printing quality for images. In terms of text, printing is good.
Advantages	Less noisy, prints faster, high print quality.	Less noisy, high print quality, no warm up time, device cost is less.	Less noisy, fast, smaller, lighter, consumes less power, portable	Cheaper to print as ribbon is cheap, carbon copy possible.
Disadvantages	More susceptible to paper jams. Toner is expensive. Device itself is expensive.	Ink is expensive and not waterproof, and nozzle is prone to clogging.	Requires special thermal quality paper, poor quality printing.	Initial purchase and maintenance are both expensive, printing is not fast, makes noise.

Three dimensional (3D) printers

This is a new generation output device used to print 3D objects. It can produce different kinds of objects in different materials and this can be done using the same printer. It can print anything from ceramic cups to plastic toys, metal machine parts, stoneware vases, fancy chocolate cakes, etc.

The 3D printing process turns the object to be printed into thousands of horizontal tiny little layers. It then prints these layers from bottom to top, layer by layer. These tiny layers stick together to form a solid object.

Plotter

It is an output device used to produce hard copies of graphs and designs on the paper. Plotters are used to print the drawings by using a special pen. Coloured pens are used to produce colour line drawings. The pens are held by an arm which can lift the pen up or down, and move across the paper. The arm and pen of the plotter creates drawing just like humans but with more speed and accuracy. A plotter is typically used to print large format graphs or maps such as construction maps, engineering drawings, and big posters. It is used in the designing of cars, ships, aircrafts, buildings, highways, etc. Plotters are used by designers and architects since they work with huge pieces of paper, that a normal printer cannot handle. They are not used to print the text and images. They are used to print the drawings prepared by the CAD software. Plotters are of two types: drum plotters and flatbed plotters.

Fig. 3.32: Drum plotter

Drum plotter

It is also known as a roller plotter. It consists of a drum or roller on which a paper is placed and the drum rotates back and forth to produce the graph on the paper. It also consists of a drum arm that holds a set of coloured ink pens or pencils. The drawing arm moves side to side as the paper is rolled back and forth through the roller. In this way, a perfect graph or map is created on the paper.

Fig. 3.33: Flatbed plotter

Flatbed plotter

It is also known as a table plotter. It plots on paper that is spread and fixed over a rectangular flatbed table. The flatbed plotter uses two drawing arms, each of which holds a set of coloured ink pens or pencils. The drawing arms move over the stationary paper and draws the graph on the paper. Flatbed plotter is very slow in drawing or printing graphs. The large and complicated drawing can take several hours to print.

Sound output device

The device which gives a sound output is called a speaker. Speaker devices are designed for personal and public use.

The audio output is the ability of the computer to produce sound. Speakers are the output devices that produce sound. They are connected to the computer through audio ports. They produce sound by the movement of the diaphragm in the speaker, forward and backward according to the electrical signals coming out of the audio port. For high quality sound reproduction, computers use 2.1 (3 speakers), 5.1 (5 speakers), and 7.1 (7 speakers) speaker systems.

Fig. 3.34: Speaker

Practical Exercise

Identify the following output devices and list its features

	
	
	
	

Check Your Progress

A. Multiple choice questions

1. In ink jet printers, to produce an image it uses _____
   (a) special pen.
   (b) tiny droplets ink.
   (c) laser beam.
   (d) All of these
2. Printer in which printing head and paper is forced together to form letters is called _____
   (a) impact printer.
   (b) non-impact printer.

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(c) page printer.
(d) line printer.

3. Which printer is an impact printer?
   (a) Laser printer
   (b) Line printer
   (c) Ink jet Printer
   (d) All of the above
4. Which of the following groups consist of only output devices?
   (a) Scanner, printer, monitor
   (b) Keyboard, printer, monitor
   (c) Mouse, printer, monitor
   (d) Plotter, printer, monitor
5. Printers are examples of _____ output device.
   (a) hardcopy
   (b) softcopy
   (c) double copy
   (d) None of these
6. In LCD, 'L' stands for _____.
   (a) light
   (b) liquid
   (c) limit
   (d) long
7. Which of the following is a type of monitor?
   (a) LCD
   (b) CRT
   (c) LED
   (d) All of above
8. Computer output which is printed on paper and is tangible is known as _____.
   (a) hardware
   (b) hard copy
   (c) document
   (d) result
9. The smallest unit of an output device display is called a _____.
   (a) pixel
   (b) picture unit
   (c) VDT
   (d) monitor
10. Touchscreen is usually used to detect the touch of a _____.
    (a) human finger
    (b) pen
    (c) wooden stick
    (d) None of these

B. Fill in the blanks

1. CRT and LCD are types of _____.
2. A digital camera can take pictures and videos and convert them into a _____ format.
3. Web camera is a compact and less expensive version of a _____ camera.
4. Smart card readers are used to access data in a _____ card.
5. The credit cards have a _____ strip.
6. A QR code is similar to _____.
7. Magnetic ink character reader reads the data written by the _____ ink.
8. The output on the screen is called a _____ copy.
9. Printers are used to produce a _____ output.
10. A laser printer produces _____ quality output.
11. The device which gives a sound output is called a _____.

C. State whether the statement given below are True or False

1. Thermal printer is used to print the drawings by using a special pen.
2. Speaker is an audio input device.
3. Inkjet printer is an impact printer.
4. CD, LED, and CRT are the technology used in monitor.

D. Short answer questions

1. What are non-impact printers?
2. What do you mean by output devices?
3. List all output devices.
4. Priyanka is taking up digital photography and she wants a printer that enables to print her photos, with the best results. Which printer would you recommend and why?
5. Printers are generally classified as 'impact' and 'non-impact'. Which category does a laser printer fall into?
6. In printing, DPI is the standard measure of printed image quality on the paper. What does DPI stand for?

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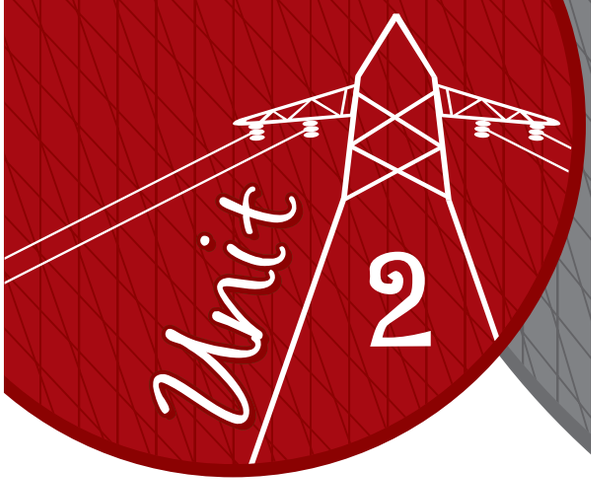

Installation and Configuration of Operating System

Introduction

Any computer system has an operating system. The user interacts with the machine via the operating system. An operating system (OS) is the software that provides an interface between the computer hardware and the application programs or users. An operating system is responsible for the management and coordination of activities and sharing of the resources in computer. The OS acts as a host for application programs that are run on the machine. As a host, one of the purposes of an OS is to handle the details of the operation of computer hardware. OS offers a number of services to application programs and users. Users may also interact with the OS by commands or using a graphical user interface (GUI).

There are various types of operating systems, but all of them essentially perform the same functions. This Unit gives an overview of operating systems. Common OS include Microsoft Windows, Mac OS X, and Linux. The installation process of Microsoft Windows 10 and Ubuntu Linux operating system is illustrated in this Unit. This will enable the students to gain fundamental knowledge and skills required to install and configure Windows 10 and Ubuntu Linux operating systems.

Chapter 4 Introduction to Operating System

Introduction

As you know that, CPU is the main processing unit of a computer. It processes the data based on the instructions received. Even for a simple calculation, it performs a series of instructions. Also, operating the several peripheral devices attached to, the computer requires executing certain instructions. The computer system has several resources such as a CPU, memory, storage devices, and network devices. All these resources are accessed by several users and several programs. The CPU manages all these resources.

A computer also requires a basic user interface to interact with the user and provides consistent support to the processor, memory, and devices. An operating system (OS) is a software that satisfies all these needs of the user.

In this Chapter, we will discuss the components of operating system, the different types of operating systems and the functions of operating system. A brief description of some operating systems is also given.

Overview of Operating System

A computer cannot perform any tasks on its own. In any computing process, both the hardware and software work together to accomplish a task. This applies to all the computing devices, including basic calculators, watches, mobile devices, and any other gadgets which use hardware components as well as integrated software components. Different files which are interrelated and accomplish a certain set of tasks make up the operating system. These files are system level files which do scheduling, interrupting, data transferring, managing the flow of data, and are a low level software component of the computer itself. The standard definition of an operating system would be—an operating system is a set of program files which control the resources of the

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computer system and allows the communication of hardware components of a computer to the software components of the computer system.

An operating system is one of the essential and important software installed in every computer. A computer is useless without an operating system. The operating system is like a resource manager. It controls and manages all the computer resources including hardware and software. Computer system mainly has four types of resources. These are CPU or processor, main memory or RAM, secondary storage, and the input output devices.

BOOTING PROCESS OF OPERATING SYSTEM

When you start the computer, it is observed that some initial text information is displayed on the screen. This is displayed by the firmware. The booting instructions are stored in ROM (read-only memory). Then the booting process starts. After booting, an operating system gets loaded in the main memory (RAM) of the computer. Let us understand the complete booting process.

- When you power on the computer, the CPU (central processing unit) activates the BIOS (basic input output system).
- The first program activated is POST (power on self-test). Using the CMOS (complementary metal oxide semiconductor) memory it checks all the hardware and confirms that they are functioning properly.
- After that it reads the MBR (master boot record) in boot drive in accordance with the firmware 'bootstrap loader' which is provided by the computer manufacturer.
- Then the computer loads in the operating system in boot drive to the RAM.
- Once this is performed, the operating system takes over the control of the computer and displays an user interface to the user.

FUNCTIONS OR TASKS OF THE OPERATING SYSTEM

The operating system is a large and complex software consisting of several components. Different components

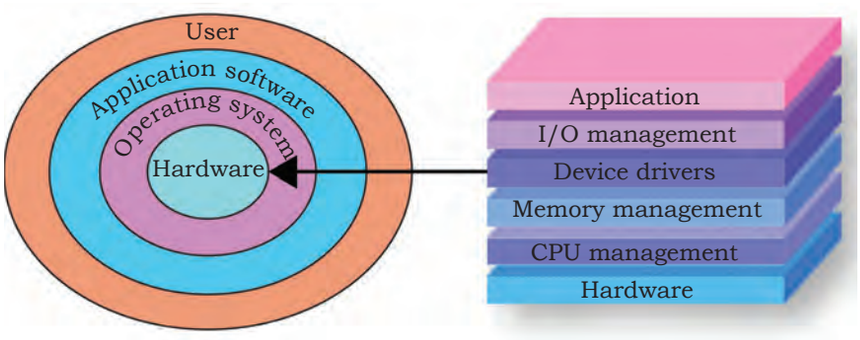

Fig. 4.1: Resource management

of OS perform specific tasks to provide overall functionality of the operating system. Figure 4.1 shows the interconnection between resource management in the computer.

Operating system is a large and complex software consisting of several components. Each component of the operating system has its own set of defined inputs and outputs. Different components of OS perform specific tasks to provide the overall functionality of the operating system.

The main functions performed by the operating system are as follows:

I/O Management

Input/Output (IO) is the basic process in any computing device. OS manages I/O devices and makes the I/O process effective. It allows interaction with I/O devices using commands. OS accepts inputs from the input device, stores it in the main memory, asks the CPU to process it, and finally, provides the result to the output device.

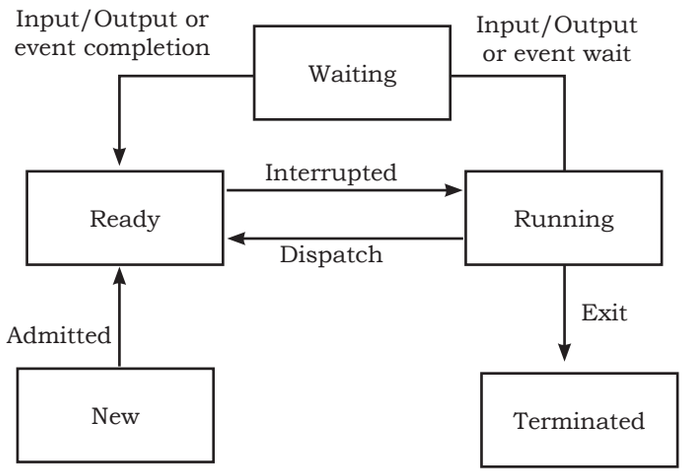

Fig. 4.2: Input/Output management

Data Management

In a computer, the data or programs are stored in a file. The data is managed by performing various operations on a file such as creating, updating, reading, writing,

storing, and deletion. These tasks are performed by using the commands of the operating system. Thus, the operating system functions for data management.

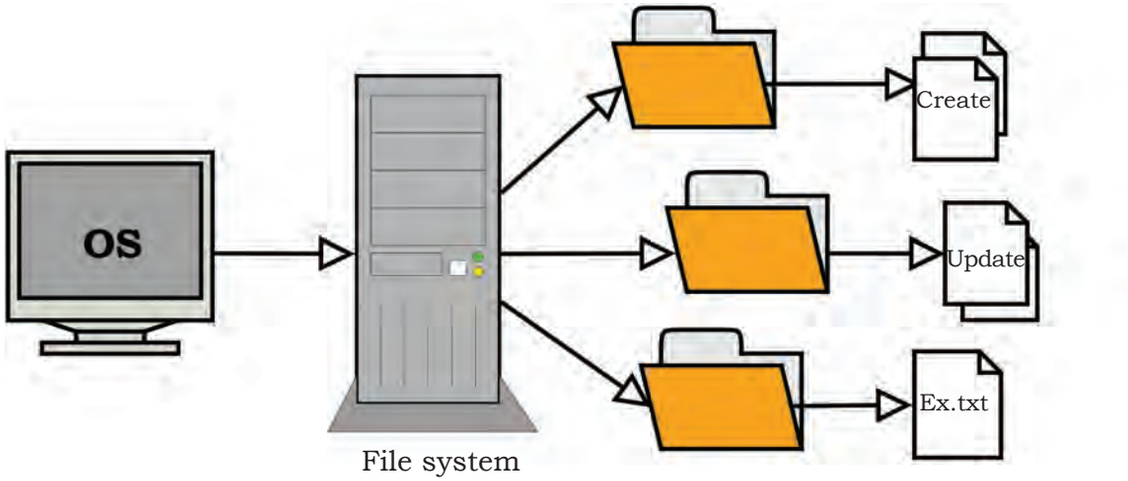

Fig. 4.3: Data management

Memory Management

Every computer has a primary memory (RAM). This memory should be managed properly for efficient functioning of the computer. Operating system loads the data and programs into RAM before sending it to the CPU for processing. The results obtained after processing are also stored in RAM before sending it to the output devices. After sending the output to output device, OS releases the memory and makes it available for use to other programs. Thus, operating system utilises the RAM efficiently to manage the memory for various processes. The activities of memory management are—allocate memory, free memory, re-allocate memory, and keep track of memory usage.

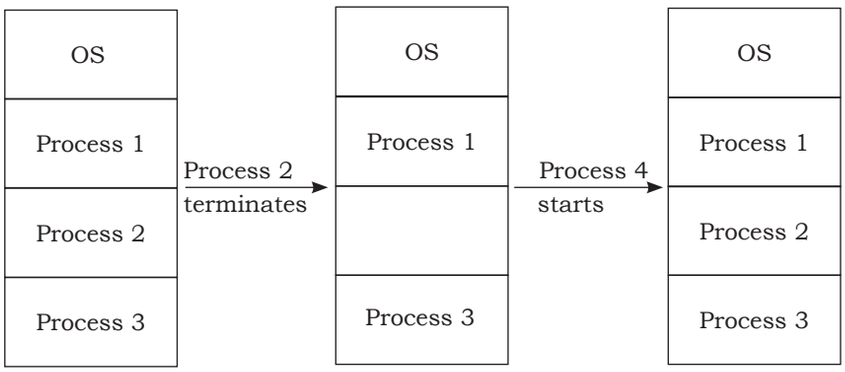

Fig. 4.4: Memory management

Process Management

Every job to be performed by the computer system is scheduled in the form of processes. These processes are

managed by the operating system. Allocation of a CPU to the processes and making the CPU free when the process is executed is also performed by the operating system. The process management activities handled by the OS are:

1. control access to shared resources like file, memory, I/O, and CPU,
2. control execution of applications,
3. create, execute, and delete a process (system process or user process),
4. cancel or resume a process,
5. schedule a process,
6. synchronisation, communication, and deadlock handling for processes.

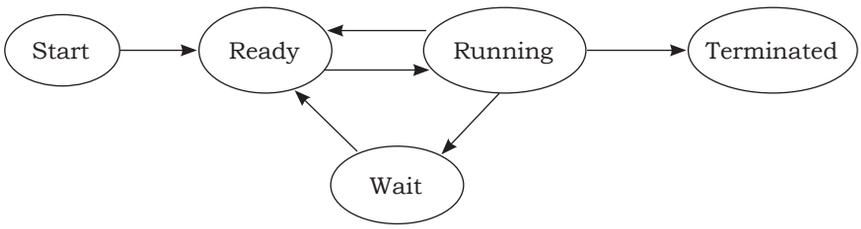

Fig. 4.5: Process management

Device Management

Operating system manages the peripheral devices attached to the computer system. The processes may require certain devices. Operating system finds the status of the device and allocates the appropriate device. Device controllers are used to control the peripheral devices and device drivers are used to control software components. The device management tasks handled by OS are:

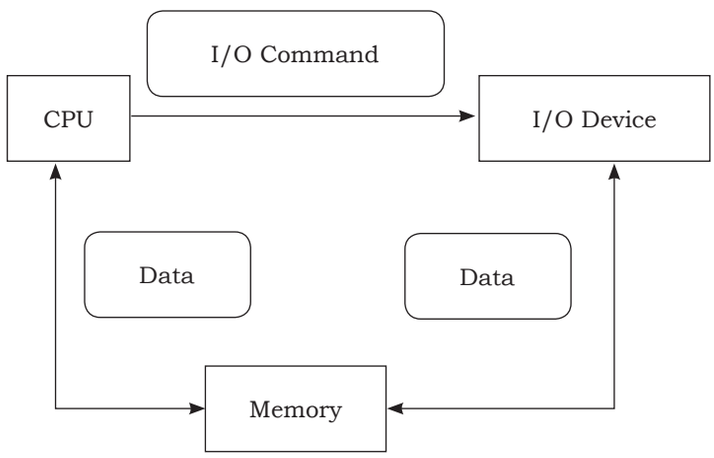

Fig. 4.6: Device management

(1) open, close and write the device driver;
(2) communicate, control and monitor the device driver.

File Management

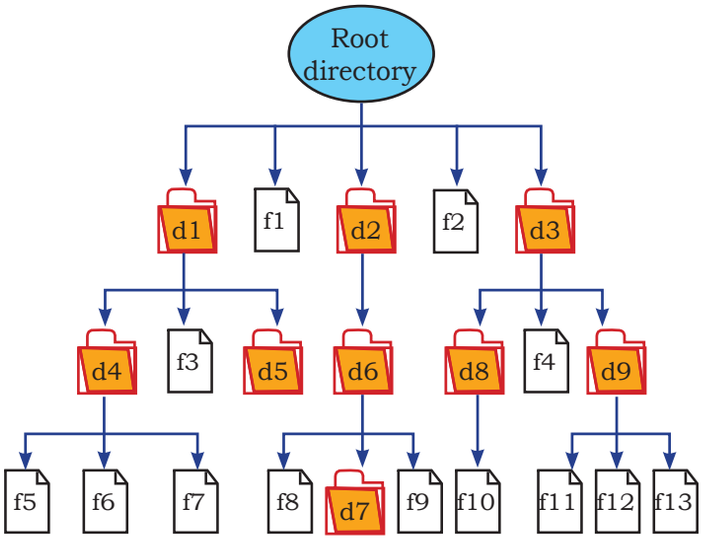

Fig. 4.7: File management

Every computer system consists of a large number of files. A user has to access these files whenever required. Operating system performs file management. File management includes storage and backups of the files, accessing files, handling files and their properties, performing file operations. Location of the file, size, its uses, and status are maintained by the operating system. Whenever a process requires a file allocation, then the file is searched and it is allocated to that process. Whenever the process is completed, then the file allocation is removed. Operating system also prevents the file from viruses or unauthorised access. The file management tasks include:

1. create and delete files,
2. provide access to files,
3. allocate space for files,
4. keep back-up of files,
5. secure files.

Time Sharing Management

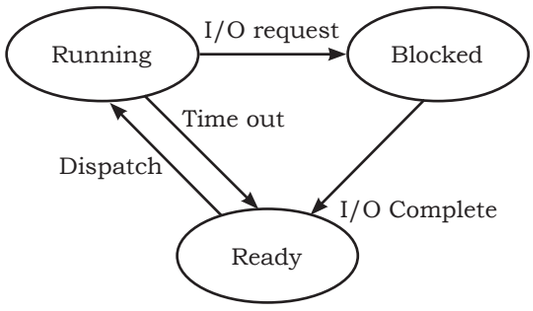

Fig. 4.8: Time sharing management

Computer network allows the use of the computing power of the server to a number of users through network operating systems. In network environment, each user is allocated a certain amount of time to access the hardware. This access time is moved from one user to another user very fast so that every user has a feel to access the computer for all the time. This time sharing management between the number of users of the computer hardware is performed by the operating systems.

Security Management

In this, the security of one user is protected from other users. Operating system provides security to the data and programs of the user. User authentication, file attributes like read, write, encryption, and back-up of data are used by OS to provide basic protection.

Deadlock Prevention

In a multi-programming environment, multiple processes may try to access the resource. A deadlock is a situation when a process waits endlessly for the requested resource which is being used by another process that is waiting for some other resource (Figure 4.9).

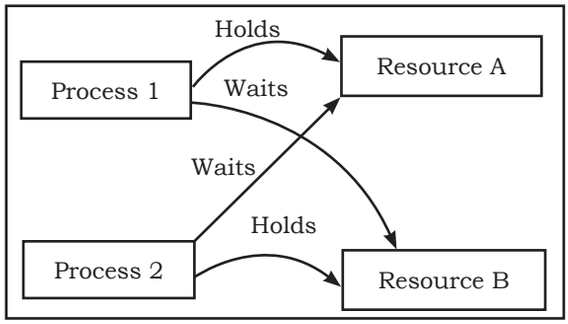

Fig. 4.9: Deadlock prevention

Virtual Storage

In a multiprogramming system, many programs are located in the memory along with the operating system. Some applications require large memory as the whole program cannot be loaded into the memory. If the program is larger than the main memory, then the operating system uses free space of the secondary memory which is known as virtual memory and the secondary storage used for storing which is known as virtual storage. Virtual memory allows the execution of those processes that are not completely in the memory.

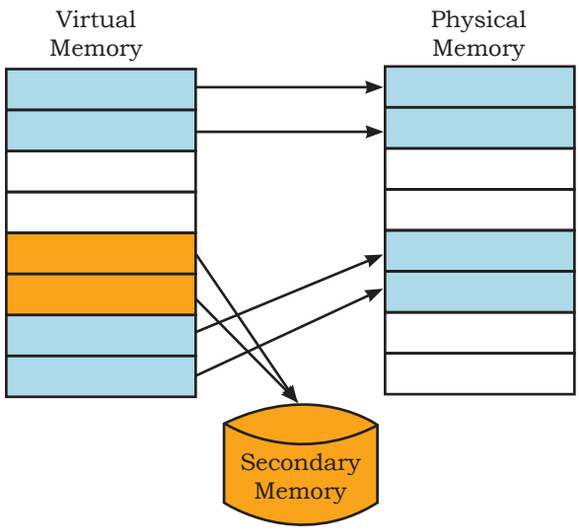

Fig. 4.10: Virtual storage

Providing User Friendly Interface

One of the important functions of the operating system is to provide the user interface. The user interface is a set of commands or a graphical user interface through which the user interacts with the applications and the hardware. There are two types of user interfaces provided by the operating systems. They are:

1. command line interface – CLI
2. graphical user interface – GUI

Command Line Interface (CLI)

The CLI has a command prompt from where you can issue a command. The CLI accepts the text based commands on the command line or terminal and executes them. In CLI, the correct syntax of commands has to be used, hence the commands need to be remembered by the user. CLI was used by the operating system of the early days. Operating systems—DOS and Unix are the examples of CLI. In using command line interface, the correct syntax has to be used.

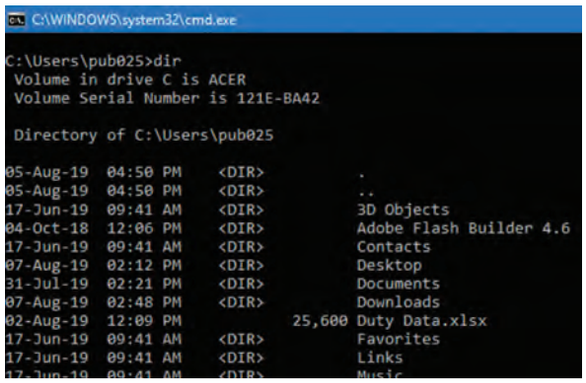

Fig. 4.11: Command line interface (CLI)

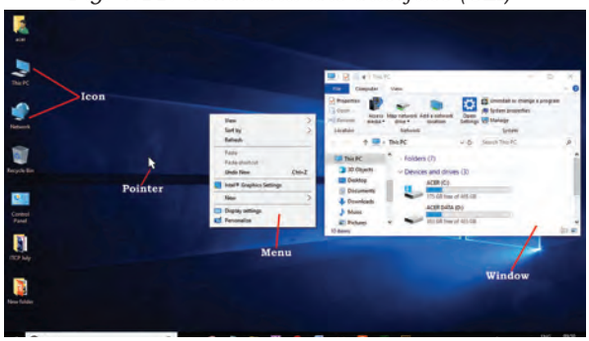

Fig. 4.12: Graphical user interface (GUI) screen

Graphical User Interface (GUI)

The modern operating systems such as Windows, Linux, and Mac all use GUI. GUI is easy to operate and user-friendly. GUI provides the ability to use the mouse or fingertips to navigate the commands. It becomes easy to interact with the computers. The operating system with GUI uses four components to interact with the system. These are abbreviated as WIMP (windows, icons, menus, and pointer).

Types of Operating Systems

Operating systems are normally preloaded on the computer that you purchase. But it is possible to upgrade or install the operating system on your computer. There are three most common types of operating systems—Microsoft Windows, Mac OX, and Linux. For mobile devices, such as smartphones and tablet computers, the commonly used operating systems are Apple iOS and Google Android.

Microsoft Windows

It is a graphical user interface (GUI) based operating system. A typical desktop image of a computer system

on which a Microsoft Window 10 is installed is shown in Figure 4.13.

In this GUI system, all the programs or commands of the operating system are available in the form of icons, buttons, and menus. Everything within the operating system is clearly displayed on the screen by making a combination of graphics and text. Whenever we want to execute any command or program, then the corresponding icon needs to be clicked.

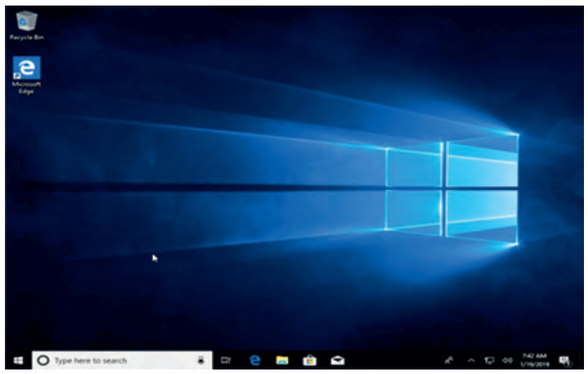

Fig. 4.13: Microsoft Windows 10 screen

There are various versions of Microsoft Windows OS available. Most recent version of Microsoft Windows OS is Windows 10, which was released in 2015. The earlier versions are Windows 8, released in 2010, and Windows 7, released in 2009. Microsoft Windows is one of the most popular operating systems.

Mac OS

It is an operating system that is created by Apple. It is a preloaded OS on Macintosh computer or Macs. A typical image of a Mac desktop is shown in Figure 4.14. Observe that this operating system also has a graphical user interface (GUI). But the GUI of Mac OS is different from that of Microsoft Windows. All the commands and programs available in Mac OS are displayed in the form of icons or buttons. By clicking appropriate buttons, we can execute that program.

Fig. 4.14: Mac OS screen

There are various versions of Mac OS. Most recent version of Mac OS is OS X which is pronounced as OS 10. The latest version released on 24 September 2018 is Mac OS 10.14 and is named as Mojave (Liberty). The earlier versions of Mac OS are OS X 10.11: El Capitan (Gala) released on 30 September 2015, OS X 10.10: Yosemite (Syrah) released on 16 October 2014, OS X 10.9 Mavericks (Cabernet) released on 22 October 2013, OS X 10.8 Mountain Lion (Zinfandel) released

Fig. 4.15: Ubuntu Linux OS screen

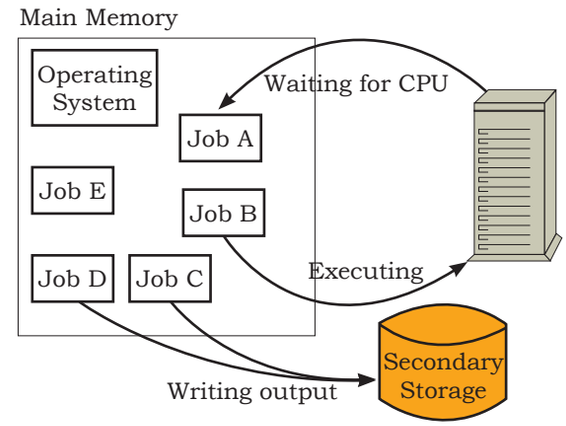

Fig. 4.16: Multi-programming with three programs

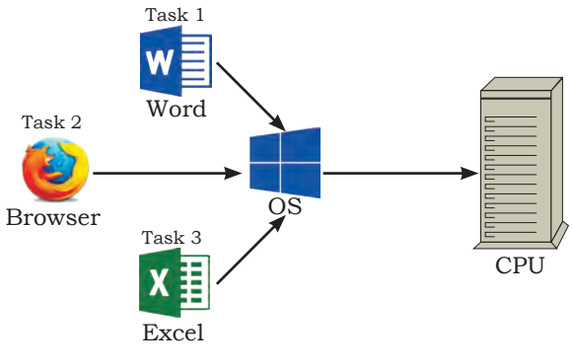

Fig. 4.17: Multitasking with three programs

on 25 July 2012, and OS X 10.7 Lion (Barolo) released on 20 July 2011.

Linux

It is a family of open source operating systems. It means that it can be modified and distributed by anyone around the world. Earlier OS that we have discussed such as Windows and Mac OS are proprietary software. It means that they can be modified only by the company that owns it. Whenever you want to use proprietary software on your computer system, you need to purchase it by paying a cost so that you can get a user license. Linux is a freeware, meaning that you need not to pay any cost and you can use it on your computer system. A typical desktop image that runs Linux is shown in Figure 4.15. Observe that Linux is also available in the form of GUI. Every program in the Linux OS is displayed in the form of an icon, button, or graphics. By clicking on the icon or button, we can execute that program. There are many distributors of Linux, for example Ubuntu, Linux Mint, Fedora, Suse, Red Hat, and so on.

Classification of OS

Operating systems can be classified based on the following:

Classification based on Processing Method

Multi-programming OS

In this, two or more programs are executed simultaneously by a single processor. It is used in a multi-user environment.

Multitasking OS

It is capable of running several tasks or programs at the same time. Most of the present operating systems like Microsoft Windows, Linux, and Mac OS are multitasking operating systems.

Multiprocessing OS

It supports running a program in more than one CPU. Two or more processors (CPU) are used to control the different activities or execution of many program instructions simultaneously. Servers are designed to support multiple processors. UNIX is an example of multiprocessing OS.

Time-sharing system

In this, the processor is shared among many users. The CPU switches so rapidly from one user to another, that every user gets the impression of getting the services of CPU for all the time.

Multithreading OS

This has the ability to divide the process into sub-processes known as threads and execute them concurrently. Threads are individual processes that execute simultaneously in multi-tasking OS.

Batch processing OS

In this, similar jobs are grouped together for processing. It consists of programs, data, and system commands. The time taken between job submission and job completion is very high. It is suitable for programs with large computation time where user involvement is not necessary.

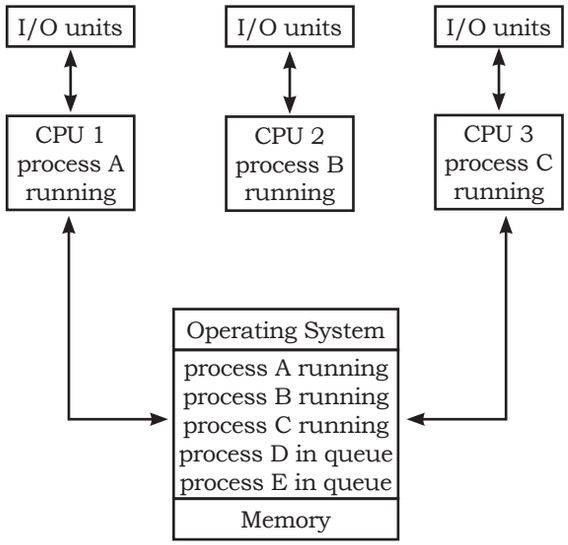

Fig. 4.18: Multiprocessing OS

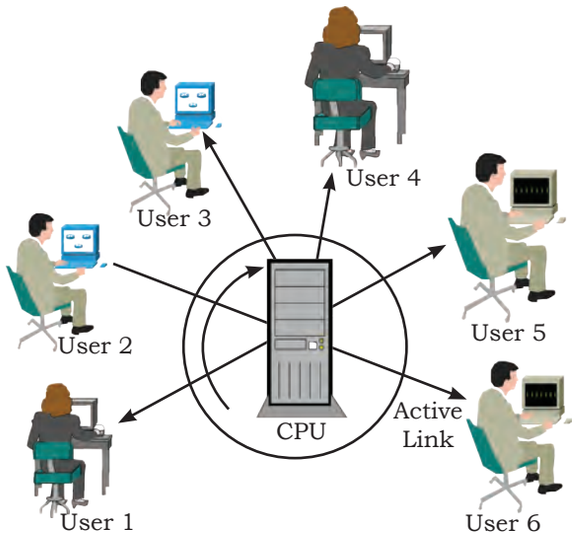

Fig. 4.19: Time sharing system

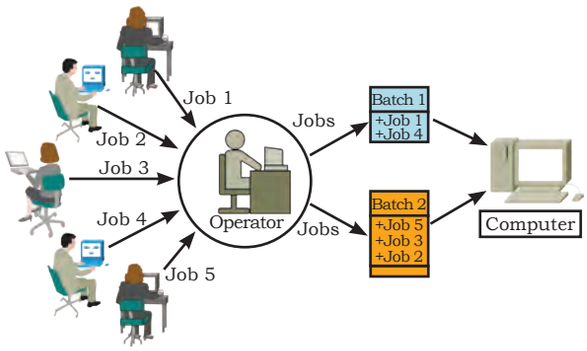

Fig. 4.20: Batch processing

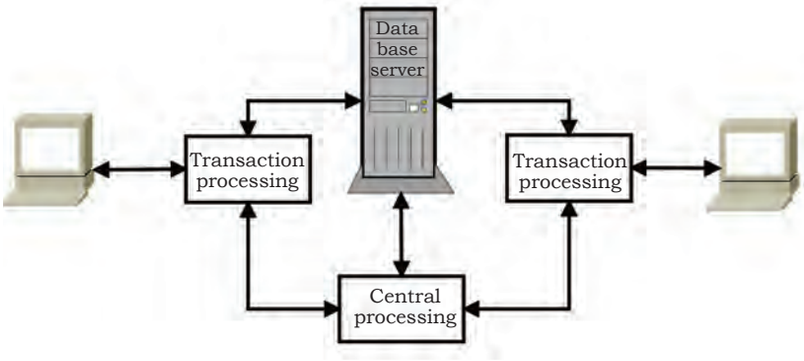

Fig. 4.21: Online processing

Examples are payroll, forecasting, and statistical analysis.

Online processing operating system

In this, transactions are processed immediately and output is provided to the user. Most of the present systems use online processing. Bank transactions are an example of online processing system.

Real-time OS

This method receives data, processes it, and returns results quickly to affect the functioning of the system at that time. It is an online processing system where the processing time is critical. Monitoring and controlling nuclear power stations, rocket launching systems, are examples of real time systems.

Classification of OS based on User Interface

As we have already learned, there are two types of user interface. One is command line interface (CLI) and other is graphical user interface (GUI). The operating system is also classified on the basis of user interface.

Fig. 4.22: Single user OS

Classification of OS based on Mode of User

Under this classification, the OS is classified as single user or multi-user.

Single user OS

The majority of small microcomputer based systems have single user OS, which allows a single user to operate the machine in an interactive mode. It allows only one user program to use the system. MS-DOS, PC-DOS are single user operating system.

Multi-user OS

A multi-user OS allows two or more users to run programs at the same time. The multi-user OS shares computer resources among these users, allowing each a small slice of the processor time. This concept is known as time sharing. Example of multi-user OS are UNIX, LINUX.

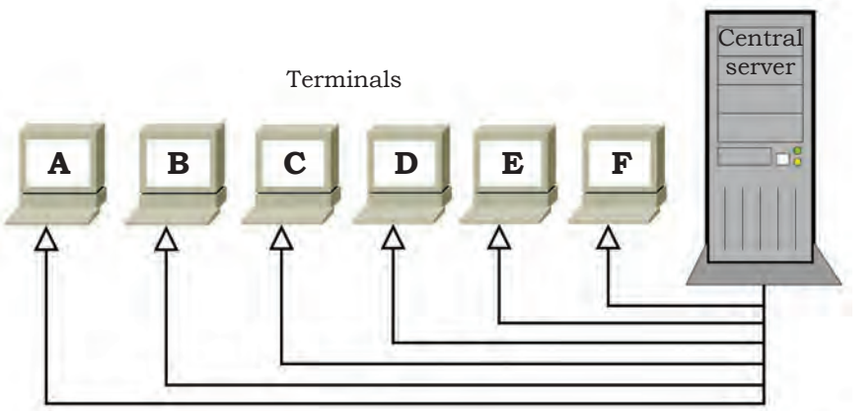

Fig. 4.23: Multi-user OS

Components of Operating System

We identify the operating system by its user interface. The look or initial screen of various operating systems looks different, but architectural view of the various operating systems remains the same. There are essentially three components of operating system as described below:

1. the device driver
2. the kernel
3. the shell

The Device Driver

This component is close to computer hardware. The device drivers are required for proper functioning of the devices attached to the computer system. These drivers can be installed or uninstalled as and when required. The kernel uses it for operating and controlling.

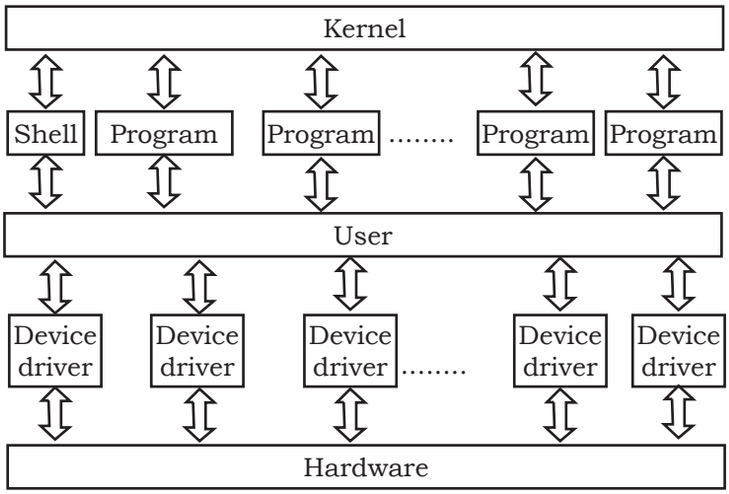

Fig. 4.24: Components of OS

The Kernel

It is the core of the operating system. It performs all the major functions of the operating system. It manages resources, controls program execution, and schedules program execution. It is the main operating system. It detects the new hardware when attached and installs the device driver for it to function properly.

The Shell

We identify the operating system by how the shell looks. It provides the user interface to interact with the kernel and hardware. There are two types of user interface— command line interface (CLI) and graphical user interface (GUI) as explained in the Chapter earlier.

The File System

The operating system provides a file system interface to secondary storage. A file system contains files and directories (folders). Directory is a container that may contain files and other directories known as subdirectories. A file is the basic unit secondary data storage on computers. Any data is stored in a file in the file system. The file has two components, file name and extension. File system that is stored on the disk may have a large number of files and/or directories. Every file system starts with a root directory.

Check Your Progress

A. Multiple choice questions

1. Operating system loads in _____.
   (a) RAM (b) CMOS
   (c) ROM (d) CPU
2. What is an operating system?
   (a) Collection of programs that manages hardware resources

(b) System service provider to the application programs
(c) Link to interface the hardware and application programs
(d) All of the mentioned

3. Which operating system allows multiple users simultaneously?
(a) Multi-user OS (b) Multi-tasking OS
(c) Real time OS (d) All of these
4. Logical extension of multi-programming operating system is _____.
(a) time sharing (b) multi-tasking
(c) single programming (d) Both (a) and (b)
5. When a computer starts, operating system checks all the _____ and loads their drivers so a user can work properly.
(a) programs (b) devices
(c) drivers (d) network
6. _____ creates a link between a user and the computer.
(a) Device driver (b) Utilities
(c) Operating system (d) Image view
7. Multi-processor system has a _____.
(a) small system (b) tightly coupled system
(c) loosely coupled system (d) macro system
8. Which one of the following error will be handled by the operating system?
(a) Power failure
(b) Lack of paper in printer
(c) Connection failure in the network
(d) All of the above mentioned
9. By operating system, the resource management can be done via _____.
(a) time division multiplexing
(b) space division multiplexing
(c) Both time and space division multiplexing
(d) None of the mentioned
10. _____ is the most popular type of operating system for personal computers.
(a) Linux (b) Unix
(c) Microsoft Windows (d) Mac OS

B. Fill in the blanks

1. Microsoft Windows is a graphical user interface (GUI) _____.
2. Mac OS is an operating system that is created by _____.
3. Linux is a family of _____ operating systems
4. In multi-programming OS, two or more programs are executed simultaneously by _____ processor.

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5. A multi-processing OS supports running a program in more than one _____.
6. The similar jobs grouped together for processing is called _____.
7. Bank transaction is an example of _____ processing system.
8. A multi-user OS allows two or more users to run programs at the _____.
9. The look or initial screen of various operating systems looks _____.
10. The kernel is the core of _____.
11. The shell provides the user interface to interact with the kernel and _____.
12. The operating system provides a file system interface to _____ storage.
13. A file system contains files and _____.

C. Short answer questions

1. What is an operating system?
2. List the various types of operating systems.
3. Describe the booting process of the operating system.
4. List the main function of the OS.
5. What are tasks of the operating system?
6. What is an interface and why it is an important aspect in the operating system?
7. Describe different types of operating systems.
8. Discuss different categories of operating systems.
9. What is single user and single task OS?
10. What is single user and multitasking OS?
11. What is time sharing?
12. What is a multi-user OS?
13. What is a multiprocessing OS?
14. Give one example each of OS using CLI and GUI interfaces.
15. What do you mean by a CLI interface?
16. What do you mean by a GUI interface?
17. What are the major components of an operating system?
18. Why is the file system important in an operating system?
19. Define real time operating systems with an example.

Chapter 5 Installation and Configuration of Windows 10

Introduction

Windows 10 operating system is available for many devices such as phones, tablets, laptops, and desktop computers. It is also available in multiple editions and in both 32-bit and 64-bit versions. First, one needs to choose the appropriate edition and architecture of Windows to provide the necessary features, such as Secure Boot, Client Hyper-V, Cortana, and others. It is also important to verify the compatibility of existing hardware such as printers, scanners, and other peripherals with Windows 10.

In a new computer, a clean installation of Windows 10 is the perferred option. For a new computer, the user needs to select another appropriate installation option as per their requirements. This installation will resolve startup and shut down problems as well as memory usage and app issues. Also, you can get rid of viruses and other types of malware, fix system corruption, and improve battery life.

Windows 10 System Requirements

Today's modern computers are capable of installing Windows 10. However, if you wish to check the hardware requirements of old computers, check the minimum hardware requirements as follows:

1. processor: 1 gigahertz (Ghz) or faster processor
2. memory: 1GB RAM for 32-bit or 2GB RAM for 64-bit
3. storage: 16 GB of disk space for 32-bit or 20 GB for 64-bit
4. graphics card: DirectX 9 or later with WDDM 1.0 driver
5. display: 800x600 pixels

It is also recommended to have an internet connection to download and install updates.

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WINDOWS 10 UPGRADE OR CLEAN INSTALLATION

It is possible to upgrade Windows 10 on the existing computers or you can choose the clean installation. If you have the licensed copy of Windows 7, then it is possible to upgrade it to Windows 10. You can choose any one of the following three methods for upgrading to Windows 10:

Inplace upgrade: The existing operating system can be updated to Windows 10 without destroying the user data and settings. It is the recommended and most preferred method for most of the users who wish to upgrade to Windows 10 in the existing hardware. In this method, Windows 10 setup program automatically retains the settings. It is important to backup user data files before starting the upgrade to avoid possible data loss. A procedure for inplace upgrade is as below:

1. check whether the computer meets minimum hardware requirements for Windows 10 and that supports all hardware,
2. verify that all the applications work on Windows 10,
3. back up the user's data files,
4. run the setup.exe program on the Windows 10 product DVD,
5. choose 'upgrade' when prompted and complete the setup wizard.

Side-by-side migration: In this method, the source and destination computers are different. You need to install Windows 10 on a new computer and then migrate the data and user setting from the earlier operating system to the new computer.

Wipe-and-load migration: In this method, you have to back up the user data and settings to an external location and then install Windows 10 on the existing computer. After that you have to restore the user data and settings.

WINDOWS 10 EDITIONS

This comes in various editions ranging from a single device to large enterprise. The specific editions of Windows 10 are listed below:

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Windows 10 Home: It is designed for home users and includes features such as Microsoft Edge, Continuum tablet mode for touch devices, Cortana, Windows Hello, virtual desktops and number of built-in Windows apps such as Photos, Maps, Calendar, Music, and Video. In Windows 10 Home, you cannot control updates as of the earlier Windows and these are received automatically.

Windows 10 Pro: It includes the same features as in Windows 10 Home with some additional features, such as, Domain Join and Group Policy Management, Microsoft Azure Active Directory Join, BitLocker, Enterprise Mode for Internet Explorer 11, Client Hyper-V, Microsoft Store for organisations, Windows Information Protection (WIP). In Windows 10 Pro, updates are provided more quickly.

Windows 10 Enterprise: It provides some more additional features other than those provided by Windows 10 Pro including Direct Access, Windows To Go Creator, AppLocker, Branch Cache, start screen control with Group Policy, Windows Defender Credential Guard and Windows Defender Device Guard.

Windows 10 Education: It provides the same features as Windows 10 Enterprise, but does not support for LTSC. Windows 10 Education is only available through Academic Volume Licensing.

Windows 10 Mobile: It is designed for phones and smaller tablets. It offers the same features as that of Windows 10 Home desktop edition.

Windows 10 Mobile Enterprise: It offers features similar to Windows 10 Mobile. It provides security updates more quickly. It is available only to Volume Licensing customers.

Windows 10 Business Edition: Microsoft also provides a special Windows 10 Business edition, which is included as a part of Microsoft 365 Business.

32-bit and 64-bit versions of Windows 10

All desktop editon of Windows 10 come in 32-bit and 64-bit. The 64-bit versions of Windows 10 provides the following advantages:

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Memory: The 64-bit versions of Windows 10 can address more physical memory than 32-bit versions. 32-bit versions are limited to 4GB of RAM, whereas 64-bit versions have no such limitation.

Security: Features such as Kernel Patch Protection, mandatory kernel-mode driver signing, and Data Execution Prevention (DEP).

Client Hyper-V: This feature is only available on 64-bit versions of Windows 10.

Performance: The 64 bit processors can handle more data during each CPU clock cycle.

General features

The following general features of Windows 10 provide general usability and functional improvements:

Client Hyper-V: enables to create, manage, and run virtual machines. For this feature, you should have a 64-bit version of Windows 10 Pro or Windows 10 Enterprise edition, a computer that supports SLAT, additional 2 GB of physical memory to support running the virtual machines.

Cortana: you can use Cortana as a digital assistant to control Windows 10 and perform tasks such as writing email, setting reminders, and performing web searches. Since Cortana is voice-activated and controlled, Windows 10 device requires a microphone.

Continuum: Windows 10 is available on a variety of devices types and form factors. With Continuum, Microsoft endeavors to optimise the user experience across device types by detecting the hardware on your device and changing to that hardware. For example, Windows 10 determines when you are using a non-touch desktop computer and enables traditional interaction with the operating system by use of a mouse. For users of hybrid devices, such as the new Microsoft Surface Pro, when you disconnect a keyboard cover, Windows 10 switches to tablet mode. When you use Windows 10 Mobile, Continuum enables you to use a second external display and optimises app behaviour on that display.

Miracast: Windows 10 uses Miracast to connect your Windows device wirelessly to an external monitor or projector. The only thing you need is a Miracast compatible external monitor or projector.

Touch: Windows 10, like Windows 8 before it, is a touch-centric operating system. Although you do not need a touch device to use Windows 10, some features are made more usable through the use of touch. To use touch, your tablet or display monitor must support touch.

OneDrive: users of OneDrive are entitled to 5 GB free online storage. OneDrive provides this storage. It is built into the Windows 10 operating system like any other type of storage, and consequently, it is easy to use. You must have a Microsoft account to use OneDrive.

Sync your settings: when you use more than one Windows 10 device, it is convenient for your user settings to move with you to the new device. You can use the 'Sync Your Settings' feature of Windows 10 to ensure that settings such as theme, Internet Explorer and Edge settings (including favorites), passwords, language, and ease of access are synchronised between your devices. You must have a Microsoft account to use this feature.

Configuring Correct Boot Order

The operating system Windows 10 has been provided to you on a DVD media. If not, then prepare the bootable media DVD or USB pen drive by using the standard process. Set the boot order first according to installation media that you are using for installation.

Inside the BIOS interface, look for the 'Boot' menu (Figure 5.1), and configure the boot order to start from the DVD or USB drive according to installation media. Save the new changes.

The bootable media can be prepared by using the windows tool or Microsoft Media Creation Tool or third-party tools like Rufus, Yumi.

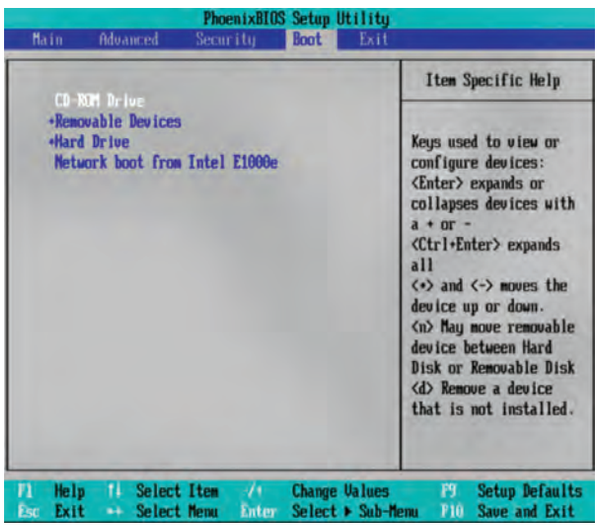

Fig. 5.1: BIOS PC Windows 10

Performing a Clean Installation of Windows 10

To perform a clean installation of Windows 10, insert a bootable media DVD or USB pen drive in your computer system, and press any key to boot from the bootable disk as shown in Figure 5.2. Let the disk allow the loading of the setup file as shown in Figure 5.3. Follow the steps below for clean installation of Windows 10.

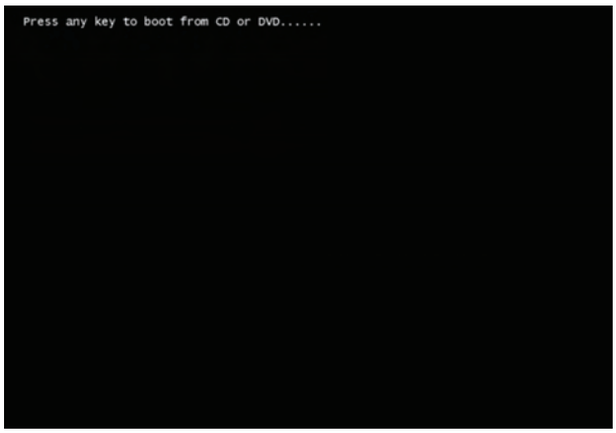

Fig. 5.2: Press any key for booting

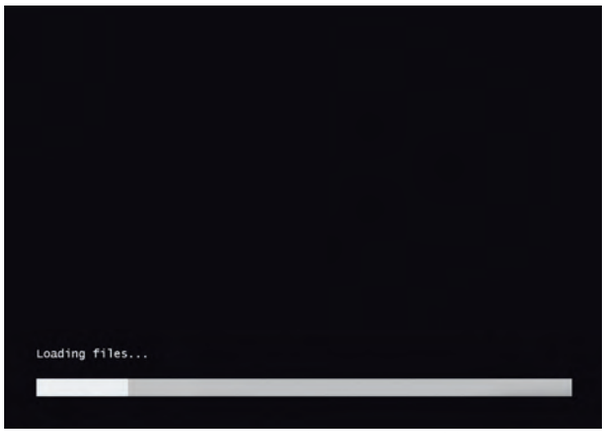

Fig. 5.3: Loading setup file

(i) Insert a bootable media DVD or USB pen drive in your computer system. Provide the details of language, time zone, and keyboard layout as shown in Figure 5.4. Then click on the 'Next' button.

(ii) Click the 'Install now' button as shown in Figure 5.5.

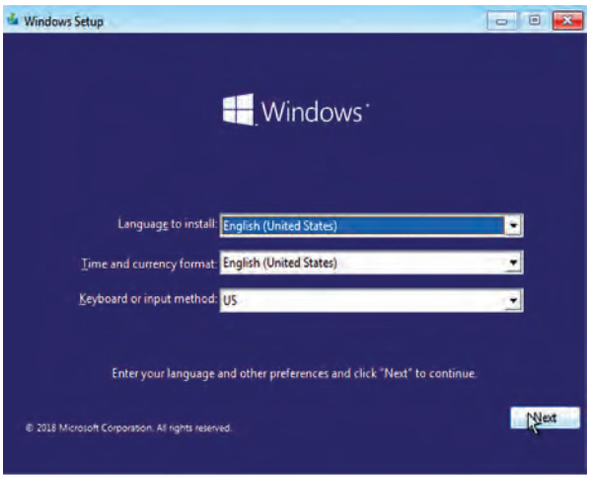

Fig. 5.4: Select language, time, and currency

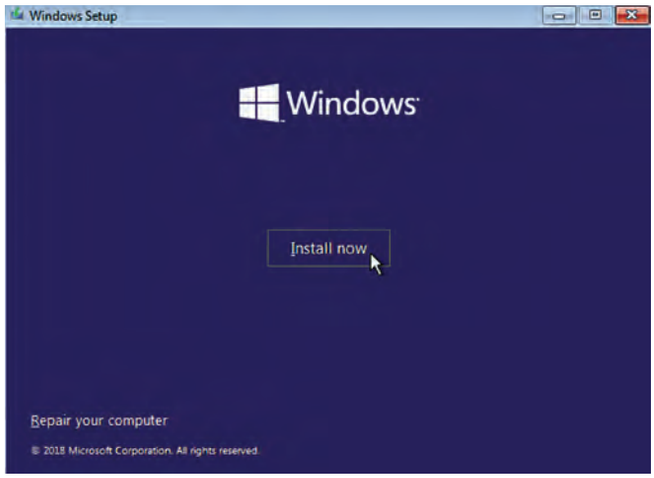

Fig. 5.5: Installation window and input

(iii) In the next window, you will be asked to enter the product key. Enter it and click on the 'Next' button to proceed. In case you don't have the product key currently, then you can skip to enter the product key by clicking on the option 'I don't have a product key' to continue the installation as shown in Figure 5.7 below.

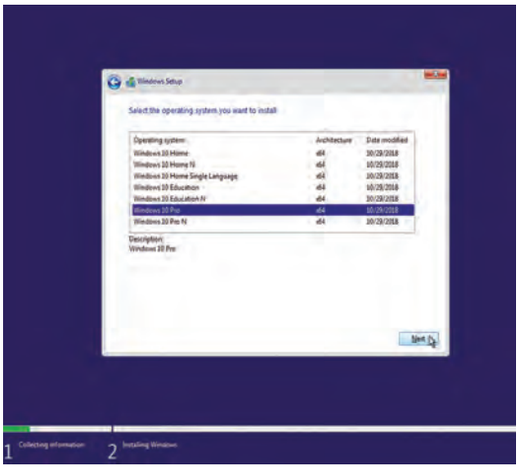

Fig. 5.6: Collecting information

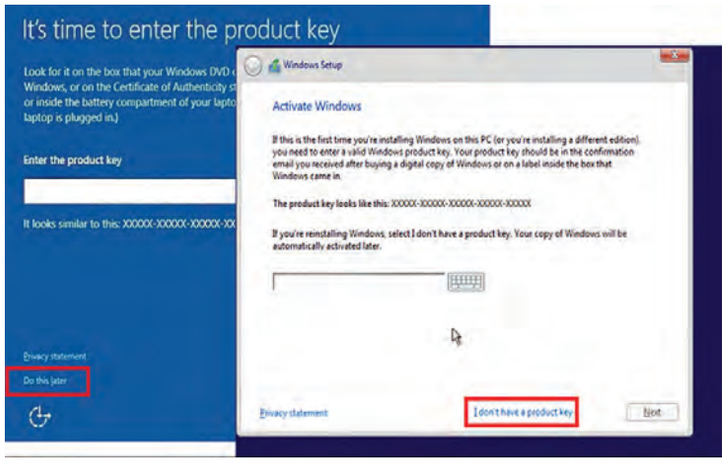

Fig. 5.7: Product key window

(iv) A new window as shown in Figure 5.8 will appear where you have to accept the licence terms by putting the tick (✓) on the checkbox 'I accept the license terms'.

(v) Click the 'Next' button as shown in Figure 5.8.

(vi) Click on the 'Custom: Install Windows only (advanced)' option as shown in Figure 5.9.

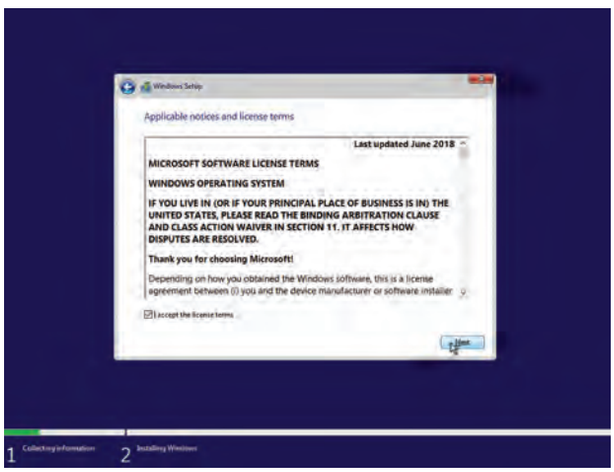

Fig. 5.8: License terms

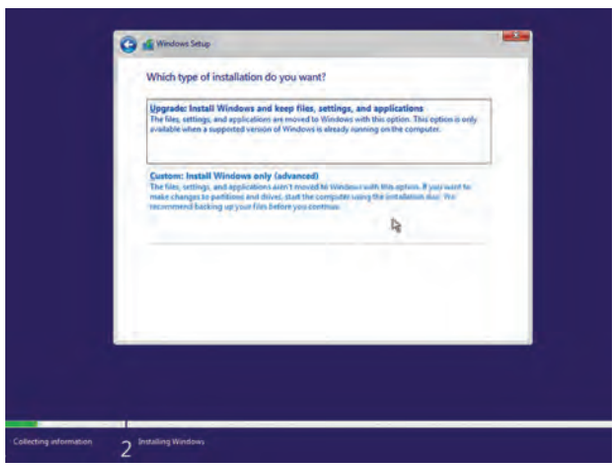

Fig. 5.9: Selecting installation setup window

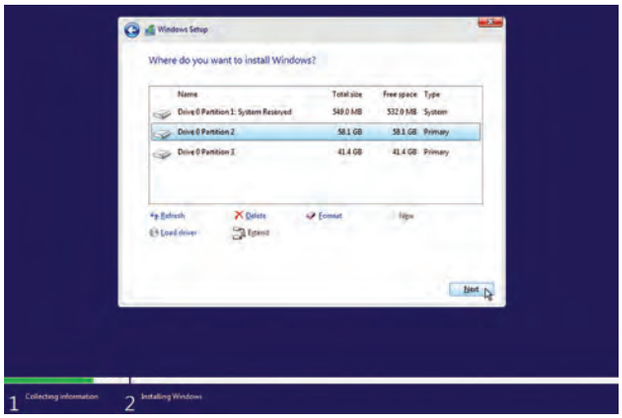

Fig. 5.10: Partition window

(vii) Select the partition with the current installation of Windows (usually "Drive 0"), and click the 'Delete' button to remove it from the hard drive.

(viii) Click the 'Yes' button to confirm the deletion.

(ix) Select the empty drive ('Drive 0 Unallocated Space') and click on the 'Next' button as shown in Figure 5.11.

(x) After completion of these steps, the set-up will proceed to install Windows 10 as shown in Figure 5.12.

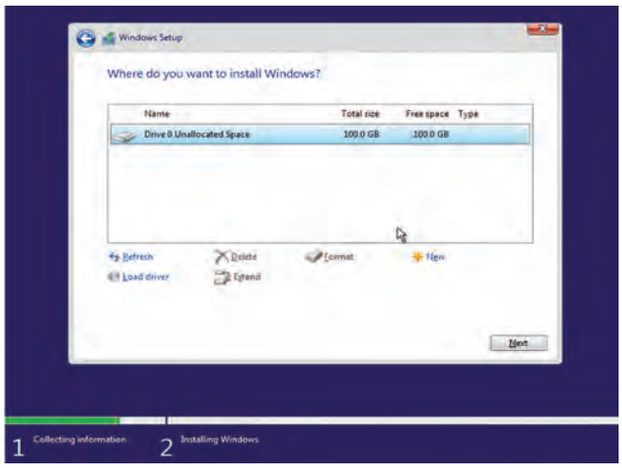

Fig. 5.11: Drive 0 unallocated Space

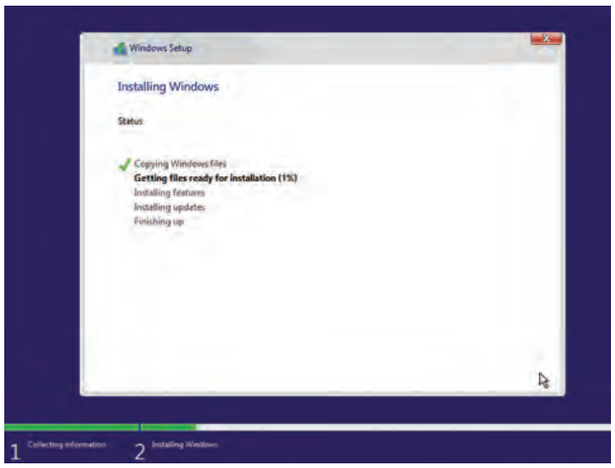

Fig. 5.12: Installing Windows

Fig. 5.13: Home window of Windows 10

(xi) After complete installation, the initial, window will appear on the computer screen as shown in Figure 5.13.

Post Installation Tasks

After installation of Windows 10, you need to perform certain post installation tasks.

(i) Check whether Windows is activated or not. To confirm that you're running an activated copy of Windows 10, open 'Settings'. For this, press the windows key and type settings in the textbox. The Windows setting will be displayed as shown in Figure 5.14.

(ii) Click on 'Update & Security' as shown in Figure 5.15.

Fig. 5.14: Window setting

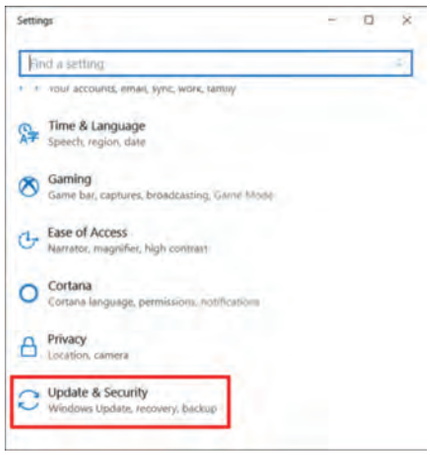

Fig. 5.15: Selecting update and security

(iii) Click on 'Activation' as shown in Figure 5.16.

(iv) Under the 'Activation' head, Windows edition and activation status is displayed as 'Windows is activated with a digital license' as shown in Figure 5.16. This confirms that your Windows 10 is activated. Instead of this if it shows the message 'Windows is not activated', then you need to activate the Window by entering the product key.

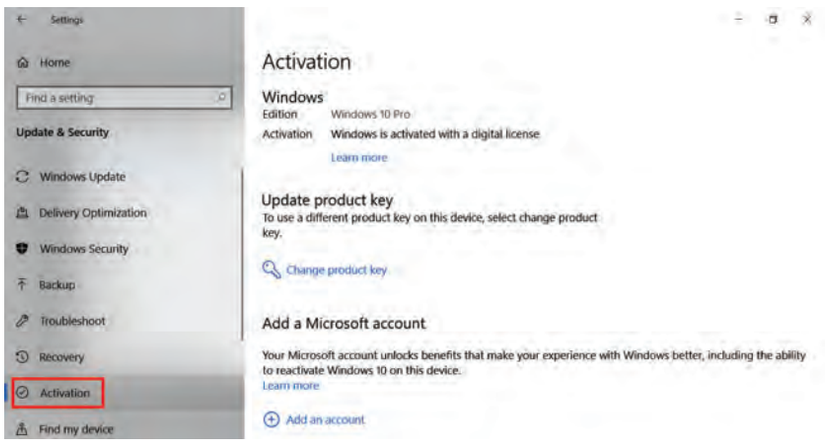

Fig. 5.16: Selecting activation

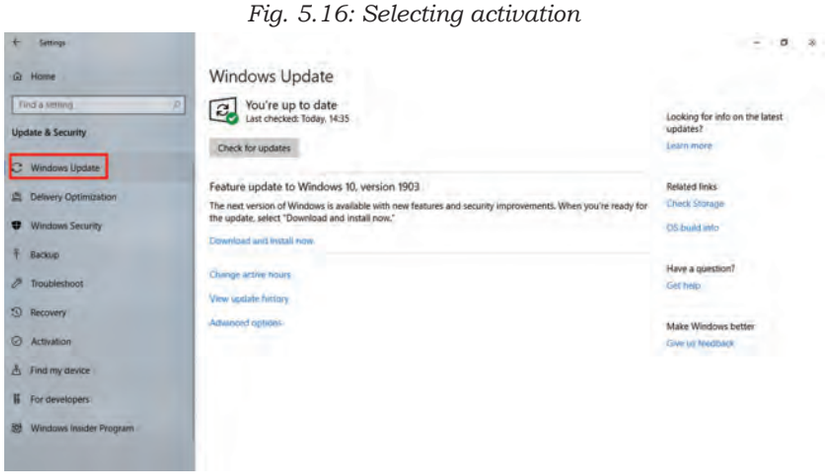

Fig. 5.17: Selecting activation

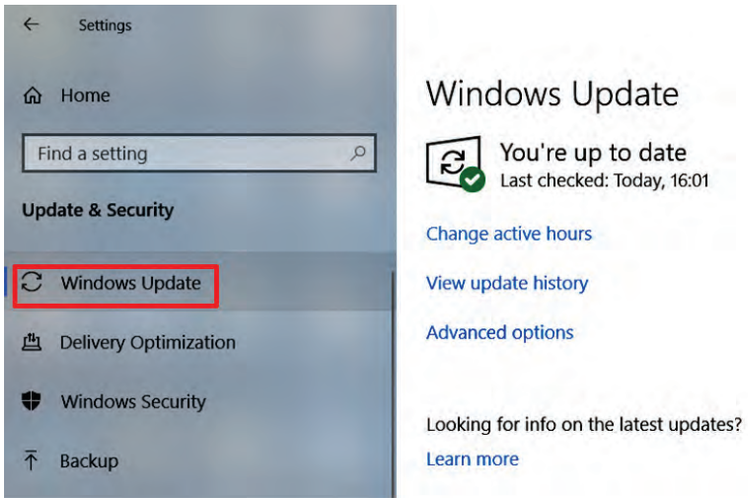

Fig. 5.18: Click on 'Windows update'

To install the latest updates:

(i) Open 'Settings' as shown in Figure 5.14.

(ii) Click on 'Update &' Security' as shown in Figure 5.15.

(iii) Click on 'Windows Update' as shown in Figure 5.18.

Region and language support in Windows 10

Windows 10 supports 111 languages of 190 countries and regions. If you want to change the language, you can download any of the additional languages for Windows 10. The following activity demonstrates how to add an input language to your PC.

Practical Activity

Configure Windows 10 for language support

1. Open 'Settings'> 'Time and Language'> 'Region & Language'.
2. Under 'Languages' select 'Add a Language'.
3. Select the language you want to use from the list, as shown in Figure 1.

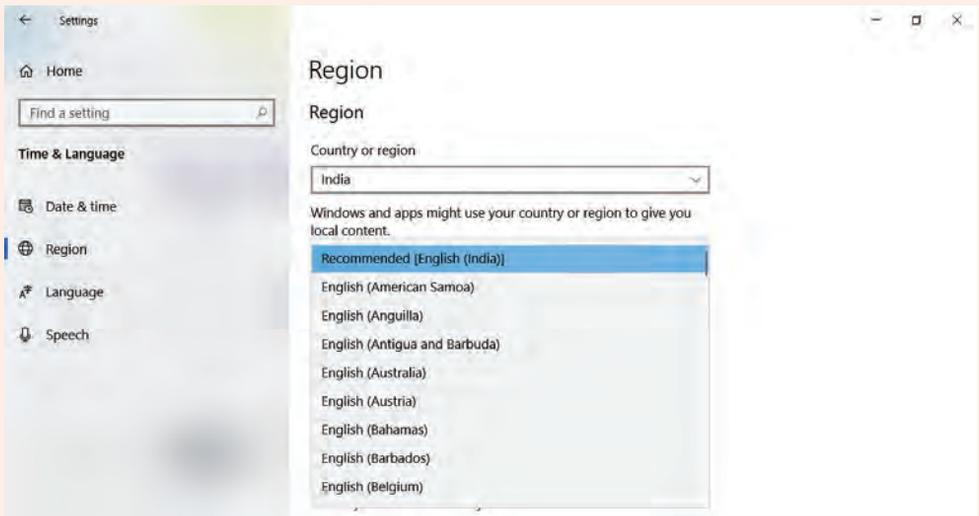

Fig. 1: Time and language window

4. Windows 10 searches 'Windows Update' for the desired language and then installs it on your computer.

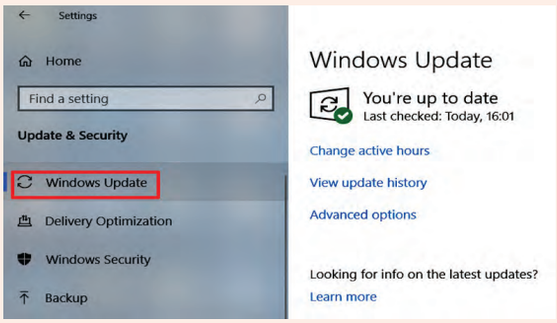

Fig. 2: Selecting 'Windows update'

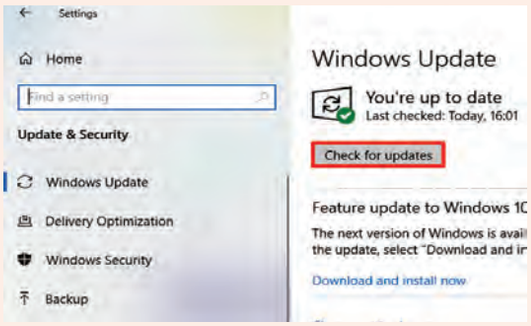

Fig. 3: Check for updates

5. Click the 'Check for updates' button as shown in Figure 3.

Device driver

1. To confirm that all the device drivers have been installed correctly, invoke the 'Device Manager' through the Windows key as shown in Figure 5.19.
2. Search for 'Device Manager' as shown in Figure 5.20. The device manager window will open as shown in Figure 5.21.
3. Observe that the drivers for all the devices are installed. In the case of any missing driver, download the latest available driver for the device manufacturer and install it.

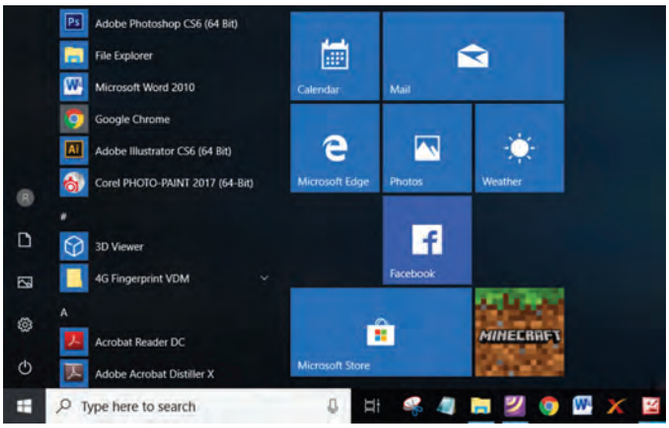

Fig. 5.19: Invoke device manager through the Windows key

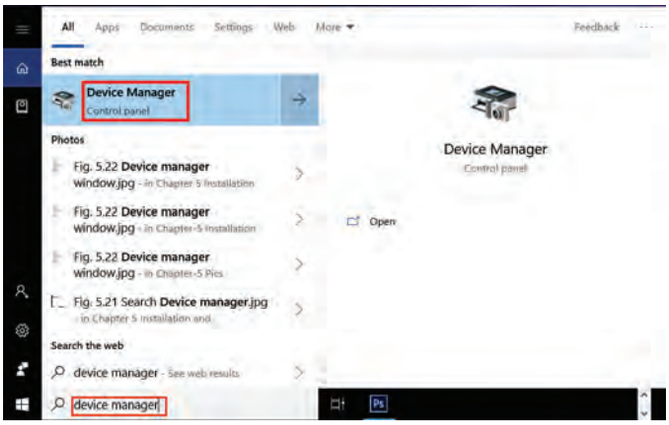

Fig. 5.20: Search device manager

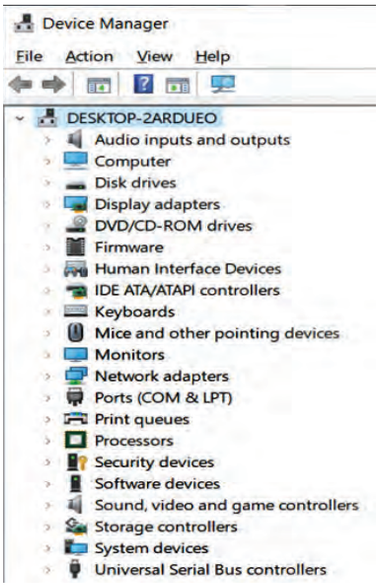

Fig. 5.21: Device manager window

Windows 10 automatically updates the device driver. If you do not want to update the device driver, then you can turn off the automatic installation of device driver. The following activity will demonstrate how to turn on or off the automatic installation of device driver.

Practical Activity

Turning off automatic installation of device driver

1. Open 'Control Panel', click on 'Devices and Printers'.
2. The icons of the various devices will be displayed. Right-click on the 'Desktop' icon. The Desktop icon shows your computer name. Then select and click on the 'Device installation settings', as shown in Figure 1.
3. 'Device installation settings' dialog box will appear as shown in Figure 2. By default the 'Yes' option is selected. Choose the option 'No' and then click on the 'Save Changes' button.

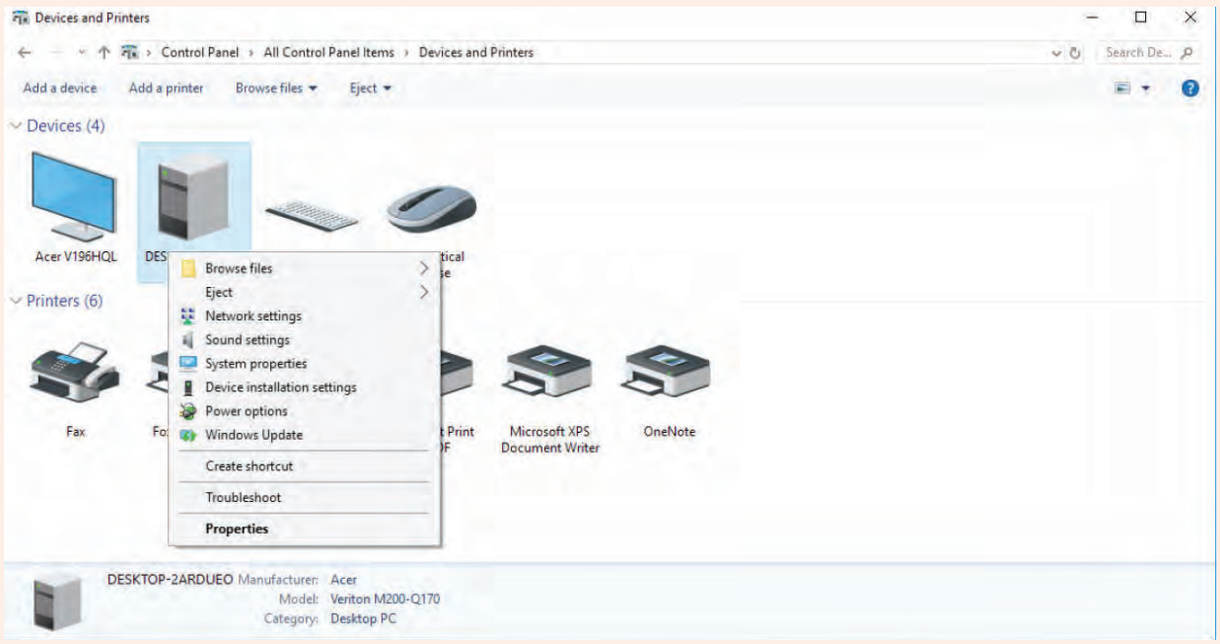

Fig. 1: Disabling the automatic device driver software installation

4. The changes will be saved which will turn off the automatic updates.

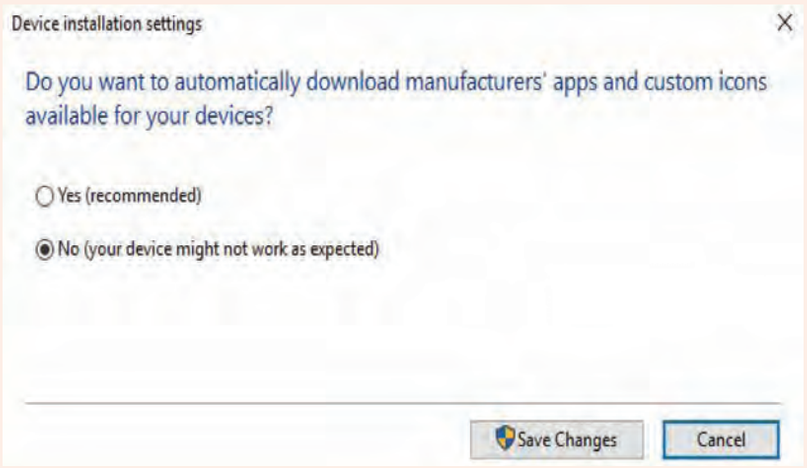

Fig. 2: Device installation settings dialog box

Static IP address configuration in Windows 10

To access Internet on your computer, you need to configure the network settings in Windows. Internet connection availability and access in Windows is indicated via an icon residing on the taskbar. If you see a yellow triangle exclamation mark on the network icon, it means that, it has limited network connectivity.

(i) Right-click the network icon in the taskbar and select 'Open Network & Internet settings' as shown in Figure 5.23.

Fig. 5.22: Selecting network access option

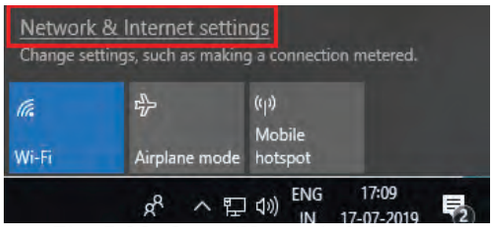

Fig. 5.23: Open 'Network & Internet settings'

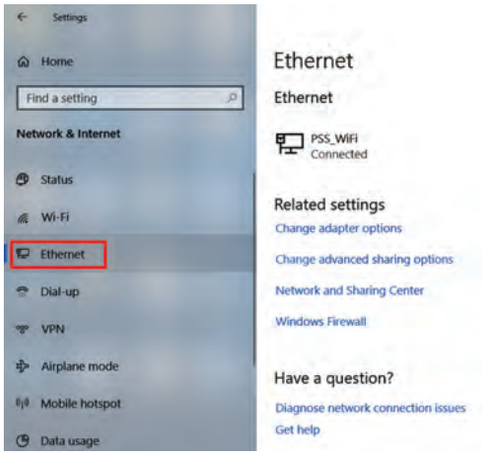

Fig. 5.24: Open Ethernet setting

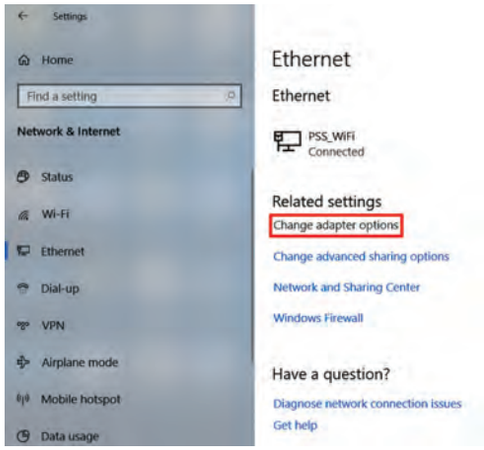

Fig. 5.25: Change adapter options

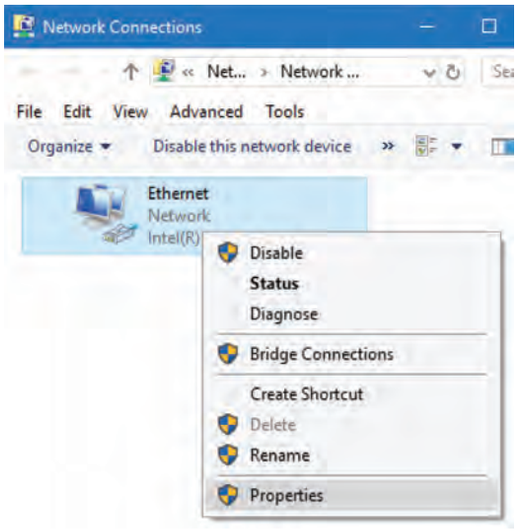

Fig. 5.26: Ethernet properties

(ii) In the 'Open Network & Internet Setting' window, click on 'Ethernet' as shown in Figure 5.24, to see the settings of your connection. You can change the related settings as shown in Figure 5.25.

(iii) Right click your active network adapter and choose 'Properties', as shown in Figure 5.26.

(iv) Under 'This connection is using the following items', double click on 'Internet Protocol Version 4 (TCP/IPv4)', as shown in Figure 5.27 to change the current IP address and the DNS server.

(v) Select 'Use the following IP address' as shown in Figure 5.29, and you will be able to edit the IP and DNS fields. You should know what IP address to put as the gateway and subnet mask.

(vi) Enter the valid IP address, subnet mask, and default getaway as shown in Figure 5.29.

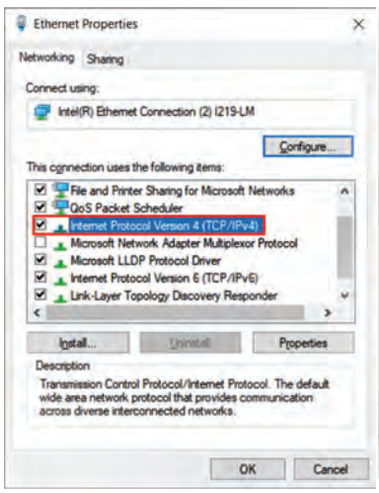

Fig. 5.27: Selecting IPv4

Fig. 5.28: IPv4 properties

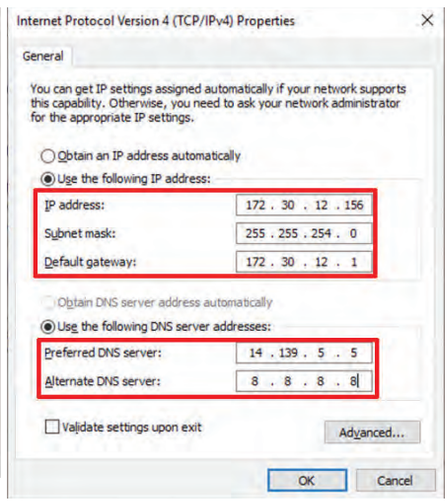

Fig. 5.29: Giving IP address

(vii) You can see the network connection details by clicking on the 'Details' as shown in Figure 5.30. The connection details will be displayed as shown in Figure 5.31.

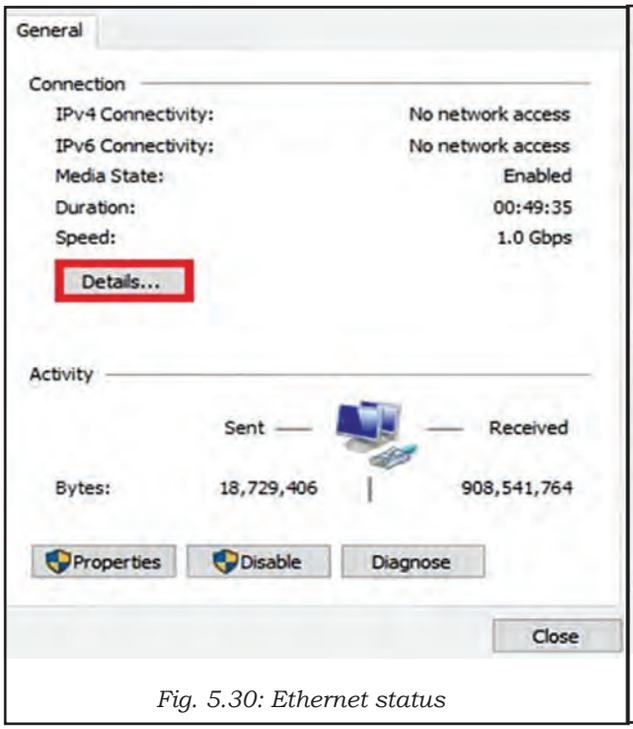

Fig. 5.30: Ethernet status

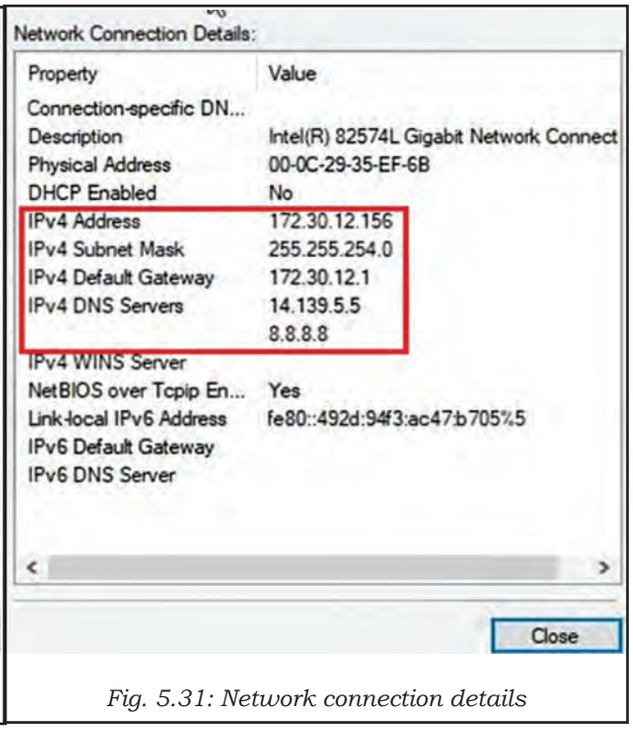

Fig. 5.31: Network connection details

Installing printer

A printer is essentially required for taking print outs from the computer. The following activity illustrates the installation of a printer in Windows 10.

Practical Activity

Installation of printer

Step 1: Click and run setup .exe file of printer as shown in Figure 1. The setup.exe file will extract as shown in Figure 2.

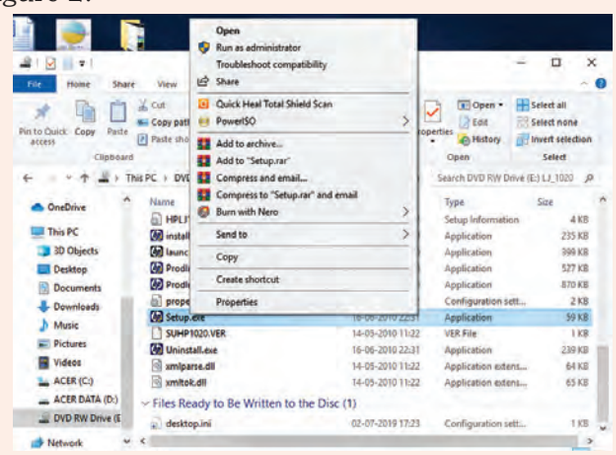

Fig. 1: Run printer .exe setup file

NOTES

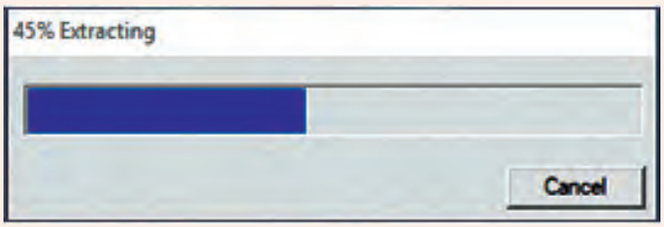

Fig. 2: Setup extracting Window

Step 2: Click on install button as shown in Figure 3.

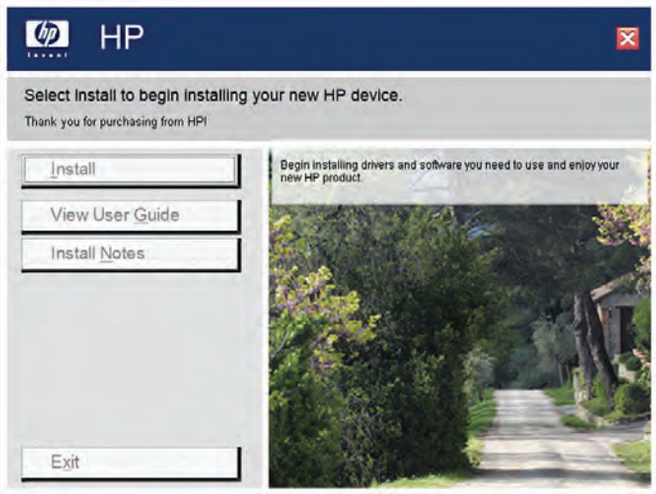

Fig. 3: HP Printer Installation

Step 3: Click on 'Add another printer' as shown in Figure 4.

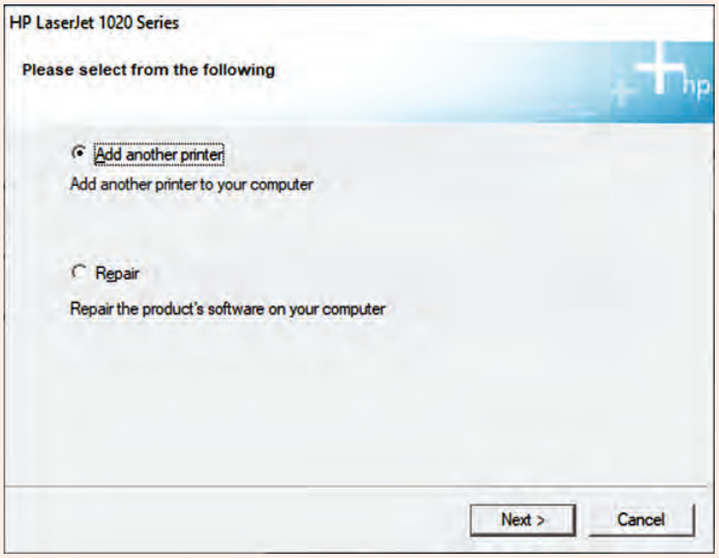

Fig. 4: Connect device window

Step 4: Check whether device is connected or not.

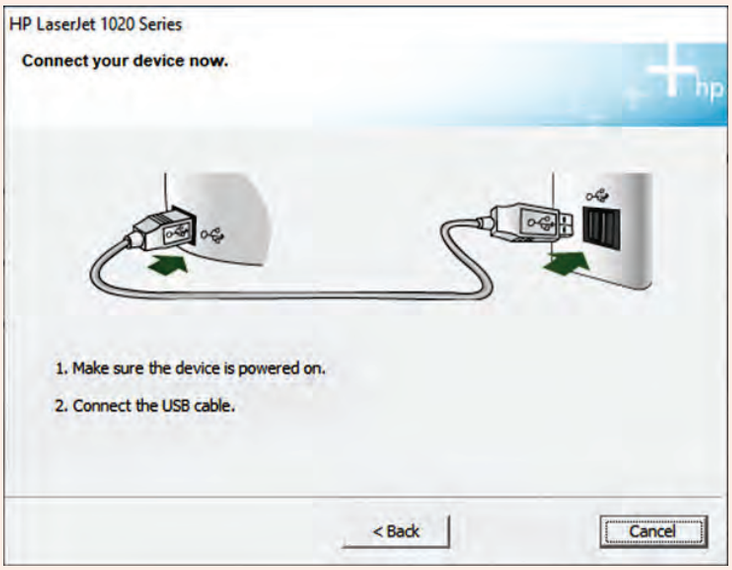

Fig. 5: Connect device window

Fig. 6: Installing driver

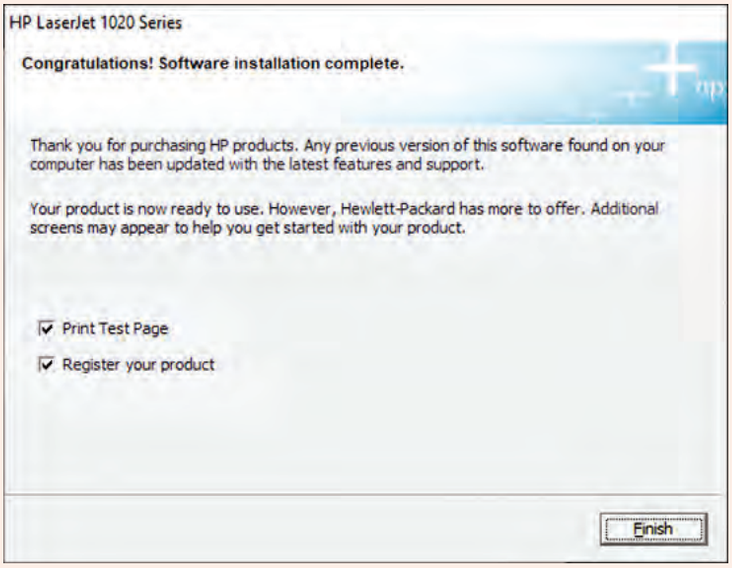

Fig. 7: Successfully setup completed

NOTES

Practical Activity

Installation of Scanner

Scanner is another important peripheral commonly required by the user. The following activity illustrates the installation of scanner in Windows 10.

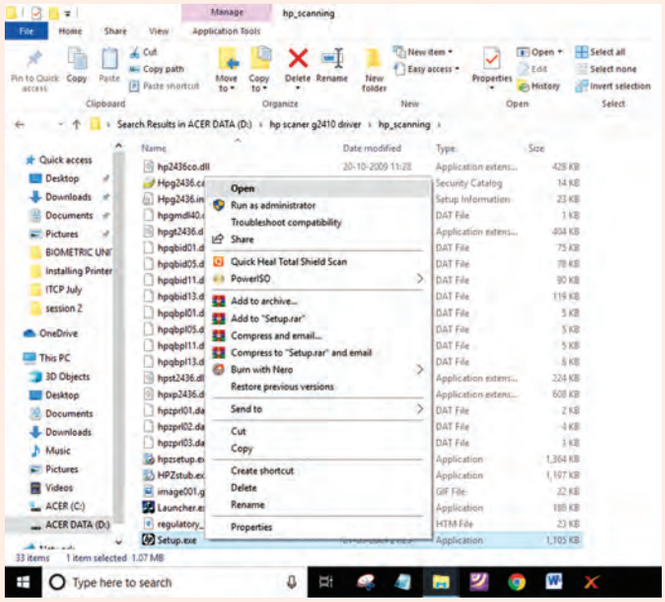

Fig. 1: Run scanner setup.exe file

Installation of Scanner

Step 1: Run Scanner setup.exe file as shown in Figure 1. The setup.exe file will extract as shown in Figure 2.

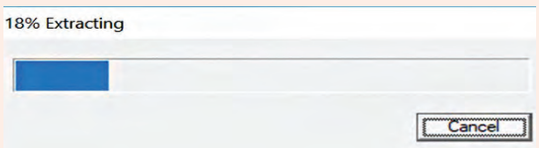

Fig. 2: Scanner setup.exe extracting window

Step 2: Click on install software as shown Figure 3.

Step 3: A new window as shown in Figure 6 will appear where you have to accept the license terms and by putting the tick (✓) on the checkbox 'I have reviewed and accept the installation agreements and settings'.

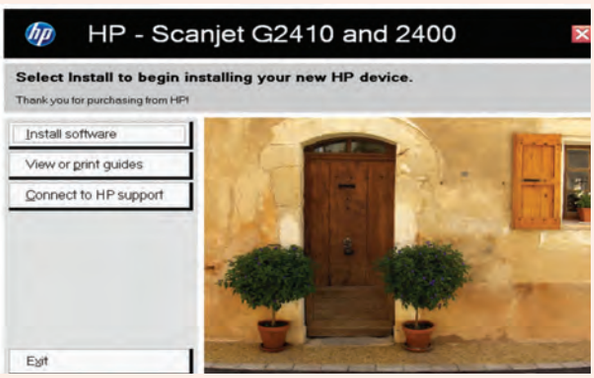

Fig. 3: HP driver installation window

Fig. 4: Checking system

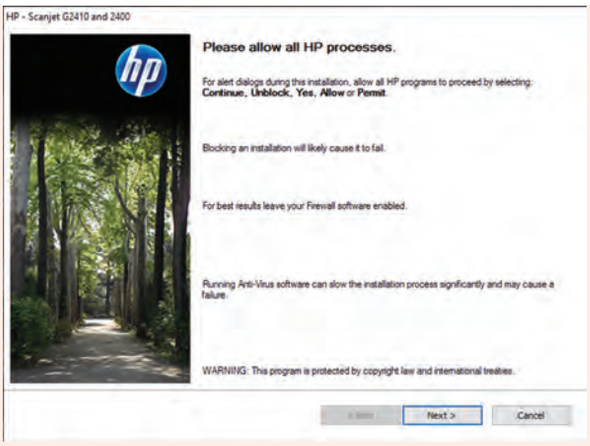

Fig. 5: Scanjet permission — allow all installation process window

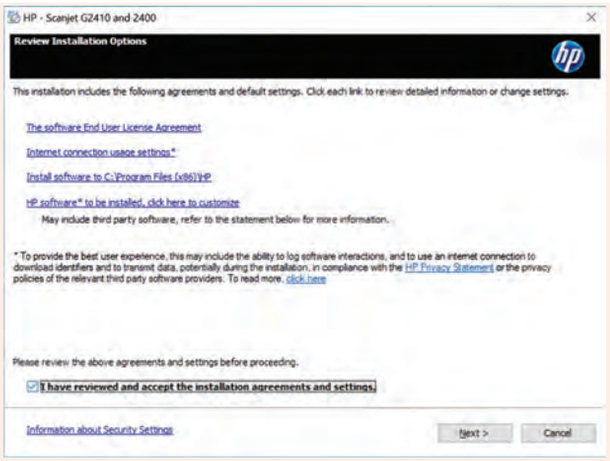

Fig. 6: Accepting 'End User license Agreement'

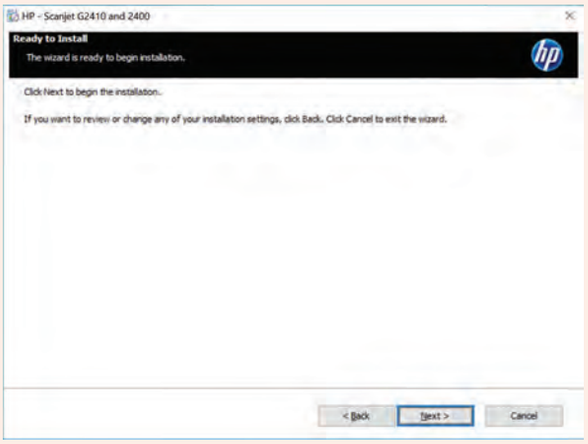

Fig. 7: Ready to install

Fig. 8: Installing software

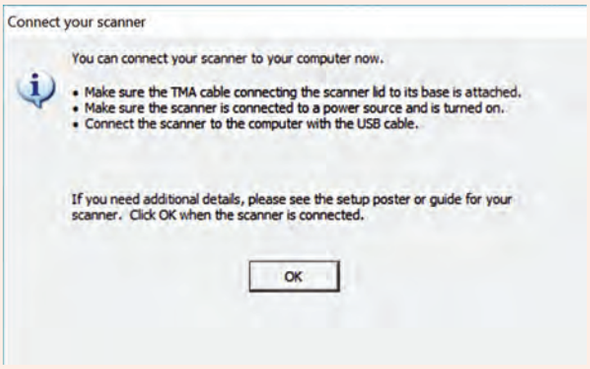

Fig. 9: Connect scanner to PC

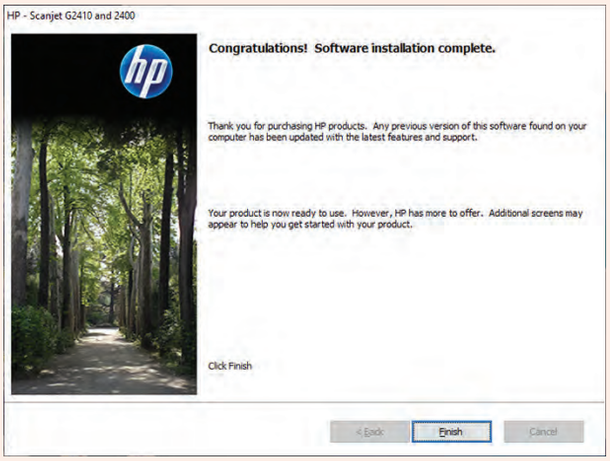

Fig. 10: Successful setup installation

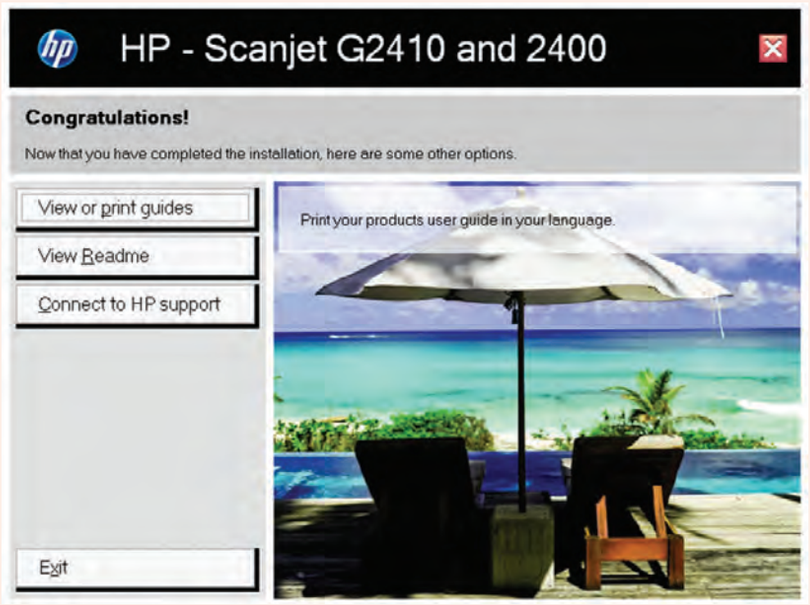

Fig. 11: HP Scanjet Window.jpg

Step 4: Connect your scanner to PC.

Installation of antivirus software

It is essential to install an antivirus software to protect your computer from viruses and worms. The antivirus software should also be updated from time to time. Use only one antivirus program in a computer system. More than one antivirus program can cause problems. There are various free as well as paid antivirus software available in the market. For example, Microsoft Security Essential, Quick Heal, Kaspersky, AVG, F-Secure, Norton, McAfee, bit defender, Avast, and Avira as shown in Figure 5.32.

Fig. 5.32: Types of Antivirus software

You can choose any one of these as per your choice. The installation process of 'Quick Heal Total Security' antivirus is given below as an example.

System requirements

To use Quick Heal Total Security antivirus, your system must meet the following minimum requirements: (However, a higher configuration will give better results.)

1. CD/DVD Drive
2. Internet Explorer 6 or later
3. Internet connection to receive updates
4. For Microsoft Windows 10, 1 gigahertz or faster CPU with 1GB RAM for 32 bit and 2 GB RAM for 64 bit operating system.

Before installing an antivirus program consider following the points:

1. close all open applications, browsers, programs, and documents for uninterrupted installation,
2. ensure that you have administrative rights for installing 'Quick Heal' antivirus.

Practical Activity

Standard installation of Quick Heal Total Security

Step 1. First, download the antivirus installer from the Quick Heal website. Click on the download button to download the software.

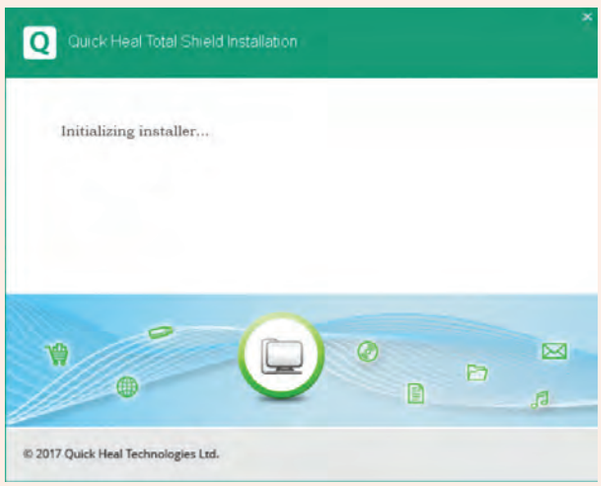

Fig. 1: Quick Heal initialising installer

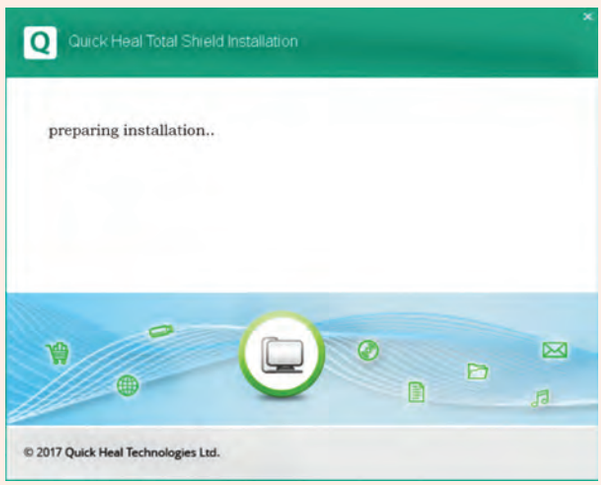

Fig 2: Preparing installation window

Step 2. Wait until the setup wizard checks and finds the updated and latest version of the antivirus or just click on the 'Skip' button to install the current version.

Step 3. Click on the 'Next' button to start setup or you can review the End-User License Agreement (EULA) as shown in Figure 3.

Step 4. Click 'Next' to review the 'Install Location' of Quick Heal Total Security as shown in Figure 4.

Step 5. Installation process continues as shown in Figure 5.

Step 6. Installation successfully completed, now click on 'Register Now' as shown in Figure 6.

Step 7. Review the features of Quick Heal Total Security antivirus by clicking 'continue'. This step is optional; you can skip it if you wish.

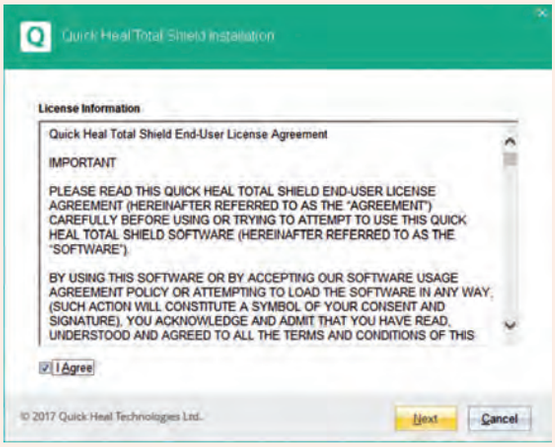

Fig. 3: 'End User License Agreement' window

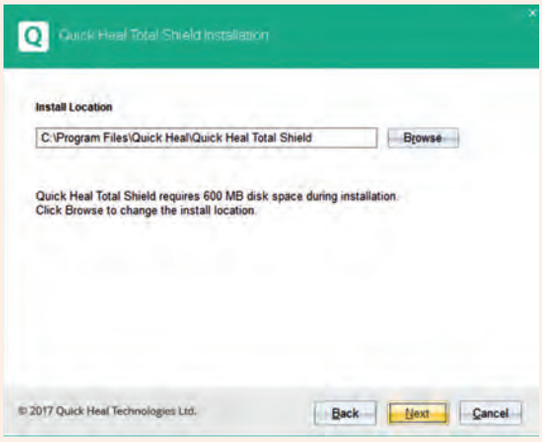

Fig. 4: Selecting 'Install Location' window

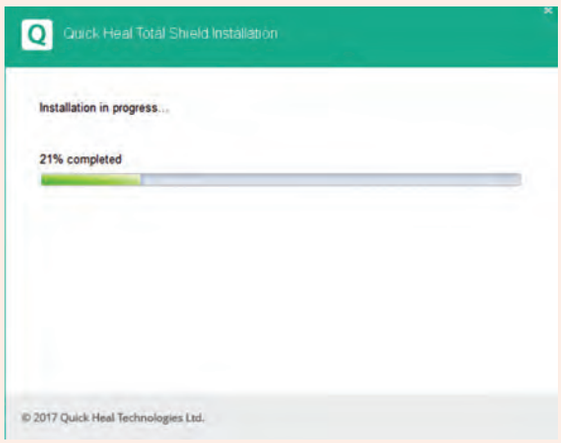

Fig. 5: Installation process progress window

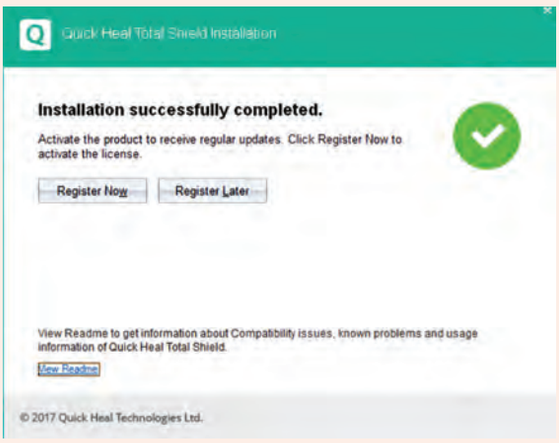

Fig. 6: Installation completed window

Fig. 7: Home window of Quick Heal Total Security antivirus

After you have installed and launched Quick Heal Total Security antivirus, activate it and scan your computer with this antivirus.

Run a full system scan

After installing and updating the antivirus software, start a full system scan process. Some antivirus software programs have different types of scanning and you have to run the most important type, known as full system scan. Scanning will take time depending on the disk size and data size. During full scan, you can continue any of your other work.

There could be a situation that the antivirus may not detect any virus or malware while an user is working on a computer. In such case, it is suggested to run a full system scan as shown in Figure 5.33 and 5.34 and any viruses may be removed.

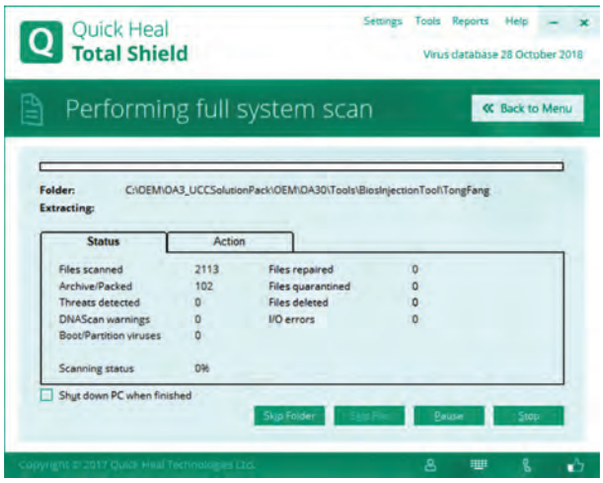

Fig. 5.33: Full system scan window

Fig. 5.34: Full system scan window

Review discovered threats and recommended action

During the scanning process or after completing scanning, the antivirus program will inform you about the various discovered threats and suitable action to be taken. Although the recommended action will be the best option, but you can take any action from the available choices. If the antivirus is not able to remove any type of infection, then just search for a proper solution on the internet or ask a professional, don't ignore the problem. You can also contact the support team or customer care of the antivirus software.

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Malware

The antivirus program may also has an anti-malware program too. If not, then install an anti-malware program and check the system again for any malware infection. Antivirus and anti-malware both programs scan for different things but they work in a similar way.

In the worst case, if you are unable to clean your computer from virus or malware or not able to repair the damaged operating system files, then take backup of important data and format the system. Reinstall the operating system and application programs. After reinstalling it, first, install the antivirus software program and update the antivirus immediately. After updating, perform the full scan of the system including backup data.

Check Your Progress

A. Multiple choice questions

1. Which is a 'text editor' for Microsoft Windows?
   (a) MS Word (b) Ms Excel
   (c) WordPad (d) Notepad
2. Which of the following user can use the administrator password to perform administrative tasks?
   (a) Administrator user account
   (b) Standard user account
   (c) Power user account
   (d) Authenticated user account
3. Which function key is pressed during reboot to enter in safe mode of Windows 10?
   (a) F8 (b) F2
   (c) F1 (d) F9
4. Which one is the latest release of Windows client operating system?
   (a) Windows XP (b) Windows 7
   (c) Windows 8 (d) Windows 10
5. Which key combination is used to minimise all open windows and displays on the screen?
   (a) Alt+M (b) Shift+M
   (c) Windows Key+D (d) Ctrl+D
6. What is the maximum number of primary partitions that can be created on a hard disk?
   (a) One (b) Two
   (c) Three (d) Four

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7. Which one is the default 'word processor' for Microsoft Windows?
   (a) MS Word (b) Ms Paint
   (c) WordPad (d) Notepad
8. Which of the following method is adopted for fresh installation of Windows 10 on a new computer in place upgrade?
   (a) Side-by-side migration
   (b) Clean installation
   (c) In place upgrade
   (d) Wipe-and-load migration
9. Which of the following Windows edition is used to install in mobile and tablets?
   (a) Windows 10 Mobile
   (b) Windows 10 Enterprise LTSC
   (c) Windows 10 Enterprise
   (d) Windows 10 Pro
10. Which of the following feature is available only in 64 bit?
   (a) Client hyper-V (b) Cortana
   (c) Direct access (d) Secure Boot

B. State whether the following statements are True or False

1. Antivirus and anti-malware both programs scan for same things but they work in a similar way.
2. After updating the antivirus, never perform a full scan of your system including that of backup data.
3. Every antivirus software programs has the same type of scanning way.
4. Close all open applications, browsers, programs, and documents for uninterrupted installation.
5. Quick Heal is a word processing software in Windows 10.
6. Without a product key, you cannot install Windows 10.
7. User is able set the boot order.
8. Windows 10 always manually updates the device driver.
9. Windows 10 comes in a single edition.
10. The Windows task manager allows the user to monitor the current CPU and memory utilisation.

C. Fill in the blanks

1. For Microsoft Windows 10, 1 gigahertz or faster CPU with 1GB RAM for 32 bit and 2 GB RAM for _____ and with operating system.
2. To access Internet on the computer you need to configure _____ setting in Windows.

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3. Windows 10 _____ updates the device driver.
4. Windows 10 supports _____ languages.
5. At the time of installation, the partition usually has drive _____.
6. When Windows 10 installation is running it asks for _____.
7. If you have the licensed copy of Windows 7, then it is possible to upgrade it to _____.
8. The existing operating system can be updated to Windows 10 without destroying the _____ data and settings.
9. Windows 10 setup program _____ retains the settings.
10. Windows 10 comes in various _____.

D. Short answer questions

1. Write steps of driver installation and removal.
2. What are the Windows 10 system requirements?
3. Write about the different editions of Windows 10 and their features?
4. What features of Windows 10 provide general usability and functional improvements?
5. Write the basic steps for clean installation of Windows 10.
6. What are the post installation tasks?
7. How to uninstall sound or any device driver?
8. How to give IP address and what is the use of IP address?
9. Write steps for installing a printer software.
10. Write steps for installing a scanner software.

Chapter 6 Installation of Ubuntu Linux

Introduction

Ubuntu (pronounced as oo-BOON-too) is an open source operating system sponsored by Canonical Ltd. Primarily, this operating system was developed for personal computers (PCs) but later on, used in servers also. The word 'Ubuntu' is from the African Zulu language whose meaning is "humanity to others." The Ubuntu desktop is very easy to use and easy to install. It includes everything you need to use in your school, home or office. It's also open source, secure, accessible, and free to download from its official website www.ubuntu.com. In this session, we will understand the installation requirement and installation procedure of Ubuntu desktop operating system using a bootable DVD drive or a USB flash drive.

Features of Ubuntu Linux

- Ubuntu is user-friendly.
- Ubuntu is FOSS (free and open source software) operating system.
- Ubuntu can be downloaded from its official website www.ubuntu.com.
- It is more secure as compared to the Windows operating system.
- High customisation, it means you can set your own flavors of working.
- Many Ubuntu flavors are readily available.
- Online Ubuntu community is available to help you out in any problem.
- Minimum hardware is required to install Ubuntu.
- Lots of free software in software centers.

Installation Requirements

Ensure the following technical requirements are in place before starting the installation:

- connect your computer system to an uninterrupted power source,

- ensure that your computer has at least 25GB of free disk storage space,
- make a bootable DVD or a USB flash drive of latest version of Ubuntu. Here we are taking the Ubuntu version 18.04,
- make sure to take data backup before starting the fresh installation.

Boot from Ubuntu Bootable Disk DVD or USB Flash Drive

To install Ubuntu, first prepare the bootable disk, either DVD or USB flash drive. Nowaday's most computers are able to boot from USB. To install the Ubuntu Linux OS, follow the steps below:

- put the Ubuntu bootable disk in case of DVD into optical/DVD drives and in case of USB flash drive, into the USB socket. Make sure the boot device order has set to the disk being used as either CD/DVD or USB flash drive.
- restart the computer. After restarting, the computer will boot from the bootable DVD and the install window as shown in Figure 6.1 will appear on your computer screen.

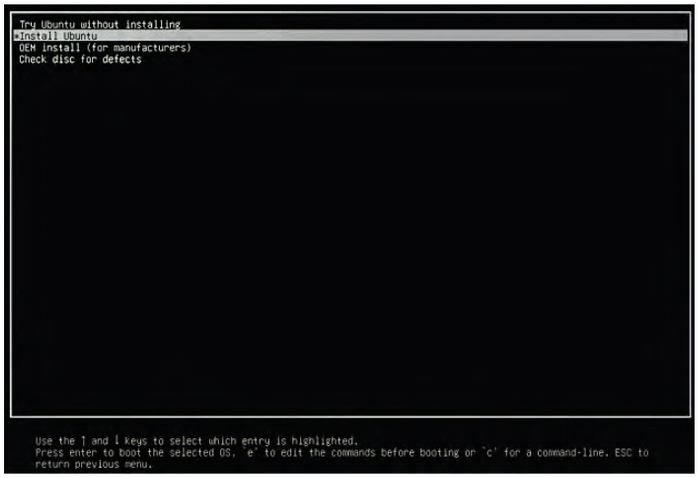


Fig. 6.1: Installation window of Ubuntu

There are two options shown, 'Try Ubuntu' and 'Install Ubuntu'. The first option 'Try Ubuntu' allows you to just use the Ubuntu on a trial basis without permanent installation; the other option 'Install Ubuntu' allows actual installation. It will launch the installer automatically, as shown in Figure 6.1. After selecting the 'Install Ubuntu' option, select the language from the left side pan. By default, the language selected is 'English'. Ubuntu can also be installed in other listed languages.

Prepare to Install Ubuntu

Now the installer will recognise your computer configuration and install the device drivers automatically.

If it doesn't correctly guess the default layout of any device, use the 'Detect keyboard layout' button to run through a brief configuration procedure. The English (US) keyboard is selected by default in the keyboard layout option as shown in Figure 6.3.

Press 'Continue' to apply. The next window will appear as shown in Figure 6.4, that will ask you the type of installation—'Normal installation' or 'Minimal installation'.

The normal installation is the default bundle of utilities, applications, games, and media players — a great launchpad for any Linux installation. The minimal installation takes considerably less storage space and allows to install the required stuff. Select the normal or minimal as per your requirement. Generally normal option is selected by the beginners. Below are the other options, the two checkboxes 'Download updates while installing Ubuntu' and 'Install third party...'.

It is recommended to tick both the options. Stay connected to the Internet to get the latest updates while the installation takes place.

Select Installation Type and Allocate Drive Space

The next installation window as shown in Figure 6.5 will ask you to provide the installation type. If the computer has already installed any other operating

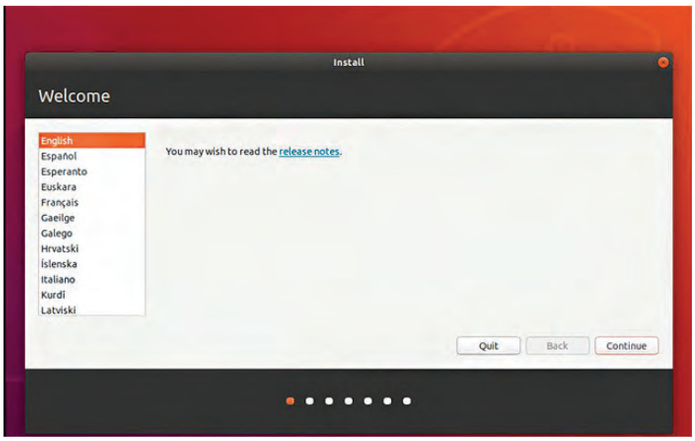


Fig. 6.2: Default language selected as 'English'

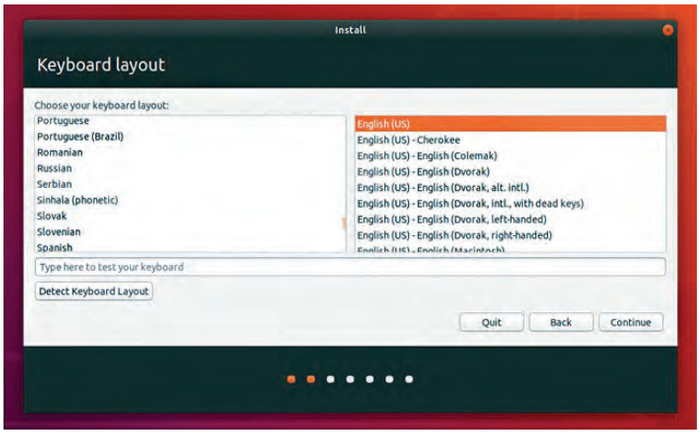


Fig. 6.3: Selecting 'Detect keyboard layout'

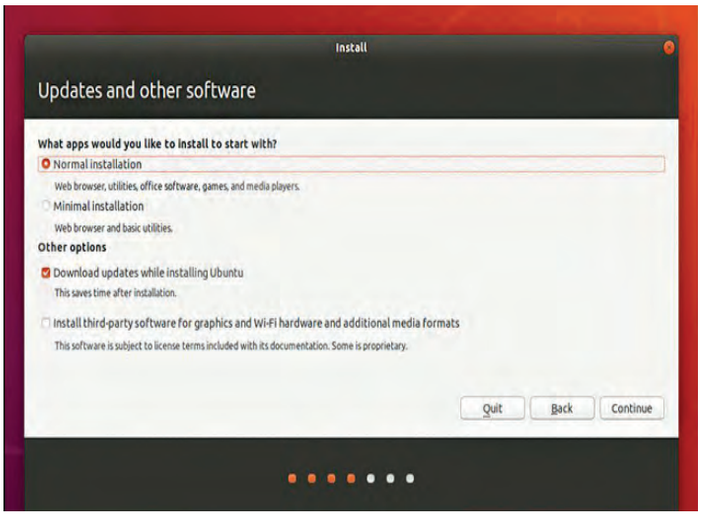


Fig. 6.4: Selecting 'Normal installation'

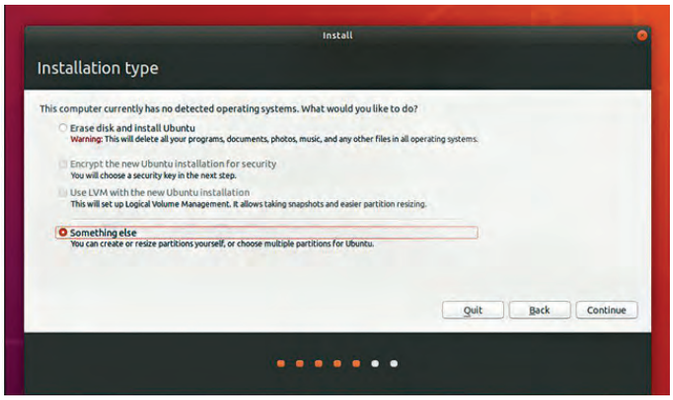


Fig. 6.5: Selecting 'Something else'

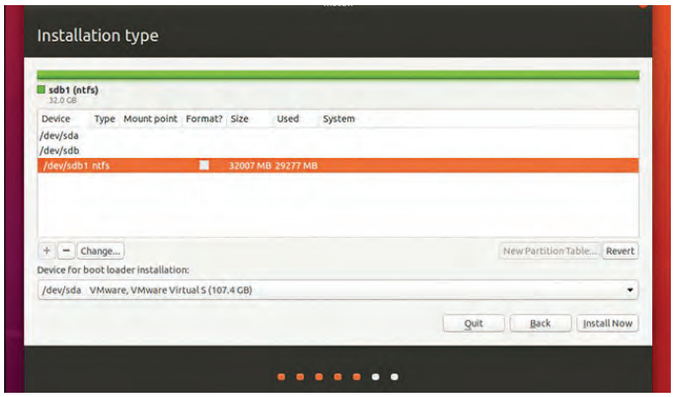


Fig. 6.6: Creating swap partition

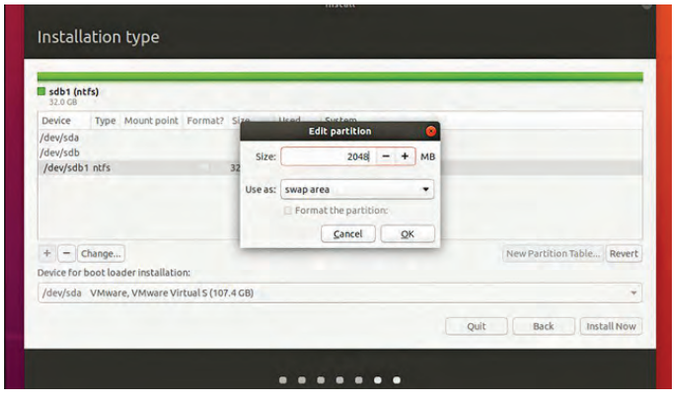


Fig. 6.7: Creating new partition table

system then you can install the Ubuntu alongside the other operating systems, so that you have the option to boot the computer with any of the operating system. The 'Erase disk and install Ubuntu' option will format the hard disk and start the installation of Ubuntu. In this case all the previous data will be lost. If you are an advanced user choose the 'Something else' option.

Select the appropriate option and click on continue. The next window as shown in Figure 6.6 will allow you to review the partition and allocate the disk space. Change the partition as per your requirement and click on 'Install Now' button.

In any Linux system, there should be three partitions namely, swap, boot, and root (/). If you keep the pre-existing partitions as it is, click on 'Install Now' button to proceed the installation with pre-existing partitions. The alert will be displayed. Then click on 'Continue' button to continue the installation.

If you have to create the partitions manually as per your requirement, then click on the 'Change' button to change the partitions. The 'Edit partition' window will be displayed where you can create the partition. First, we will create the swap partition. Swap is a small space on the drive that is used like system memory (RAM). It is recommended to keep the swap area slightly more than

Note: Options related to side-by-side installation or erasing a previous installation are only offered when pre-existing installations are detected.

the amount of RAM in your PC. For example, having 1 GB of RAM creates swap area of 2GB (2048 MB) as shown in Figure 6.7. When you click 'OK' an alert will be displayed. Then click on 'Continue' button as shown in Figure 6.7 to create the partition name 'swap area'.

A new partition is created with swap area of 2048 MB as shown in Figure 6.8. Next to create '**/**' boot partition, use Ext4 journaling file system as shown in Figure 6.9.

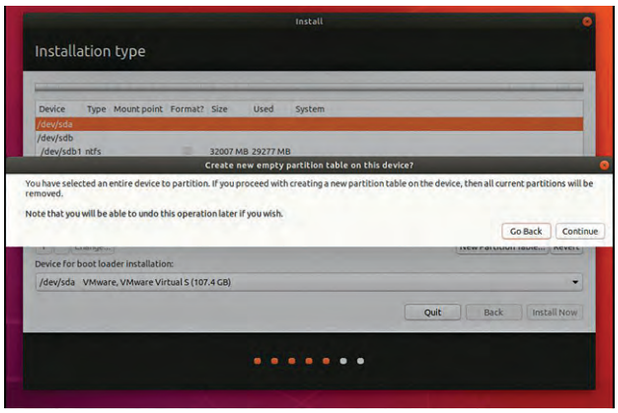


Fig. 6.8: Create a new partition

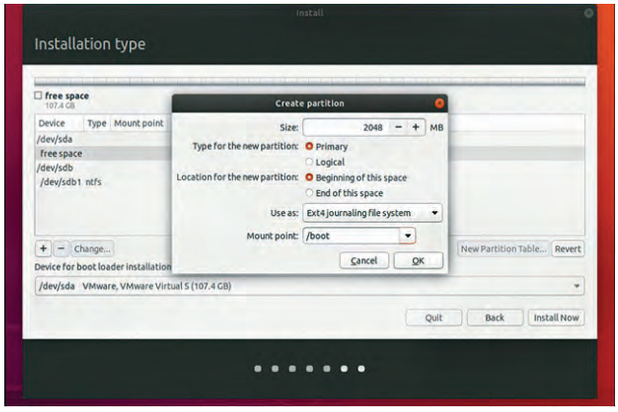


Fig. 6.9: Creating '/' boot partition

To create boot partition, select 'boot' from dropdown of 'mount point'. Also, note that the file system which Linux uses is selected by default as Ext4. Click 'OK' to create '/boot' partition.

Then create '/home' partition, use Ext4 journaling file system as shown in Figure 6.10.

Then you will need to create '/' partition, Using Ext4 journaling file system as shown in Figure 6.11.

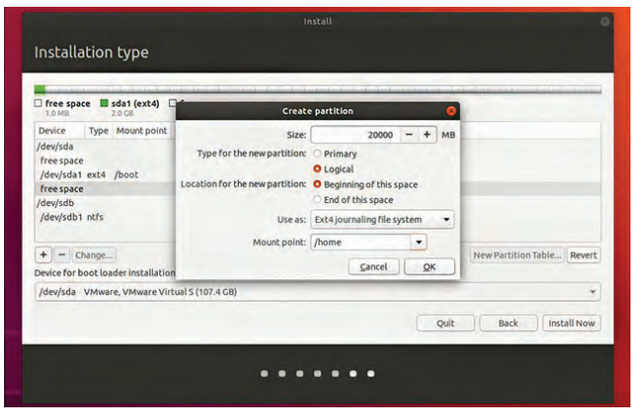


Fig. 6.10: Creating '/' home partition

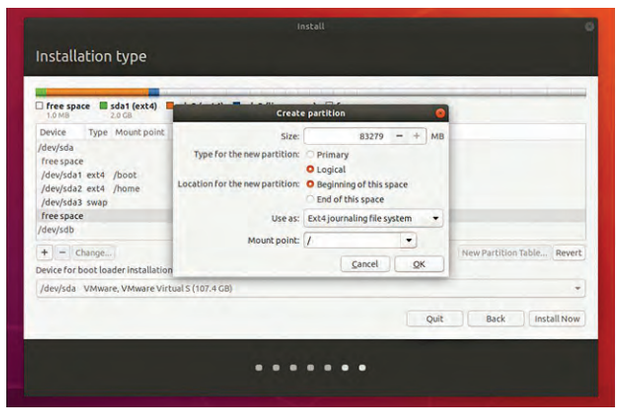


Fig. 6.11: Creating root (/) partition

Begin Installation

After creating the partitions as above, the new partition table along with the storage space allocated to each area will be seen as shown in Figure 6.12. To begin installation, click on the 'Install Now' button.

Clicking on 'Install Now' button, a small pane will appear with an overview of the storage options you have chosen as shown in Figure 6.13. You have the chance to go back by clicking on the 'Go Back' button if the details are incorrect.

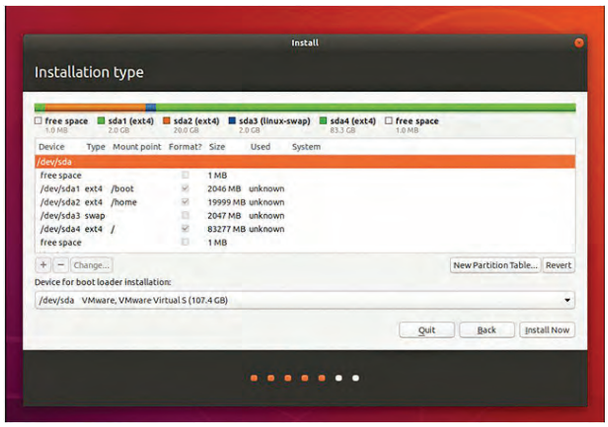


Fig. 6.12: Begin installation

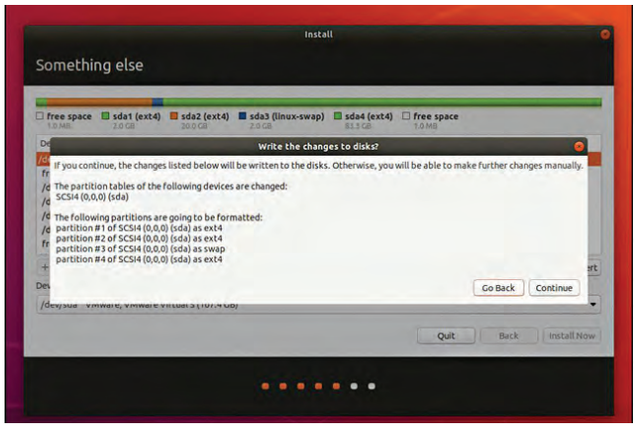


Fig. 6.13: Write changes to disk

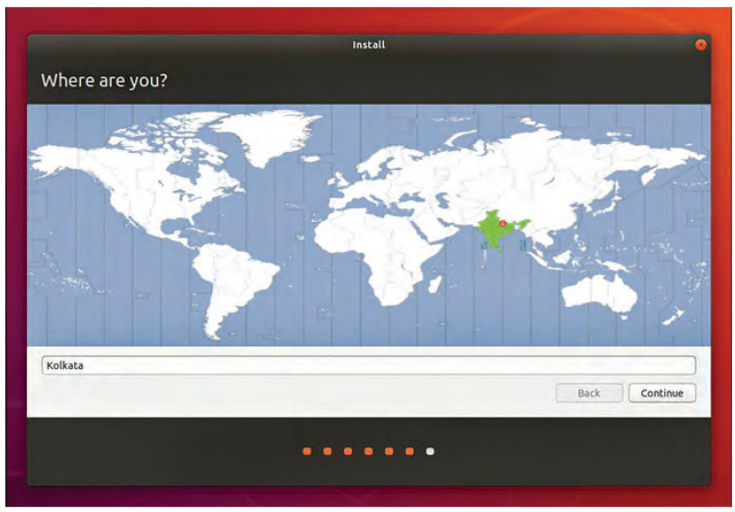


Fig. 6.14: Select your geographical location

Click 'Continue' to fix those changes in place and start the installation process.

Select your location

If you are connected to the internet, your location will be detected automatically. Check if your location is correct and click 'Forward' to proceed. If you are not sure of your time zone, type the name of a local town, city, or use the map to select your location.

Change login details

Enter your name and the installer will automatically suggest a computer name and username. These can

be changed if you prefer. The computer name is how your computer will appear on the network, while your username will be your login and account name.

Next, enter a strong password (Figure 6.15). The installer will let you know if it's too weak. You can also choose to enable automatic login and home folder encryption. If your machine is portable, it is recommended to keep automatic login disabled and enable encryption. This should stop people from accessing your personal files if the machine is lost or stolen.

If you enable home folder encryption and you forgot your password, you won't be able to retrieve any personal data stored in your home folder.

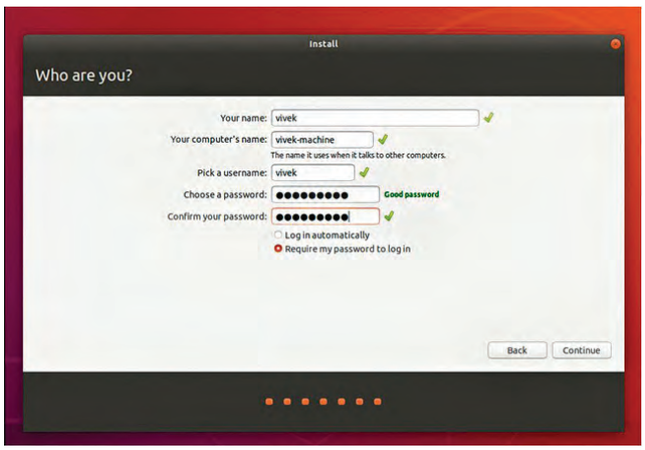


Fig. 6.15: Supplying user credentials

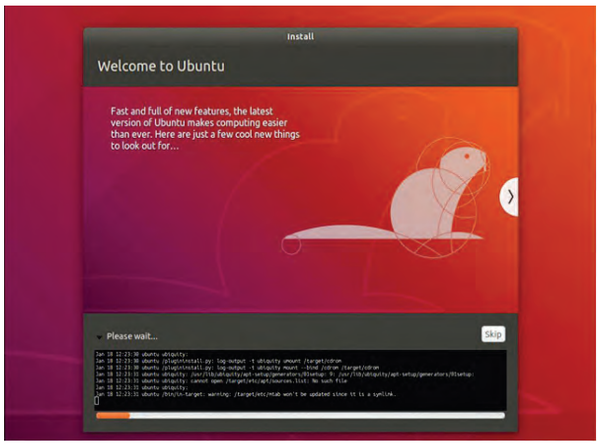


Fig. 6.16: Expanding background installation window

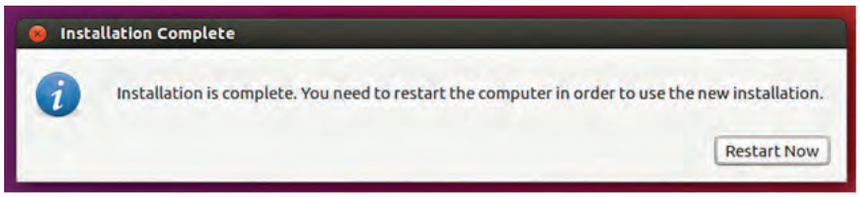


Fig. 6.17: Restart after installation complete

Background installation

The installation will now complete in the background while the installation window teaches you a little about how wonderful Ubuntu is. Depending on the speed of your machine and network connection, installation will take a few minutes.

Fig. 6.18: Login to Ubuntu

Fig. 6.19: Ubuntu home screen

Installation complete

After everything has been installed and configured, a small window will appear, asking you to restart your machine. Click on 'Restart Now' and remove either the DVD or USB flash drive when prompted. If you initiated the installation while testing the desktop, you also get the option to continue testing.

Thus, you have successfully installed Ubuntu Linux in your computer. Enter user credentials and use the Linux.

Check Your Progress

A. Multiple choice questions

1. System structure of Linux is _____.
   (a) Microsoft Windows
   (b) UNIX
   (c) Window Vista
   (d) Monolithic Kernel
2. Linux is an/a_____.
   (a) closed Source
   (b) freeware
   (c) open source software
   (d) Both (a) and (b)
3. Core of Linux operating system is _____.
   (a) kernel
   (b) shell
   (c) terminal
   (d) command
4. Which one provides command interpreter environment?
   (a) kernel
   (b) shell
   (c) CPU
   (d) hardware
5. Which directory contains configuration files in Linux?
   (a) /etc/
   (b) /bin/
   (c) /dev/
   (d) /root/

6. In Linux, a user can load or upload _____.
   (a) I/O modules
   (b) I/O devices
   (c) Kernel modules
   (d) File base I/O
7. File name that handles interrupts in Linux is _____.
   (a) access file
   (b) control file
   (c) interrupts file
   (d) proc interrupts file
8. In Kernel, signals are used to notify a certain _____.
   (a) decision
   (b) fault
   (c) strategy
   (d) procedure

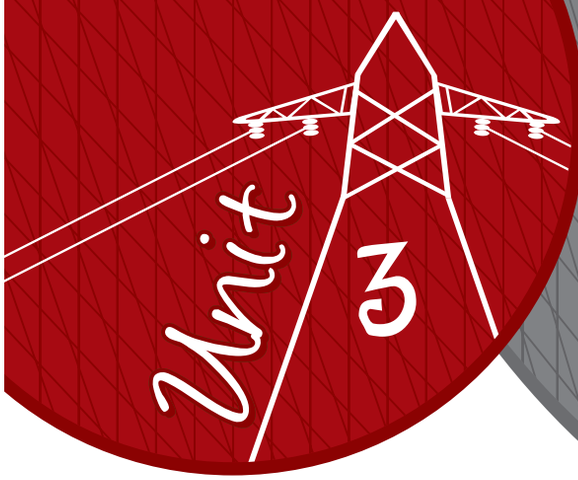
B. Fill in the blanks

1. Ubuntu is a/an _____ source operating system.
2. On the time of installation of Ubuntu, if you are connected to the internet, your location will be detected _____.
3. Linux is _____ sensitive.
4. Linux considers _____ as its standard input device.
5. The administrative privileges are available to only a user know as _____.

C. Short answer questions

1. What is Linux Kernel?
2. What is the advantage of open source?
3. What are the basic components of Linux?
4. What is GUI?
5. What is the root directory?

NOTES



Installation of Computer Hardware

Introduction

Computer hardware refers to the physical components of a computer. Computer consists of various internal components, such as, motherboard, CPU, memory, disk drives, and SMPS. For proper functioning of a computer system, each and every component must be installed and configured properly. For installation, one should have the relevant knowledge of that component as well as the installation process. The motherboard is the main circuit board inside a computer. The important system components like CPU, RAM modules are connected directly to the motherboard via slots or sockets. All the ports to interface with both inside and outside of the computer are fixed on the motherboard. Internal integrated ports are directly wired to the motherboard. External ports are grouped together and connected to the motherboard directly (integrated) or by circuit boards that are inserted into slots on the motherboard. CPU is the main component of a computer system. It is necessary to understand the working principle and architecture of the CPU. In this Unit, we will understand the basic working principle and installation of internal components of computer system. The installation process of these components is demonstrated.

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Chapter 7 Installation of Motherboard and BIOS

Introduction

The motherboard is the main circuit board inside a computer. The important system components like the central processing unit (CPU) and random access memory (RAM) modules are connected directly to the motherboard via slots or sockets designed specifically for those components. The motherboard will also provide a number of expansion slots designed to accommodate add-on cards such as video graphics adapter (VGA) cards and network interface cards (NICs). In this Chapter, we will understand the main features of the motherboard, types of motherboard, motherboard form factors, and various components of motherboard.

Introduction to Motherboard

The motherboard is also known as main board or system board. The motherboard connects the components of a computer and provides power to the systems that need low power. The motherboard contains a socket in which one or more processors are attached. In addition it has slots that allow connecting peripheral cards such as video cards, sound cards, and networking cards. The internal structure of a motherboard is shown in the Figure 7.1.

Types of Motherboard

Motherboards are classified as either integrated or non-integrated.

Integrated motherboard

This has several components integrated into the board itself. These may include the video card, sound card, and various controller cards. The maintenance is of a specific nature as the repairing of the whole board is a complex task.

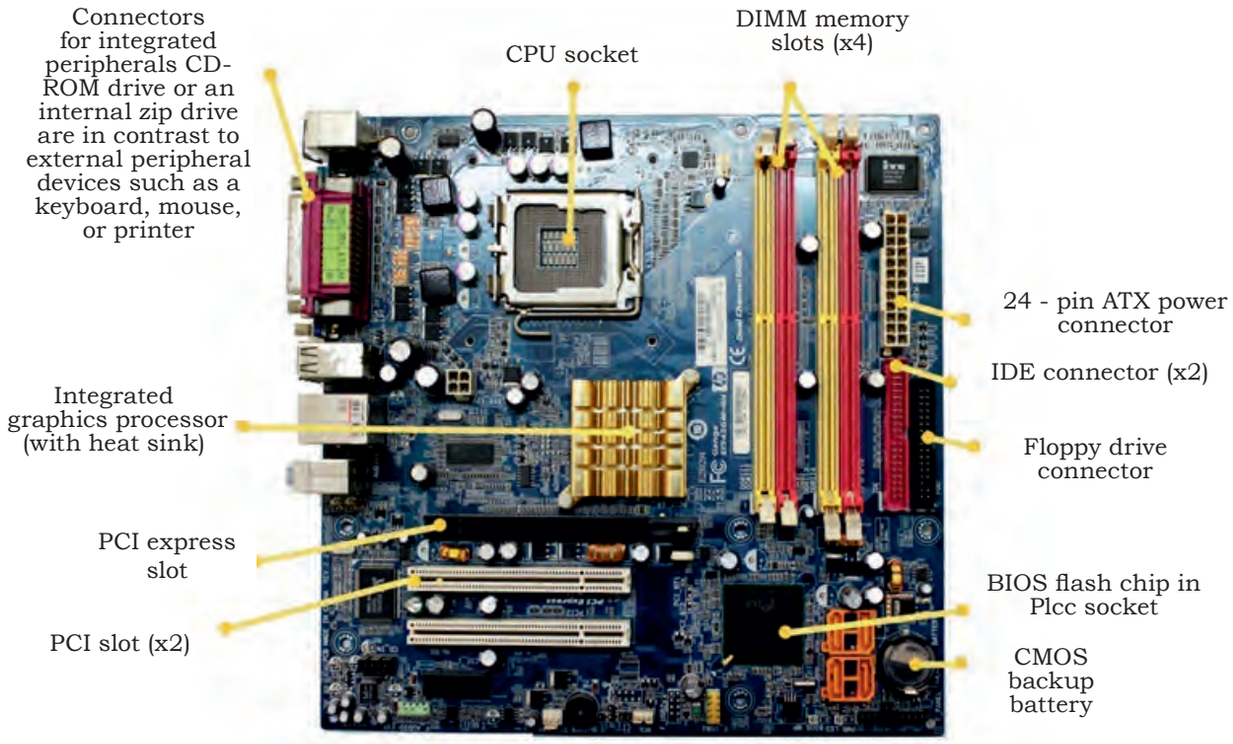


Fig. 7.1: Internal structure of motherboard

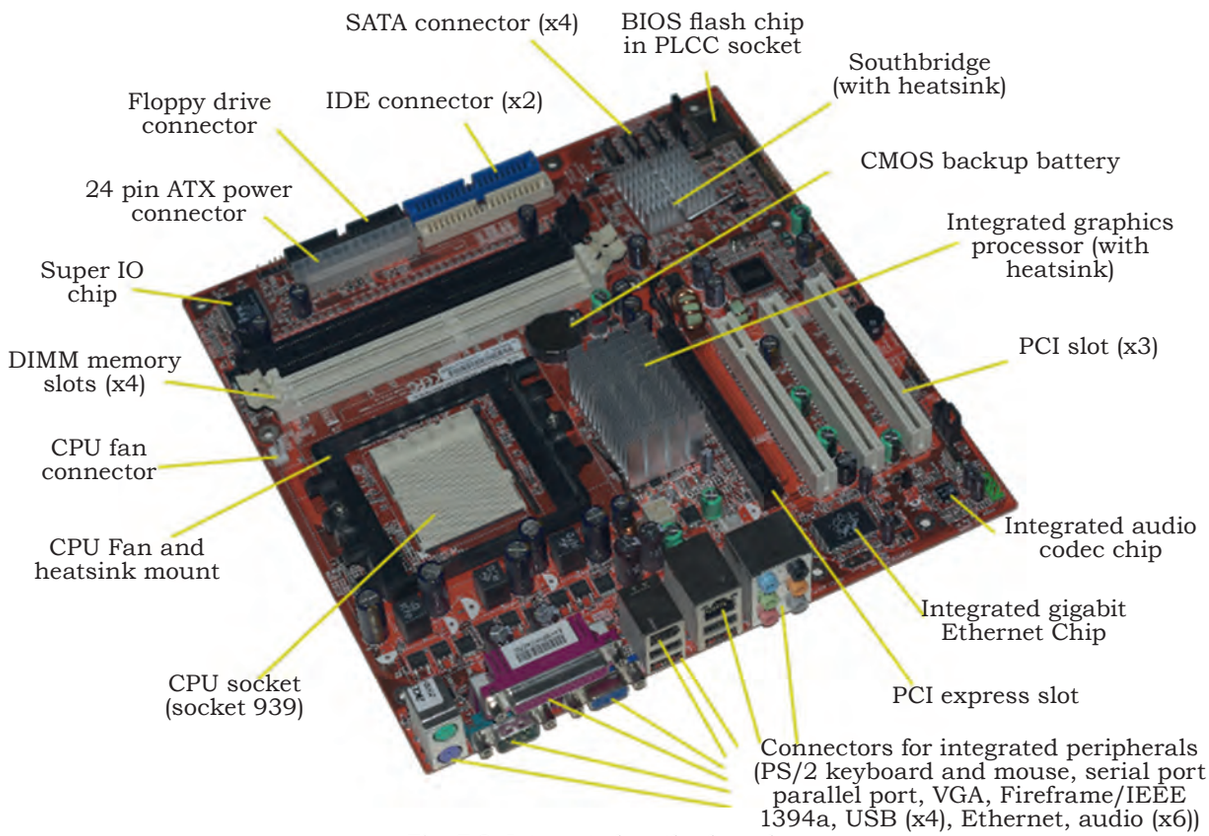


Fig. 7.2: Integrated motherboard

Non-integrated motherboard

This motherboard uses installable components and expansion cards. In non-integrated motherboard, if any component fails, it is possible to replace that component instead of changing the entire motherboard. For example, you can remove the old video card and install a new one. Non-integrated motherboards typically have several PCI Expansion slots as well.

Basic Components of Motherboard

The modern motherboard has the following components—

- sockets (or slots) to install one or more microprocessors.
- slots to install main memory RAM.
- a chipset which forms an interface between the CPU's frontside bus, main memory, and peripheral buses.
- non-volatile memory chips usually flash ROM in modern motherboards, containing the system's firmware or BIOS.

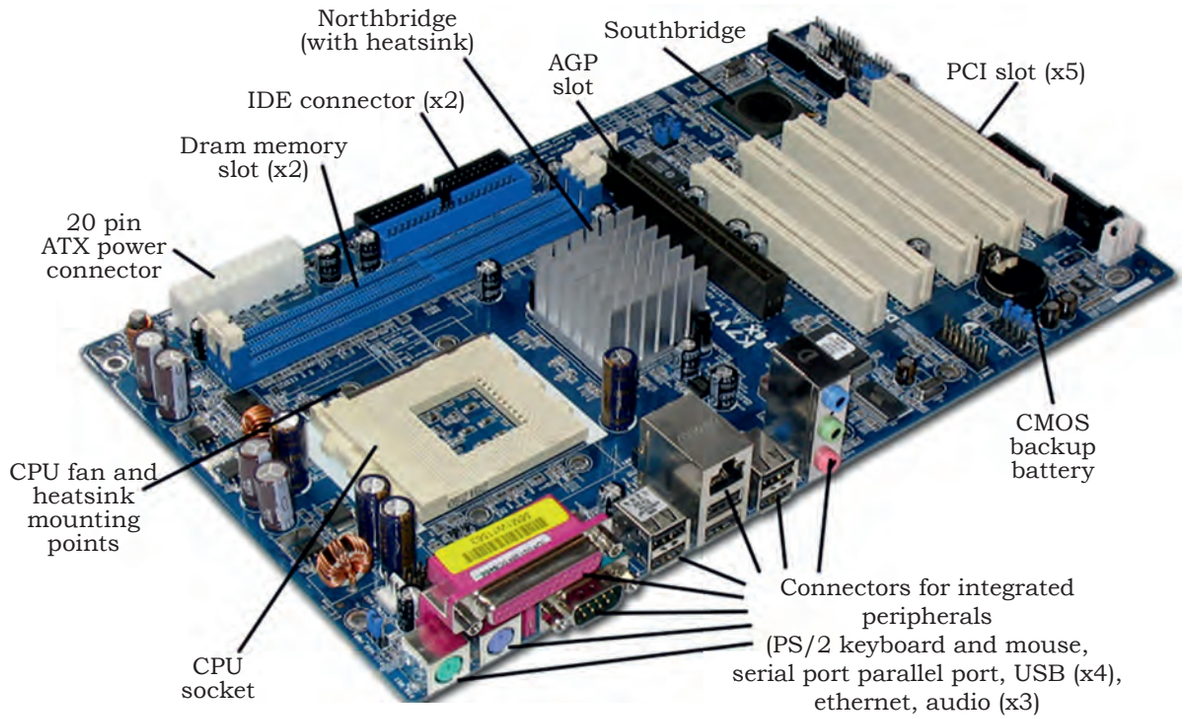


Fig. 7.3: Motherboard components

- a clock generator which produces the system clock signal to synchronise the various components.
- slots for expansion cards. These interface to the system via the buses supported by the chipset.
- power connectors, which receive electrical power from the computer power supply and distribute it to the CPU, chipset, main memory, and expansion cards.

Motherboard Form Factors

Motherboards are classified by form factors. The form factor of motherboard refers to its overall dimensions and layout. Form factors essentially define the layout of the actual motherboard including the dimensions, component positioning, mounting holes, number of expansion slots, and so on. There are several different types of form factors as explained below.

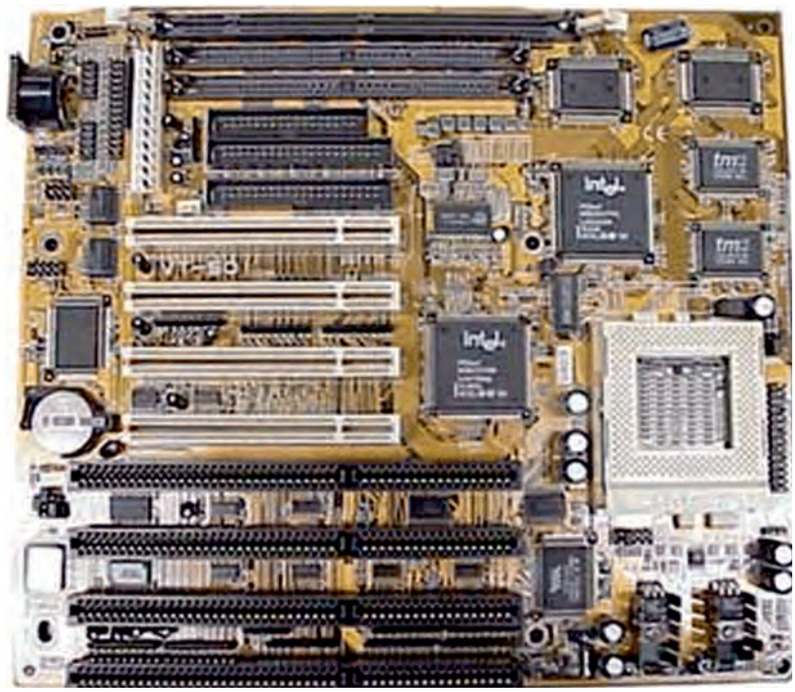


Fig. 7.4: AT original IBM form factor design

AT

AT (Advanced Technology) form factor first introduced by IBM in 1984, and used till 1997, in processors like P2 to P5 generation. Its size was 350 mm x 305 mm (13.8" x 12"). It works on the six pin plugs and sockets which are used to work as power connectors. The processor, memory, and expansion slots were all arranged in a straight line as shown in Figure 7.4.

Baby AT

The smaller version of the AT form factor is known as Baby AT, introduced in 1989 and still found in computers today. The Baby AT has dimensions of 330 mm x 216 mm (13" x 8.5"). It is also cheaper.

ATX Motherboard

The (ATX) Advanced Technology eXtended form factor, introduced by Intel in 1995, was designed to overcome issues with the Baby AT. In ATX, the processor and memory are arranged at a right angle to the expansion slots, allowing room for the use of full length expansion cards. In the newer computers, the combined height of the processor, heat sink, and cooling fan make it possible to insert full length cards in any other form factor, and most new computers, including servers, are built around the ATX form factor.

ATX motherboards also offer advanced power management features that make them ever more attractive to computer manufacturers. For example, ATX motherboards offer a soft shutdown option, allowing the operating system to completely power down the computer without the user having to press the power switch.

A full size ATX board is 12" wide and 9.6" deep. There is also a smaller version referred to as the Mini-ATX board that is 11.2" wide and 8.2" deep.

Fig. 7.5: MicroATX

MicroATX

This was introduced by Intel in 1997 and is a compatible variation to the ATX board outlined above. As the name would imply, the microATX is smaller than the standard ATX board because of the reduced number of I/O slots on the board. Due to the fact that it is smaller than the standard ATX board, the microATX form factor reduces the cost of computers and is used in lower cost systems.

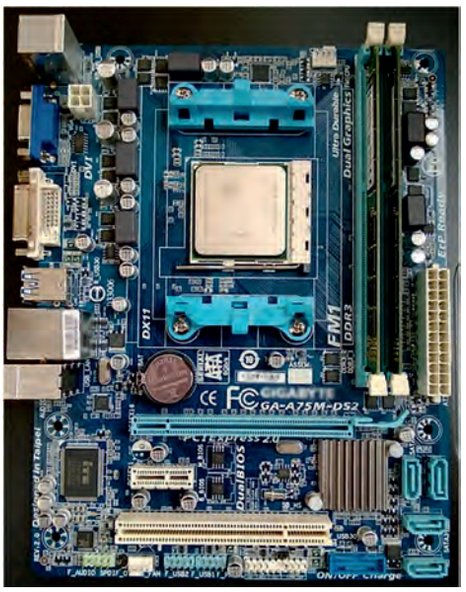


Fig. 7.6: FlexATX

FlexATX

A further variant of the ATX form factor called FlexATX was released by Intel in 1999, reducing the size of the motherboard to 229mm x 191mm (9" x 7.5") and limiting the number of expansion slots to two. This further reduces the overall cost of the system and

allows an even more compact system design, while maintaining backward compatibility with other ATX formats. The FlexATX uses the same mounting holes as its predecessors, avoiding the need to retool an existing chassis.

LPX

In an attempt to reduce the space requirements of computer systems, Western Digital introduced their proprietary Low Profile eXtension (LPX) form factor in the early 1990s. The LPX form factor is a non-standard proprietary one sometimes found in desktop computer models. This form factor is characterised by an expansion board that runs parallel to the motherboard. A riser card arrangement is used for expansion cards thereby allowing for smaller cases. The disadvantage is that this limits the number of expansion cards available.

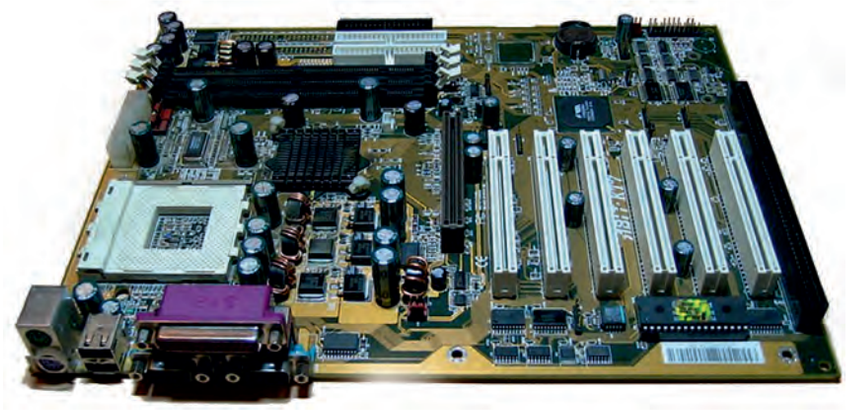


Fig. 7.7: LPX form factor

LPX motherboards are typically integrated and most have the video and sound components built-in. However, due in part to the fact that the form factor is non-standardised, the ATX form factor is more popular.

NLX

The number of expansion slots was limited in LPX, the system was difficult to upgrade or repair due to its proprietary format and the low availability of compatible parts and poor airflow inside the chassis could lead to cooling problems. The format was revised by Intel and standardised in the shape of the New Low-Profile eXtended (NLX) form factor in 1997. NLX motherboards are easily distinguished by the riser card to which the expansion cards connects. The riser cards allow two to four expansion cards to be plugged in. These expansion cards sit parallel to the motherboard.

Servers with this form factor offer power that is similar to the larger traditional servers but in the size of a VCR. The obvious benefit of the NLX form factor is that the bulk of a traditional server is reduced to a space saving smaller server. Additionally, servers assembled in a rack mount case can be secured to a rack which can itself be secured to the floor, providing better equipment safety.

BTX

The Balanced Technology eXtended (BTX) form factor was released by Intel in 2004 as the successor to the popular ATX format. It has a number of new features including changes to the layout of the board designed to improve component placement, enhancing airflow inside the case, and reducing the number of cooling fans needed.

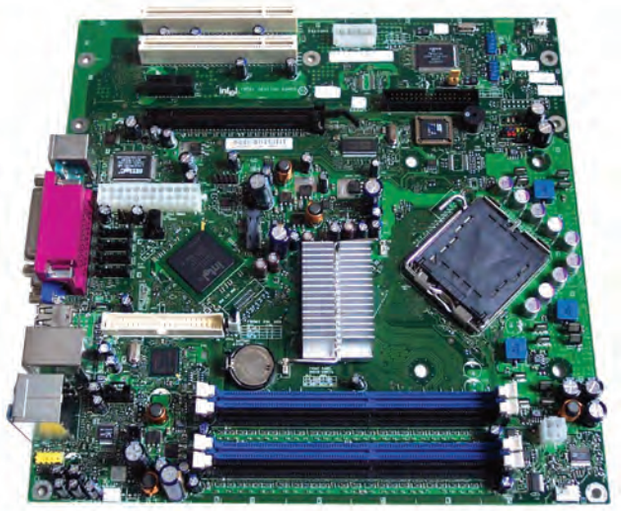


Fig. 7.8: BTX form factor

The BTX form factor allows for more integrated onboard components because it is larger than ATX. The airflow path is optimised by moving the memory slots and expansion slots. This allows the main system board components to use the same airflow thereby requiring fewer fans and reducing noise.

The three motherboards included in the BTX form factor are outlined below:

1. PicoBTX: This is the smallest BTX motherboard form factor. It uses four mounting holes and one expansion slot.
2. MicroBTX: This form factor is slightly smaller than the regular BTX but larger than the PicoBTX. It uses seven mounting holes and four expansion slots.
3. BTX: Also referred to as regular BTX, it is the largest BTX form factor. It uses up to ten mounting holes and supports a maximum of seven expansion slots.

Table 7.1: Form factors of motherboard

Form Factor	Description
ATX	This form factor is commonly used in tower and desktop systems. It supports a maximum of seven expansion slots.
MicroATX	This form factor is a smaller version of ATX. It supports a maximum of four expansion slots.
FlexATX	This form factor is the smallest version of ATX. It supports a maximum of three expansion slots.
NLX	This form factor can be found in smaller desktop and mini towers. The number of expansion slots supported, varies.
BTX	This form factor is commonly found in newer tower and desktop systems. It supports a maximum of seven expansion slots.
PicoBTX	This form factor is the smallest version of BTX. It is commonly used in smaller low-end systems and supports a maximum of one expansion slot.
MicroBTX	This form factor is slightly smaller than the regular BTX. It is commonly found in newer mid range systems and supports a maximum of four expansion slots.
NLX	This form factor can be found in smaller desktop and mini towers. The number of expansion slots supported varies.

Practical Activity

Installation of Motherboard

Step 1: Open the case

- First step in assembling the computer is to open the computer case. There are different methods for opening cases.

Fig. 1: Unscrew case

Fig. 2: Remove the side panel

- The computer comes with various types of cabinets. The methods of opening the case are different based on the manufacturer.
- To open the case, first remove the screws of the left side cover and slide the side cover.
- Pull the latch to release the side panel. Then lift the side cover out from the chassis.

Install Motherboard

After preparing the motherboard, you can install the computer case, as shown in Figure 7.9. Plastic and metal standoffs are used to mount the motherboard and to prevent it from touching the metal portions of the case. To install the motherboard, follow these steps:

- lay the motherboard over the standoffs to mount it on the holes.
- align the screw holes of the motherboard with the standoffs.
- then screw the board using a standard screwdriver.
- tighten all the motherboard screws.
- connect the 4pin ATX power connector from the power supply to the motherboard.

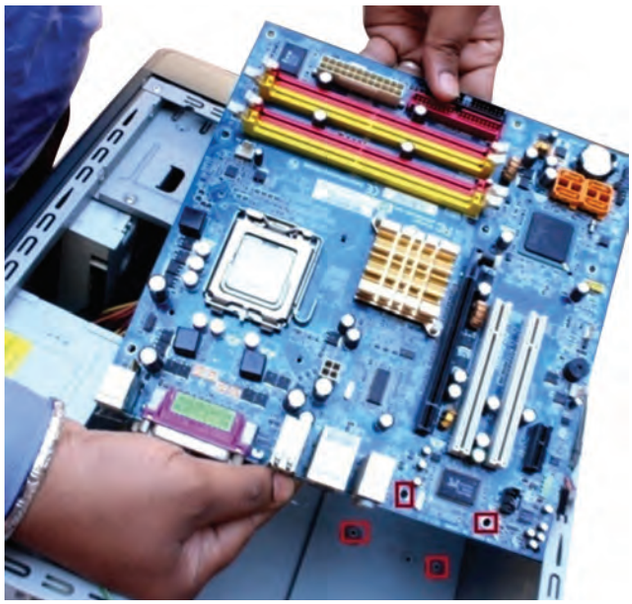


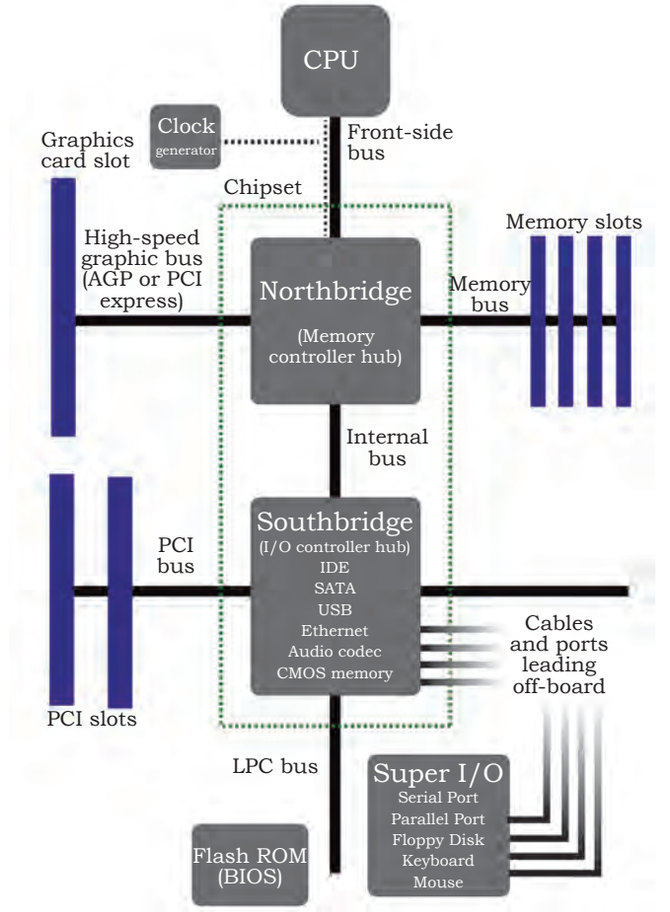
Fig. 7.9: Motherboard over the standoffs holes

Processor support

Every motherboard supports either an AMD or an Intel processor. They are not interchangeable. If a motherboard requires an AMD processor, it cannot use an Intel and vice-versa. You don't have to figure out which CPU matches a particular board, you are always told the type of CPU that a motherboard uses.

The chipset

It is a collection of microcontroller chips integrated into the motherboard. It provides a high speed communication interface between the main system components. The chipset is designed for a particular processor or range of processors to maximise performance. The latest chipset includes integrated graphics, sound cards, Ethernet, and wireless network adapters. A new chipset has to be developed for a new processor to accommodate its technology. The two main manufacturers are NVIDIA and Intel.



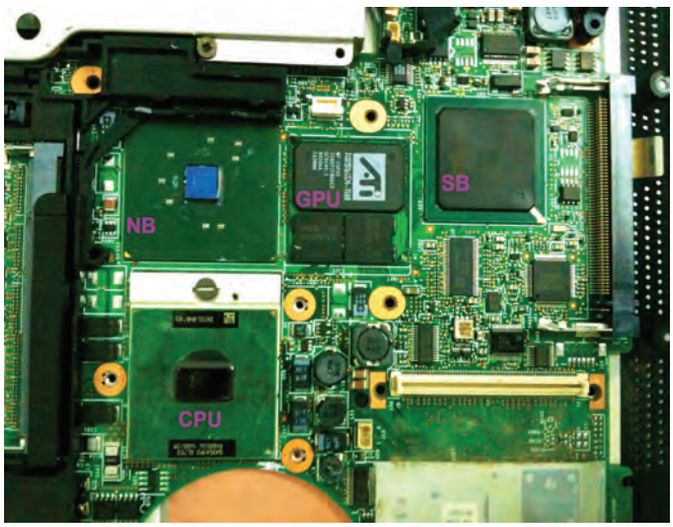


Fig. 7.10: Chipset north and southbridge

The two most important chips on the motherboard are known as the northbridge and the southbridge. These two chips have most of the important communications and control functions provided by the motherboard.

The northbridge also known as the memory controller hub is connected directly to the processor via the front-side bus to system memory via the memory bus, and to the southbridge via an internal bus.

It is also connected to a high speed graphics card slot via either an Accelerated Graphics Port (AGP) bus or a PCI Express (PCI-E) bus, depending on the type of slot provided. The communication handled via the northbridge that is between the CPU, memory, and video card requires the use of highspeed buses. The CPU gains fast access to memory via a memory controller built-in to the northbridge. The northbridge basically controls the processor, RAM slots, PCI Express and southbridge.

The southbridge also known as the I/O controller hub connects to the processor indirectly via the northbridge and controls slower devices such as the hard drive, USB, audio, video, LAN, PCI, I/O controller, and integrated device hardware, such as, sound card, video card, USB, PCI, Ethernet, IDE, ISA, Bios. If there is one chip, then everything is controlled by that chip. The PCI bus connects the southbridge to the northbridge.

Bus and bus speed

In computers, there has to be a communication between the CPU and other parts. On current Intel computers not using the Core i7 processor, the front-side bus is still used as the data path that connects the processor to the northbridge and other components. The motherboard mentiones the speed as 1333 Mhz it is the front side bus speed. It is the speed of data travel between the CPU and memory and is measured in megahertz (MHz). This speed is obtained by using a quartz crystal on the motherboard. When an electrical current passes through it, it vibrates. These vibrations or pulses occur millions of times per second. This is known as the clock speed. So if the bus speed is 1500 MHz (1.5 GHz), it means there are 1500 million rising and falling edges every second. Bus speed is one of the primary factors that has an impact on a computer's performance.

BIOS chip

Every motherboard has a BIOS (basic input output system). BIOS memory is a small memory on motherboards that is used to store BIOS settings. This chip contains a small amount of code that is responsible for booting the computer system. It reads the CMOS settings, performs the POST (power-on self-test), checks for devices, and then reads the master boot record on the hard drive so that the operating system can load. In modern motherboard, the BIOS chip is integrated as a part of the southbridge chipset.

CMOS battery

All personal computers require a small battery on the system board that provides power to the complementary metal oxide semiconductor (CMOS) chip even while the computer is turned off. This chip contains information about the system configuration for example hard disk type, floppy drive types, date and time, and the order in which the computer will look for bootable disks. The CMOS battery allows the

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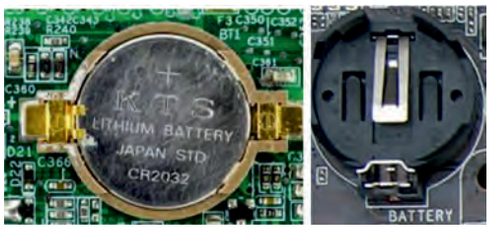

Fig. 7.11: Lithium battery and its socket

CMOS to preserve these settings. The battery is small, round, flat, and fits into a socket as shown in Figure 7.11.

Expansion slots

Modern motherboards come with on-board sound, wired networking, and video card. Expansion slots are specific slots on a PC motherboard that are used to plug the expansion cards. Plugging in a dedicated expansion card, instead of the motherboard's built-in hardware increases the functionality of computer. Expansion cards can also provide new functionality, such as allowing your computer to capture TV signals or access to a wireless network. They are located at the back of the computer, and allow more ports to be added to the computer for example, USB 2.0/USB 3.0.

PCI

PCI (Peripheral Component Interconnect) motherboard expansion slots is an older standard of 1993, which provides less bandwidth for expansion cards.

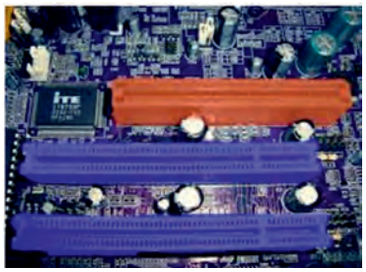

Fig. 7.12: AGP slots

AGP slots

The AGP (Accelerated Graphics Port) expansion slot standard was introduced when video cards needed more bandwidth for performance than was provided by PCI. These slots have been popular for many years now but they have slowly been phased out in favor of PCI express slots, which offer faster bandwidth and greater compatibility with other kinds of cards as well.

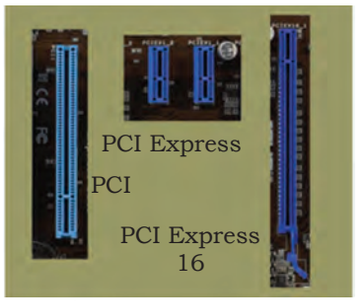

Fig. 7.13: PCI Express

PCI Express

Peripheral Component Interconnect (PCI) Express (or PCIe) is the newest standard for expansion cards on personal computers. PCI Express is replaced by the previous standards like PCI and AGP. PCIe provides more bandwidth for higher performance of video cards and network cards. PCI Express slots have different versions and a numbers of lanes.

ISA slots

ISA (Industry Standard Architecture) concept was introduced by IBM in 1984. These are obsolete now because of their large size and slow bandwidth slots.

Fig. 7.14: (PCI) bus slots

VESA slots

VESA (Video Electronics Standards Association) are also obsolete now because of their limited compatibility with a large number of expansion cards. The bandwidth speeds were much higher than the ISA slots.

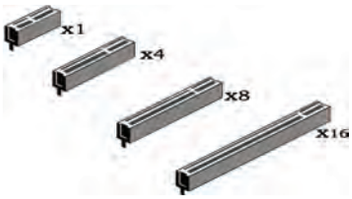

Fig. 7.15: Different types of (PCI) bus slots

PCMCIA slots

These slots are present in laptops because of their unique feature that they can be used even when the laptop is switched on and is running. Commonly, PC cards and express cards are used in such slots. It allows the laptop to get the flexibility and the features of a desktop.

Fig. 7.16: ISA (Industry Standard Architecture)

Expansion cards

The purpose of an expansion card is to provide or expand the features not offered by the in-built features of the motherboard. An expansion card is an electronic board or card added into the expansion slot of a desktop computer for better functionality. Types of expansion cards in a computer:

- Interface card (ATA, Bluetooth, EIDE, FireWire, IDE, Parallel, RAID, SCSI, Serial, and USB)
- Modem
- MPEG decoder
- Network card
- Sound card
- Video card

Fig. 7.17: PCMCIA slots

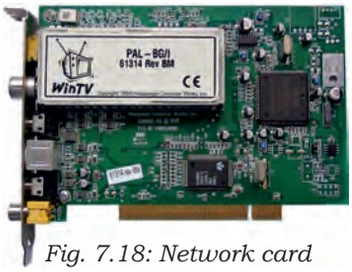

Fig. 7.18: Network card

Memory slots

These allow the insertion of memory (RAM) modules into the computer. There are usually two to four memory slots depending on the motherboard.

Fig. 7.19: Memory slots

Fig. 7.20: Jumpers in motherboard

Jumpers

Motherboards have a variety of different pins that can be connected with jumpers for different purposes. Jumper is a small connector made from conductive metal with plastic coating, which makes it easy to handle and also will not affect the live circuit when touched. There are certain common motherboard jumper settings. In modern motherboard, there are two jumper switches that are the flash BIOS jumper and the clear CMOS jumper. It is possible to change the setting of the flash BIOS jumper with new BIOS software. The clear CMOS jumper can be used to reset the BIOS. If you forget the BIOS password, you can clear it with jumper. The following figure shows the connections to clear the password. By default the jumper is connected to pins 2 and 3. To clear the password, connect the jumper to pins 1 and 2. The removed jumper is lying to the left of the pins.

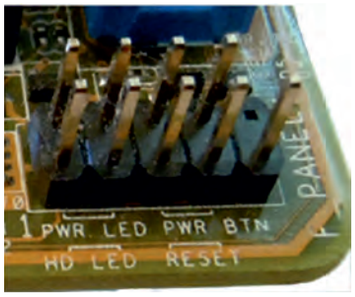

Fig. 7.21: Front panel connectors

Front panel connectors

A computer case has buttons on the front panel. Motherboards have a front panel connector as shown in Figure 7.21. Wires are plugged into these connectors while the other ends go to the connections on the front panel. Some of the common connections are briefly explained below.

Power light

This indicates when the system is turned on from the front panel power button. In the Figure 7.21, it is labelled as PWR LED for power light emitting diode (LED).

Power button

This turns the power on for the computer and is labelled as PWR BTN in the Figure 7.21. This is different from a power switch on the back of the computer. If there is a power switch on the back of the computer, it turns on the power supply but not the computer.

Drive lights

When the disk drive is actively reading or writing data, the LED will blink.

Reset button

Many systems include a reset button that will force the computer to restart. Whenever possible, it is better to logically shut down and restart a computer, but if the computer is not responsive to either the keyboard or mouse commands, you can force a restart by pressing the reset button.

USB

On the rear panel, motherboards commonly include USB connections that are connected directly to the motherboard. However, USB devices are very popular with users and users often want access to the USB ports on the front panel. Wires run from the USB ports on the front panel to connectors on the motherboard.

Audio

Many systems include one or more audio outputs on the front panel that are connected with the motherboard. A headphone or speaker jack is usually lime green coloured and has a headphone icon. Some systems also have a microphone jack usually pink in color, with a microphone icon.

Input Output Ports and System Resources

Desktop computers require a grounded (three prong) power outlet for proper operation.

Table 7.2 Older computer ports

Parallel Port 	The parallel port, also known as a DB-25 port, is primarily for printers and scanners and is often referred to as the 'printer port'. The parallel port is currently being phased out with most printers interface using an USB port.
Serial Port 	The serial port, also known as a DB-9 port is an older port, that was used in the 1980s for a variety of peripheral device. In the 1990s, it was used primarily to connect mouse, joysticks, and modems. The serial port has almost completely phased out. Some desktop computers have serial ports since they share motherboard components in common with the parallel port.
PS/2 Port 	The PS/2 port was developed by IBM to connect keyboards and mouse. Computers will usually have two of these ports, one purple (for the keyboard) and one green (for the mouse). PS/2 was the standard for about 15 years, but is now being replaced by the USB port.

Table 7.3

	**USB** The universal serial bus (USB) port is the most versatile interface used on modern computers. USB port scan be used to connect mouse, keyboards, printers, scanners, cameras, external hard drives, network switches, and more. There are three speed specifications for USB ports—USB 1.0, 2.0, and 3.0. USB ports come in six different forms—USBA, USBB, Mini-A, Mini-B, Micro-A, and Micro-B.
	**USB Type-C** USB Type-C is a new port designed to use a reversible connector. Its usage is not common yet and only a handful of devices have been built to use this port. One such device is the 2015 Apple MacBook.
	**Network/Ethernet (RJ-45)** The port used for networking on most modern computers is typically referred to as an Ethernet port but may also be called a RJ-45 jack, network port, or cats port. The variety of names comes from the fact that most modern computers connect to Ethernet networks using category-5 twisted pair cables, which plug into RJ-45 jacks.
	**Sound** Sound ports in computers can be used for headphones, speakers, or microphones. These ports are often colour coded and marked with icons that represent its use.
	**VGA** The videographics array (VGA) port is used exclusively for video and has been the main PC-video interface for over 15 years. This port is being replaced by Digital Video Interface (DVI) ports and DVI-VGA adapters are available.
	**DVI** The DVI port is used for video on newer monitors. There are multiple versions of DVI that have a slightly different form or pin layout.

HDMI

The HDMI is a higher end video port. Alienware and the MAC mini were some of the first computers to come standard with these ports. This port can also handle audio input.

Display Port

This is an alternative to the HOMI port and appears on select laptops and other devices. In addition to being able to carry video, it can also carry audio and USB data. It is backward compatible with VGA and DVI through the use of adapters. An adapter can be used to allow HDMI cables to be used as well.

Mini DisplayPort and Thunderbolt 2

The Mini DisplayPort and the Thunderbolt port have the exact same shape and size but it is important to keep in mind that a Mini DisplayPort will not work with a Thunderbolt connected device. These ports are used by Apple computers to accomplish a wide range of data transmissions including video signals, audio signals, and high speed data transfer. Apple has built a number of adapters that can be connected to this port, including Gigabit Ethernet, VGA, DVI, and USB.

Firewire (IEEE 1394)

Firewire, also known as IEEE 1394, was developed by Apple computers in 1995. Firewire is a trademarked term and other companies use the same technology under different names. It is used for many devices and was much faster than its contemporary, USB 1.0, but had similar speeds to USB 2.0. Firewire never reached the popularity level of USB, and has since been dropped by Apple on iPods (but not on their computers yet).

Modem (RJ-11)

The modem was the primary way to access (dial-up) networks in the 80s and 90s. With broadband (cable and DSL) networks replacing dial-up, many modern computers no longer come with modems.

Performance factor of motherboard

- The bus architecture and type of components integrated in the motherboard.
- Clocking ability, amount, and type of memory it can use, power supply, CPU type and speed, voltage limits.

Practical Exercise

A motherboard is described in the table below. Find out the cost.

Brand and Model Number	Features	Cost
Intel Motherboard: Z390 Aorus Pro Wifi	Form Factor: ATX Socket: LGA-1151 (8th and 9th-gen only) Chipset: Intel Z390 Memory support: 4 x DIMM sockets (up to 64GB) Multi-GPU support: Nvidia 2- and 4-way GPU SLI, AMD 2-, 3- and 4-way CrossFire Features: 2 x PCIe M.2 (Key M), reinforced PCIe	

Accessing BIOS/CMOS setting

Introduction to BIOS and CMOS

BIOS (basic input output system) and CMOS (complementary metal-oxide-semiconductor) both are essential parts of every computer's motherboard. Let us have a look at BIOS and CMOS for their different tasks.

Fig. 7.22: BIOS memory

BIOS

This is an important piece of software which is stored in a ROM (read-only memory) chip inside the computer motherboard. It is the first program that runs every time when we turn on our computer. It stores all instructions related to controlling the keyboard, serial/parallel ports, hard disk drive, and other various storage drives. The BIOS is also responsible for storing all the specifications

of the system in the battery backed RAM (which is also known as CMOS RAM) and provides a special setup program to change this information.

The BIOS performs the POST (power-on self-test), which initialises and tests the computer's hardware. After that, it searches the boot loader and executes it. After that, the operating system gets loaded on the computer memory. BIOS creates an environment for configuring our computer hardware. You can see a message like 'Press F2 for setup' as you start your computer. It enables to see the BIOS interface or change its setting accordingly.

CMOS

As you modify the setting in BIOS configuration, the changes you have made are not stored in the chip of the BIOS. Basically these changes are stored in another special chip memory known as CMOS.

Almost all chips like RAM and others (whichever store the BIOS setting) are manufactured in the same way as CMOS chips are manufactured. They can store data of a small size like 256 bytes. They store the information like disk drives installed, date and time of system, and booting sequence of our system. They may be present in a few motherboards. There is a separate chip for CMOS.

The BIOS chip memory is non-volatile. It is capable of storing data even if powered off from computer. This is due to a separate power source of CMOS known as CMOS battery.

CMOS Battery: This is a dedicated power source via a Lithium-ion whose size is equal to a coin. The life of a CMOS battery is approximately 10 years before it requires replacement. As soon as the battery gets expired, your CMOS setting will reset. If your CMOS battery dies, your computer BIOS settings will also reset to their default as soon as you shut down your PC.

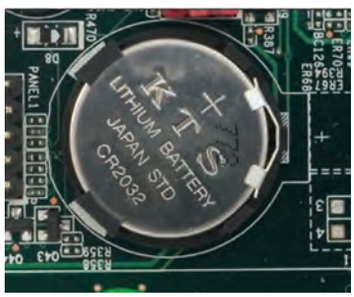

Fig. 7.23: CMOS battery

BIOS/CMOS setting

You can open BIOS Setup in many ways. Every motherboard make and model has a different way to open it.

1. Press [Enter any key] to enter setup. (See Figure 7.24)
2. Setup: [Delete]
3. Enter BIOS by pressing [F2 or Delete].
4. Press [F10] to enter BIOS setup.
5. Press [F10 and holding F10 key] to access BIOS.
6. Press [Window] to access system configuration.

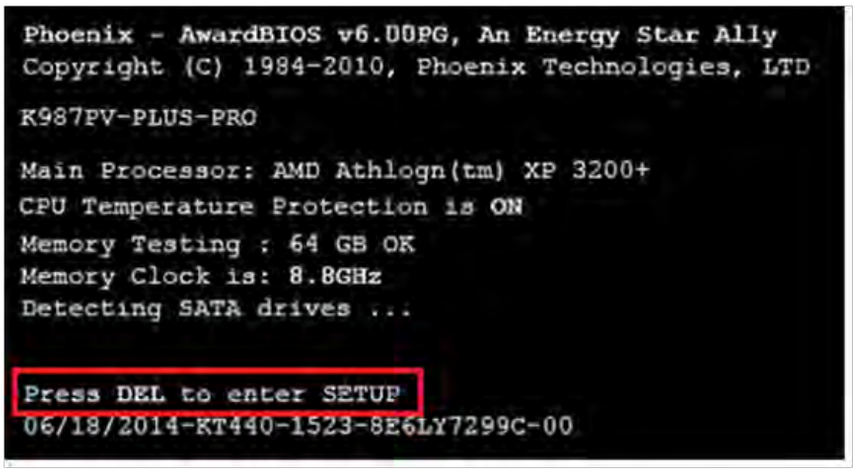

Fig. 7.24: Entering setup

Depending on the motherboard manufacturers, BIOS setup utility may have different types of options to set in different ways.

1. This BIOS screen will be different as per new settings and technology which get updated regularly (see Fig. 7.25). Exit save configuration

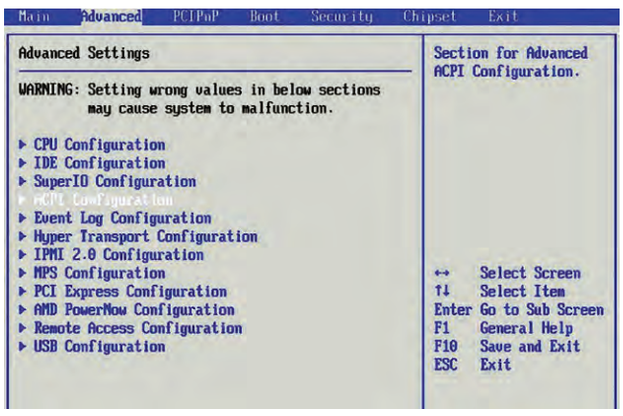

Fig. 7.25: BIOS setup utility for advance configuration

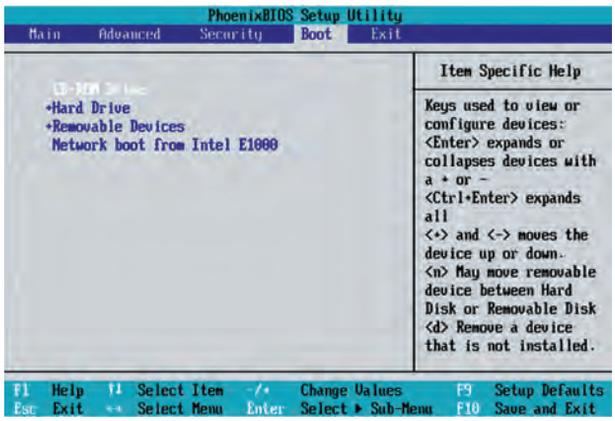

Fig. 7.26: BIOS setup utility for chipset configuration

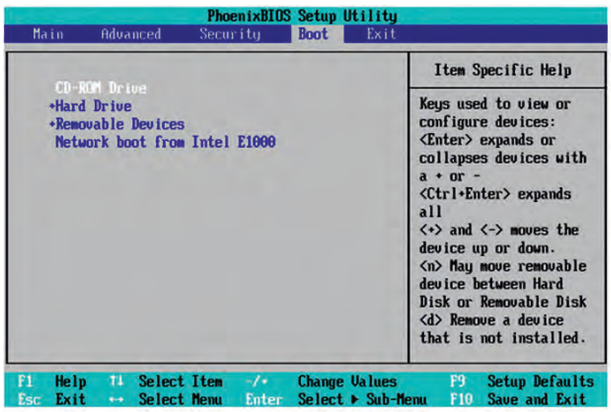

Fig. 7.27: BIOS setup for boot order setting

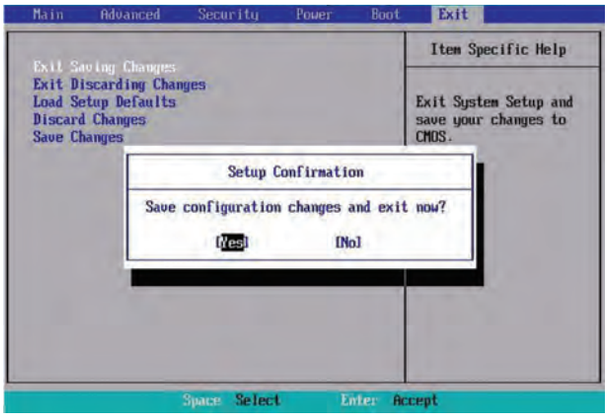

Fig. 7.28: Save configuration changes

changes and exit confirmation as shown in Figure 7.28.

2. To set the boot sequence of any bootable media on first priority like CD or DVD or HDD or USB over any drive, move it to the first position.
3. There could be different keys in different motherboards for changing the values of boot sequence. You can see these keys on the screen on the downside or right hand side.
4. After making necessary changes, save the setting by pressing F10 Key (or any other key as shown in your BIOS setup) and exit the BIOS setup utility.
5. Your computer will then restart with the new settings.

BIOS utility

BIOS hardware configuration has a lot of setting options. You can change these settings as per your need and requirement. After modification and saving, the computer will restart with the respected changes. These changes instruct the hardware to function as per the new settings.

There are a few common things which you can do in almost all BIOS systems:

- change the boot sequence/order (To install operating system).
- default BIOS setup loading.

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- set a new BIOS password or remove it.
- adjust the date and time.
- change HDD, FDD, CD/DVD settings.
- display or hide the computer logo.
- activate or deactivate the quick power-on self-test (POST).
- enable or disable the CPU internal cache.
- change CPU settings.
- change memory settings.
- enable or disable onboard USB, IEEE1394, audio.
- change power-on settings.

Practical Exercise

1. Start your computer and note down the key by which you can enter the setup.
2. Change the date and time of your computer using BIOS setup utility.
3. Change the boot order sequence to DVD and USB flash drive for Windows installation.

Check Your Progress

A. Multiple choice questions

1. _____ is one way to connect your computer with other computers.
   (a) Motherboard (b) NIC card
   (c) CD card (d) ROM card
2. The power supply provides power for _____.
   (a) only components in the computer
   (b) only the PC peripherals
   (c) both the components in the computer and many peripherals
   (d) many of the PC peripherals
3. The main circuit board in the computer is called_____.
   (a) RAM (b) the motherboard
   (c) the bus (d) the CPU
4. The part of the computer used for calculations is _____.
   (a) RAM (b) the CPU
   (c) the bus (d) the motherboard
5. The contents of _____ are erased when the computer is turned off.
   (a) the motherboard (b) the hard drive
   (c) floppy disks (d) RAM

NOTES

6. Instructions needed when starting the computer are stored in_____.
   (a) the motherboard (b) cache
   (c) ROM (d) RAM
7. Which of the following are in the ATX family of motherboards?
   (a) ATX (b) Mini-ATX
   (c) FlexATX (d) None of these
8. Incorrect settings in the CMOS setup may prevent you from doing what?
   (a) Loading OS
   (b) Running an application
   (c) Using a specific hardware component
   (d) None of these
9. Which chip contains the system BIOS and can hold data permanently, even without electricity?
   (a) Flash ROM (b) NVRAM
   (c) RAM (d) ROM

B. Fill in the blanks

1. _____ form factor is commonly used in tower and desktop systems.
2. _____ form factor can be found in smaller desktop and mini towers.
3. Processor technologies are classified into _____ categories.
4. A _____ is a collection of transistors.
5. CMOS is power driven by a _____ battery.
6. BIOS chip memory is _____.
7. In modern PCs, CMOS settings are stored in _____.

C. State whether the statements given below are True or False

1. Regular BTX is the biggest BTX motherboard form factor.
2. The Mini DisplayPort and the Thunderbolt port have the exact same shape and size.
3. The modem was the primary way to access (dial-up) networks.
4. The smaller version of the AT form factor is called the Baby AT.
5. The serial port are also known as a DB-19.
6. The parallel port are also known as a DB-25 port.
7. The PS/2 port was developed by Microsoft to connect keyboards and mouse.
8. The data stored in BIOS remains the same even if power is off.

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9. BIOS settings will reset to their defaults when the computer is restarted.
10. For loading operating system, BIOS is necessary.

D. Short answer questions

1. What is a computer motherboard?
2. What does a common modern motherboard contain?
3. Explain what are motherboard components.
4. Explain primary functions of the motherboard.
5. Which process is controlled by the motherboard?
6. List out the different types of motherboards.
7. Explain the difference between CMOS and BIOS.
8. What is booting?
9. List the various types of operating systems.
11. Define real time operating systems with an example?
12. What is the difference between BIOS and CMOS?
13. What is the sequence of things done by the BIOS when you turn on your computer?

Chapter 8 Installation of CPU and Heat Sink

Introduction

The processor is commonly known as central processing unit or CPU. It is an electronic circuit which executes computer programs containing a processing unit and a control. A central processing unit (CPU) processes the instructions by performing the basic arithmetical, logical, and input/output operations of the system. Although the form and design of CPUs is changing with generation but its main working principle remains the same.

CPU Basics

In 1971, the first microprocessor Intel 4004 was invented. It was a 4 bit calculation device with a speed of 108 kHz. A microprocessor is also known as a central processing unit in which a numbers of peripherals are fabricated on a single chip.

Architecture of Microprocessor

A microprocessor is a single integrated circuit (IC) chip. A number of useful functions are integrated and fabricated on a single silicon semiconductor chip.

The system bus consists of data bus, address bus, and control bus for transfer of data and instructions in a proper manner. The central processing unit consists of arithmetic logic unit (ALU), registers, and control unit. Based on the registers, the generations

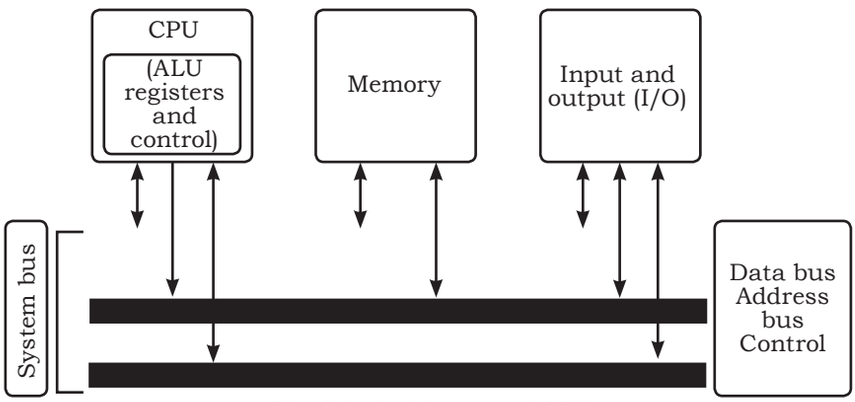

Fig. 8.1: Architecture of CPU

of microprocessors can be classified. A microprocessor consists of general purpose registers and special types of registers to execute instructions and to store the address or data while running the program. The ALU computes all arithmetic as well as logic operations on data and specifies the size of microprocessor like 16 bit or 32 bit.

The memory unit holds the program as well as data and is divided into processor, primary, and secondary memory. The input and output unit interfaces the I/O peripheral devices to microprocessor for accepting and sending information.

Generations of Microprocessors

1st generation: This was the period during 1971 to 1973 of microprocessor's history. In 1971, INTEL created the first microprocessor 4004 to run at a clock speed of 108 KHz.

2nd generation: During the period from 1973 to 1978 very efficient 8-bit microprocessors were implemented like Motorola 6800 and 6801, INTEL-8085, and Zilogs-Z80 which were of this generation.

3rd generation: During the period from 1979 to 1980, 16 bit processors were designed using HMOS technology. INTEL 8086/80186/80286 and Motorola 68000 and 68010 were developed. Speeds of these processors was four times better than the 2nd generation processors.

4th generation: From 1981 to 1995, 32 bit microprocessors were developed by using HCMOS fabrication. INTEL-80386 and Motorola's 68020/68030 were the processors of this generation.

5th generation: From 1995, high-performance and high-speed processors that make use of 64-bit processors were designed. Such processors include Pentium, Celeron, dual and quad core processors.

Some of the fifth generation of processors with their specifications, are briefly explained below:

Fig. 8.2: Intel Celeron processor

Intel Celeron

This was introduced in April 1998. It refers to a range of Intel's X86 CPUs for value personal computers. It is

based on Pentium 2 and can run on all IA-32 computer programs.

Pentium

This was introduced on March 2 in 1993 after Intel 486, the 4 here in 486 indicates the fourth generation. Pentium refers to Intel's single core x86 microprocessor which is based on the fifth generation micro-architecture. This processor's name was derived from the Greek word 'penta' meaning 'five'. The Pentium MMX with a data bus of 64 bits was developed in 1996. More improved versions of pentium processors were designed from the year 2000.

Fig. 8.3: Pentium processor

Xeon

This is a 400 MHz Pentium processor from Intel for use in workstations and enterprise servers. This processor is designed for multimedia applications, engineering graphics, internet, and large data base servers.

Fig. 8.4: Xeon processor

Functions of a CPU

A CPU or processor carries out certain instructions and manipulates data. The main function of a CPU is to execute a sequence of stored instructions called a program. It can execute only machine code and fetches the machine coded instructions from memory and executes them. CPU processes instructions in four steps—fetch, decode, execute, and write back.

Fetch: The CPU reads data and instruction from memory.

Decode: The data and instructions are decoded to determine what action is required.

Execute: The instructions are executed by performing arithmetic or logical operation on data.

Write: The result of an execution is written to memory or an I/O module.

Concept of program execution

The instructions to be executed by a computer are loaded in sequential locations in its main memory. To execute instructions, the CPU fetches one instruction at a time

and performs the functions specified. Instructions are fetched from successive memory locations until the execution of a branch or a jump instruction.

The CPU keeps track of the address of the memory location where the next instruction is located through the use of a dedicated CPU register, referred to as the program counter (PC). After fetching an instruction, the contents of the PC are updated to point at the next instruction in sequence.

For simplicity, let us assume that each instruction occupies one memory word. Therefore, execution of one instruction requires the following three steps to be performed by the CPU:

1. fetch the contents of the memory location pointed out by the PC (program counter). The instructions are stored in the instruction register (IR).
2. increment the contents of the PC by 1.
3. carry out the actions specified by the instruction stored in the IR.

The first two steps are the fetch phase and step three is the execution phase. Fetch cycle involves reading of the next instruction from the memory into the CPU and updating the contents of the program counter. In the execution phase, it interprets the opcode and performs the indicated operation. The instruction fetch and execution phase together are known as the instruction cycle. The instruction cycle is shown in the Figure 8.5.

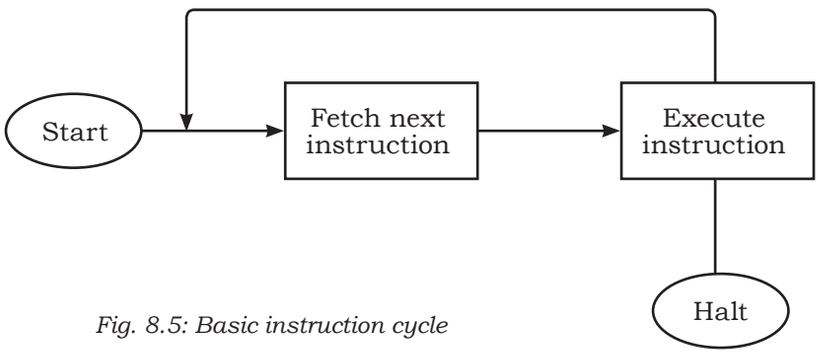

Fig. 8.5: Basic instruction cycle

In cases where an instruction occupies more than one word, step one and step two can be repeated as many times as necessary to fetch the complete instruction. In these cases, the execution of an instruction may involve one or more operands in memory, each of which requires a memory access. Further, if indirect addressing is used, then additional memory accesses are required.

Major components of the CPU

The three major components of the CPU are — arithmetic and logic unit (ALU), control unit (CU), and registers.

Arithmetic and logic unit (ALU)

This performs arithmetic and logical operations. For example, it can add together two binary numbers either from memory or from some of the CPU registers.

Control unit

This controls the action of the other computer components so that instructions are executed in the correct sequence.

Registers

These are temporary storage inside the CPU. It is internal memory of CPU which can read and write at a high speed. It is used to hold data and instructions temporarily while processing. It also holds the location of the last instruction. With this it can find the location of the next executable instruction.

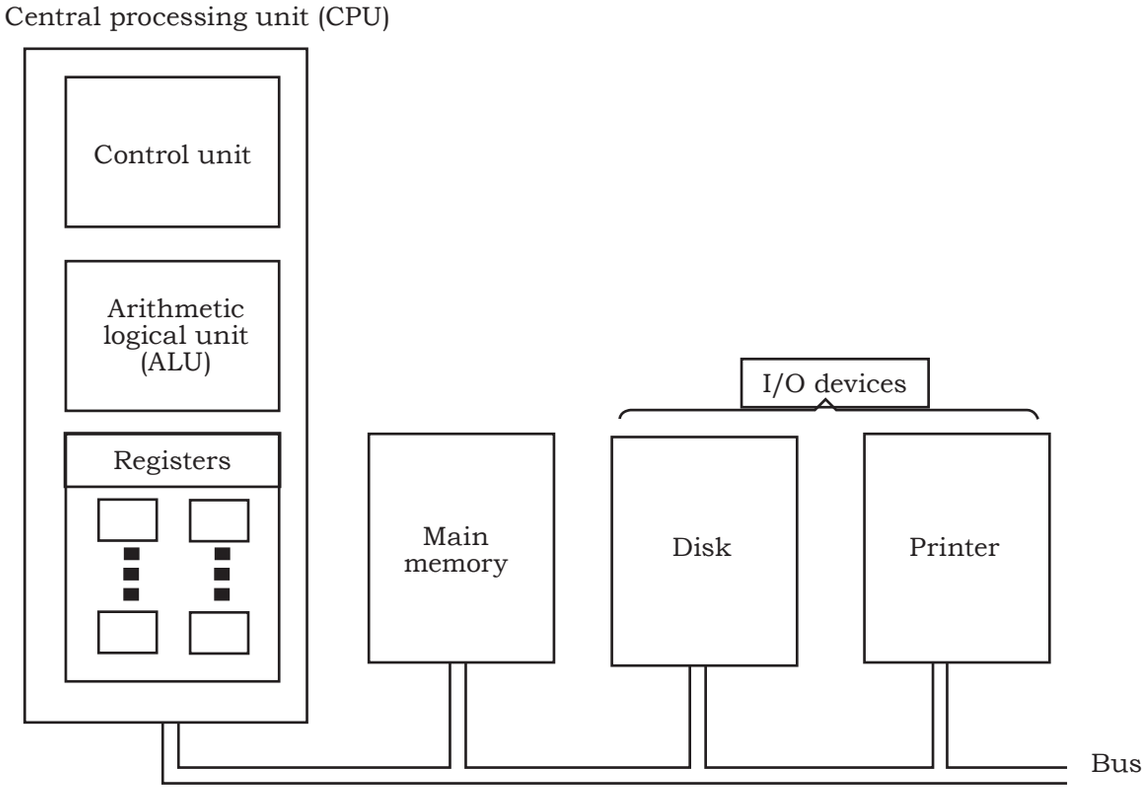

Fig. 8.6: Major components of the CPU

Register organisation

There are a variety of CPU registers to control the operation of the CPU. The four most commonly used registers, essential for instruction execution are listed below.

Program counter (PC)

It contains the address of an instruction to be fetched. The program counter is updated by the CPU after each instruction fetched so that it always points to the next instruction to be executed. A branch or skip instruction will also modify the contents of the PC.

Instruction register (IR)

It contains the instruction most recently fetched. The fetched instructions are loaded into an IR, where the opcode and operand specifiers are analysed.

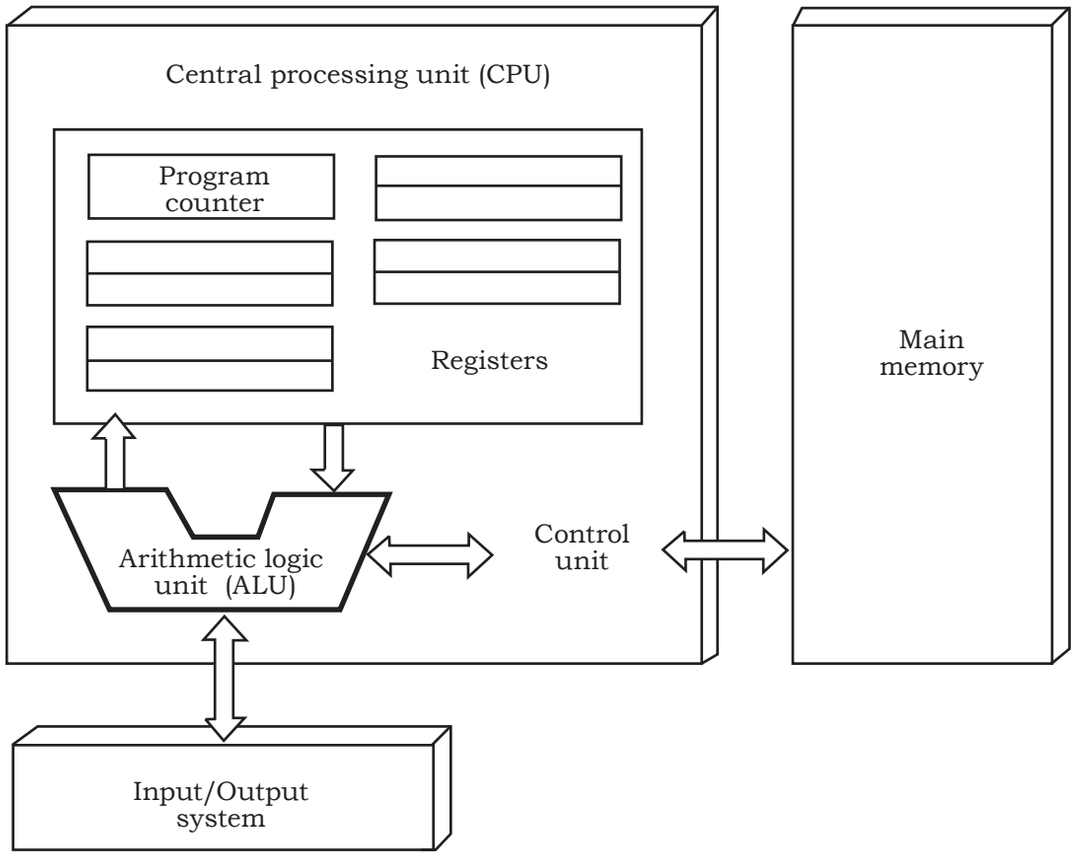

Fig. 8.7: Organisation of register

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Memory address register (MAR)

It contains the address of a location of main memory from where information has to be fetched or stored. Contents of MAR are directly connected to the address bus.

Memory buffer register (MBR)

It contains a word of data to be written to memory or the word most recently read. Contents of MBR are directly connected to the data bus. It is also known as memory data register (MDR).

Apart from these specific registers, we may have some temporary registers which are not visible to the user. As such, there may be temporary buffering registers at the boundary to the ALU; these registers serve as input and output registers for the ALU and exchange data with the MBR and user visible registers.

System bus

The CPU is connected to the rest of the system through system bus. Through system bus, data, or information gets transferred between the CPU and the other components of the system. The system bus may have three components:

Data bus

This is bidirectional, used to transfer the data between main memory and CPU. It determines the size of the data transferred between the processor and memory or I/O device. It refers to the size of the data bus in bits.

Address bus

This is unidirectional and used to access a particular memory location by putting the address of the memory location. It determines the size of the memory addressable by the processor

Control bus

This is used to provide different control signals generated by the CPU to the different parts of the system.

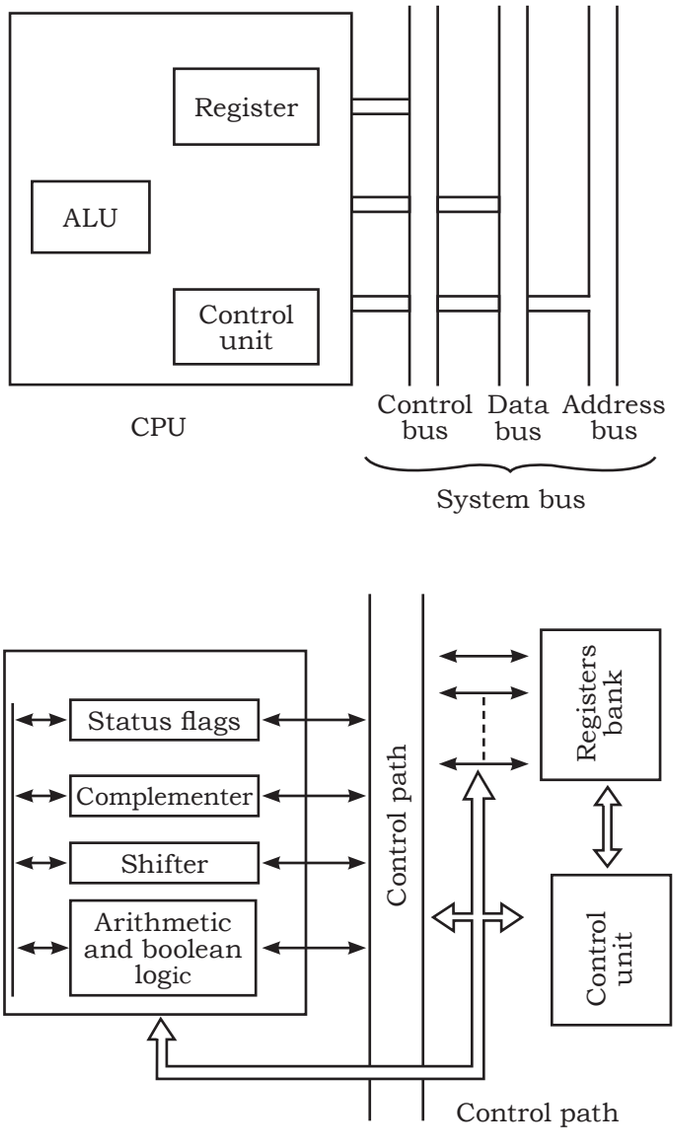

Fig. 8.8: Internal organisation of CPU

It indicates the type of action taking place on the system bus. For example, memory read is a signal generated by the CPU to indicate that a memory read operation has to be performed. Through the control bus, this signal is transferred to the memory module to indicate the required operation.

The following Figure 8.8 shows the internal organisation of the CPU.

CPU Features

There are many features that influence the performance of a processor:

Processor speed/clock rate

The clock speed of a processor is the number of instructions it can process in one second. It is the speed of the clock that drives the processor. The first processor 8088 was released at 4.77 MHz. Modern processors run at speeds of 2 GHz or greater. A CPU with a clock speed of 3.0 GHz can process three billion instructions per second. A faster CPU uses more energy and generates more heat.

CPU cores

A CPU can contain one or more processing units. Each unit is called a core. Modern PC processors are multicore. CPUs with multiple cores have more power to run multiple programs at the same time. Each core is fully functional, meaning each core contains an ALU, control unit, and registers. A dual core has two cores, quad core has four cores.

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For example, Intel Core i7 chips perform better than i5 chips which perform better than i3 chips. Intel Core i3 processors are dual core processors, while i5 and i7 chips are quad core processors.

Cache

This is a small memory of CPU closer to the CPU than RAM. It is used to temporarily hold instructions and data that the CPU is likely to reuse. The CPU control unit automatically checks cache for instructions before requesting data from RAM. This saves fetching the instructions and data repeatedly from RAM. RAM is a relatively slow memory than cache. Cache memory is fast and takes less time to transfer data and instructions to the CPU. More cache can hold more data to make the processing in the CPU faster. There are three types of cache memory—Level 1 (L1), Level 2 (L2), and Level 3 (L3).

Level 1 (L1) is the part of the CPU chip itself. It is the smallest and the fastest to access. Its size is often restricted to between 8 KB and 64 KB. Level 2 (L2) and Level 3 (L3) caches are bigger than L1. They are extra caches built between the CPU and the RAM. Sometimes L2 is built into the CPU with L1. L2 and L3 caches take slightly longer to access than L1. A computer with more L2 and L3 cache memory can run faster. Modern CPUs have 512 KB L1 cache built in and 1024 KB or 2048 Kb(2 Mb) of L2 cache memory.

Cache is more expensive than RAM. It is allocated less physical space than RAM which is usually larger and less expensive. Each CPU core has its own L1 cache, but may share L2 and L3 caches.

Bandwidth of data bus

The data bus connects the CPU to memory as well as all the storage, input/output, and communication devices. The processor uses data bus to transfer data between itself and the system memory (RAM and ROM) and the secondary devices. The size in bits determines how many characters are needed to transfer at a time. They are usually 8, 16, or 32-bits wide. An 8 bit data

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bus transfers one character at a time, a 16 bit data bus transfers two characters at a time, and a 32 bit data bus transfers four characters at a time. Thus, performance of a CPU also depends on the size of the data bus.

Memory

This is the area where the computer stores data and instructions. It provides the CPU with instructions. There are different types of memory and each one plays an important role in the running of a computer system. It is sometimes called primary memory or main memory or RAM. More amount of RAM can run the computer faster and also can handle the large programs. It is the main place for storing instructions and data when a program is being executed. Program data is copied into RAM before the CPU can run the program.

Word size

The word size of the machine is how many bits the CPU can manipulate in one go. Each unique memory location in RAM holds one word of information. Every memory location has an unique address. RAM also has a word size measured in bits to indicate the size of the memory location.

Types of CPU

CPU can be categorised on the basis of its processing power as 32 bit or 64 bit and can also be classified on the basis of brands (Intel and AMD).

32 bit and 64 bit CPU

CPUs are identified as either 32 bit or 64 bit. The amount of data that a CPU can manipulate with one machine code instruction or transfer over a bus is measured in bits. The CPU specification is 32 bit, 64 bit, or 128 bit. A CPU with a 64 bit word size can process 64 bits using one single machine code instruction. This is twice as many bits as a 32 bit

CPU. Increase in the word size means more data can be manipulated at a greater speed. It also means that the CPU can keep track of a larger range of memory locations.

A 32 bit CPU supports a 32 bit address bus and can address 232 memory locations or 4 GB of RAM. A 64 bit CPU supports a 64 bit address bus and can address 264 memory locations.

Operating systems and applications that are 64 bit specific cannot run on a 32 bit processor. The 64 bit operating systems can run only on 64 bit CPUs. If you want to directly address more than 4 GB of RAM, you need both a 64 bit CPU and a 64 bit operating system.

Intel and AMD Processors

There are two primary manufacturers of computers: Intel and Advanced Micro Devices (AMD).

Intel

It is the largest seller of CPUs, selling about 80 percent to 85 percent of all CPUs. It manufactures other products as well, including chipsets, motherboards, memory, and SSDs.

AMD

It is the only significant competition to Intel for CPUs and it sells about 10 percent to 15 percent of all CPUs. It also manufactures other products including graphics processors, chipsets, and motherboards.

Processor technologies

These might be used by AMD only, by Intel only, or by both vendors. These technologies are used to help distinguish different processors from each other in terms of performance or features.

When we talk about processor technologies, we can classify them into:

Overclocking: For most motherboards and processors, you can override the default frequencies by changing

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a setting in BIOS setup. Running a motherboard or processor at a higher speed than the manufacturer suggests, is called overclocking. This is not recommended because the speed is not guaranteed to be stable. Also, know that running a processor at a higher than recommended speed can result in overheating, which can damage the processor. Dealing with overheating is a major concern when overclocking a system.

VRM: A CPU is a collection of transistors. These transistors work at a specific voltage level. If excessive voltage is supplied to the transistor, it will burn off. Hence, the motherboard manufacturers have to take special care of the CPU voltages.

Throttling: Most motherboards and processors offer some protection against overheating so that if the system overheats, it will throttle down or shut down to prevent the processor from being affected.

Hyper-threading (HT Technology): It is a technology developed by Intel for processing two execution threads within a single processor. Essentially when HT Technology is enabled in the system, BIOS and the processor is running a multi-threaded application and the processor is emulating two physical processors.

Processor difference

Although Intel and AMD processors share two common architectures— x86 (used for 32 bit processors and for 64 bit processors, running in 32 bit mode) and x64 (an extension of x86 that enables larger files, larger memory sizes, and more complex programs), these processor's family differ in many ways from each other, including:

1. different processor sockets
2. different types of microcode
3. differences in dual-core and multi-core designs
4. cache sizes
5. performance versus clock speed

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The various activities that a microprocessor performs, such as storing data, doing arithmetic calculations (addition, subtraction, multiplication, division, etc.), are the result of instructions given to the CPU in the form of sequences of 0s and 1s. Microprocessors are designed to carry out a large number of instructions and all the instructions may be represented by different sequences of 0s and 1s. Each instruction is represented by a unique set of 0s and 1s.

The internal structure of a typical CPU consists of circuits which form a number of registers (the typical number is 16), an arithmetic unit for carrying out arithmetic operations, a logic unit, and a control unit.

Practical Activity

Installation of CPU

The CPU and motherboard are sensitive to electrostatic discharge. So place them on a grounded anti-static mat and wear an anti-static wrist strap while handling the CPU. When handling a CPU, do not touch the CPU contacts at any time. The CPU is secured to the socket on the motherboard with a locking assembly.

Thermal compound which is used to conduct heat away from the CPU is applied on top of the CPU. In case of an old CPU, first clean the top of the CPU and then apply the thermal compound. Clean the top of the CPU and the base of the heat sink with isopropyl alcohol and a lint free cloth. This removes the old thermal compound. Then apply a new layer of thermal compound.

Fig. 1: Installing CPU on the motherboard

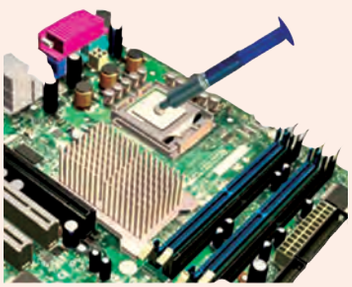

Fig. 2: Applying thermal compound on CPU

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CPU heat sink

This is an important component in the modern computer. It is an attachment for a chip that prevents the chip from overheating. The components that generate the most heat in your computer are the CPU (central processing unit) and the power supply. These components need to be kept within a specified temperature range to prevent overheating, instability, malfunction, and damage leading to a shortened component lifespan. They always have some cooling usually in the form of a fan.

A heat sink is a device that incorporates either a fan or some other means, to keep a hot component such as a processor, cool. It is made from metal, which serves as the thermal conductor that carries heat away from the CPU. It uses either copper, aluminum, or a combination of the two in order to move heat from the base of the cooler through heat pipes to the heat sink. A fan then blows air through the heat sink to move the heat into the air, and then out of the system, effectively keeping the CPU within safe operating temperatures.

A liquid cooling system essentially applies the same idea but replaces the copper heat pipes with tubes filled with a thermally conductive liquid that is pumped to a radiator. Copper is a very good thermal conductor with a thermal conductivity of 400 W/mK. Aluminum has a thermal conductivity of 235 watts per Kelvin per meter (W/mK), but is lighter than copper. A heat sink is attached to the motherboard, its weight puts stress on

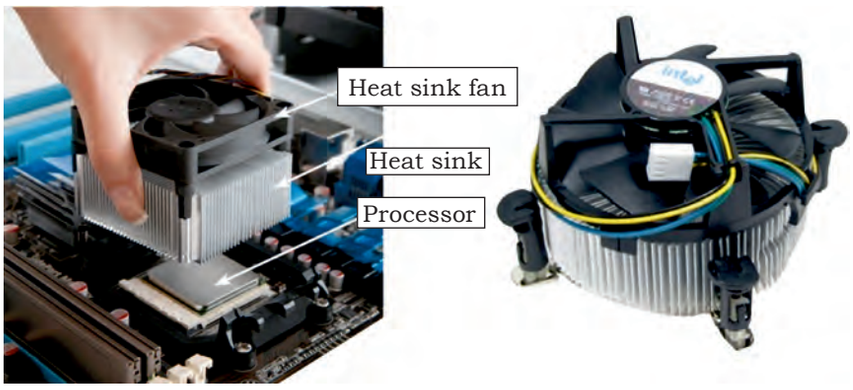

Fig. 8.9: Heat sink with cable and connector

the motherboard. The light weight of an aluminum heat sink puts a little weight and stress on the motherboard.

A heat sink is designed to increase the surface area in contact with the cooling fluid surrounding it, such as the air, thus allowing it to remove more heat per unit time. Other factors which improve the thermal performance of a heat sink are the approach air velocity, choice of material, usually an aluminum alloy due to its high thermal conductivity values (229 W/m°K), fin (or other protrusion) design, and surface treatment.

The heat conducted from the processor goes out through the heat sink. A fan inside the computer moves air across the heat sink and out the computer. Most computers also have an additional fan installed directly above the heat sink to help properly cool the processor. Heat sinks with these additional fans are called active heatsinks, while those with the single fan are called passive heat sinks. The most common fan is the case fan, which draws cool air from outside the computer and blows it through the computer, expelling the hot air out of the rear.

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Practical Activity

Installation of heat sink

Heat sink and fan assembly

Heat sink is a cooling device. The heat sink draws heat away from the CPU. The fan moves the heat away from the heat sink. The assembly has a 3-pin power connector. Figure 1 shows the cable and the motherboard connector for the heat sink.

Fig. 1: Screwing the heat sink

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To install a CPU fan and heat sink, follow these steps:

- align the heat sink and fan assembly with the holes on the motherboard.
- screw in the heat sink.

Check Your Progress

A. Multiple choice questions

1. Which was the first microprocessor?
   (a) Intel 4004 (b) Intel 8088
   (c) Intel 8086 (d) Intel
2. Which of the following is not a system bus?
   (a) Address bus (b) Data bus
   (c) Control bus (d) Memory bus
3. Which of the following is not a part of a CPU?
   (a) Arithmetic logic unit (b) Memory
   (c) Control unit (d) Registers
4. Which of the following register points to the next instruction to be executed?
   (a) Program counter (b) Instruction register
   (c) Memory address register (d) Memory buffer register
5. The clock speed of recent processor is measured in _____.
   (a) MHz (b) KHz
   (c) GHz (d) Hz
6. The memory data bus width in Pentium processor is _____.
   (a) 16 bit (b) 32 bit
   (c) 64 bit (d) 8 bit
7. Copper and aluminum is used to prepare heat sink because of _____.
   (a) low thermal conductivity and heavyweight
   (b) high thermal conductivity and lightweight
   (c) low thermal conductivity and lightweight
   (d) high thermal conductivity and heavyweight

B. Fill in the blanks

1. A 32-bit CPU can address _____ memory locations.
2. A 64-bit CPU can address _____ memory locations.
3. Hyper threading technology supports processing _____ execution threads within a single processor.
4. Contents of MAR is directly connected to the _____ bus.
5. Contents of MBR is directly connected to the _____ bus.

6. Copper has a thermal conductivity of _____.
7. A heat sink is attached on the _____.
8. Heat sinks with additional fans are called _____.
9. Heat sinks with a single fan are called _____.

C. Short question answers

1. What are the major components of a CPU?
2. What is the overall function of a processor's control unit?
3. What are the basic tasks performed by a CPU?
4. Why registers are used in a CPU?
5. Name the four registers in a CPU.
6. Explain the use of the four registers—program counter, instruction register, memory address register, and memory buffer register.
7. Give and explain the instruction cycle state diagram.
8. Explain the system bus briefly.
9. What is a heat sink?
10. Why are copper and aluminum used to prepare a heat sink?
11. What is the thermal conductivity of aluminum?

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Chapter 9 Installation of RAM Modules

Introduction

The basic purpose of memory is to remember the information for a period of time. Humans have their memory in their brains, which is a part of the human body. Computers also have memory as a part of the computer system. Computer memory is the storage space in the computer, to store data and instructions. The memory is divided into a large number of small parts called cells. Computer has internal as well as external storage. The internal storage is known as primary or main memory while external storage is known as secondary storage. There are different types of memory and each one plays an important role in the running the computer system. In this Chapter, we will mainly understand the primary memory, RAM and its types. Installation of RAM modules in the computer is also demonstrated in this Chapter.

Importance of memory in computers

Memory is one of the most essential components of a computer. The CPU is constantly using memory right from the startup to shut down of the computer.

When you turn on the computer, the computer loads data from read-only memory (ROM) and performs a power-on self-test (POST) to make sure that all the major components are functioning properly. Memory controller checks all the memory addresses with a quick read/write operation to ensure that there are no errors in the memory chips. Read/write means that data is written to a bit and then read from that bit.

The computer loads the Basic Input/Output System (BIOS) from ROM. The BIOS provides the most basic information about storage devices, boot sequence, security, plug and play capability, and a few other items.

The computer loads the operating system (OS) from the hard drive into the system's RAM. Generally, the critical parts of the operating system are maintained in the RAM as long as the computer is on. This allows the CPU immediate access to the operating system,

which enhances the performance and functionality of the overall system.

When you open an application, it is loaded into RAM. After loading an application, any files that are open for use in that application, are loaded into RAM. When you save a file and close the application, the file is written to the specified storage device and then the file and applications are removed from the RAM.

In the above process, RAM is used as a temporary storage so that the CPU can access that information more easily. The CPU requests the data from RAM, processes it, and sends the output back to RAM in a continuous cycle. In computers, this shuffling of data between the CPU and RAM happens millions of times per second. The outputs are saved permanently on the storage device. If the output is not saved to a permanent storage device, the data is lost.

Classification of memory

Computer memory is classified as either internal or external memory:

Internal memory

It is also called as main or primary memory. It refers to memory that stores small amount of data, that can be accessed quickly while the computer is running.

External memory

It is also called secondary memory. It refers to a storage device that can retain or store data persistently. There are internal or removable storage devices. Examples include hard disk or solid state drives, USB flash drives, and compact discs (CD).

There are basically two kinds of internal memory—ROM and RAM.

ROM

It is read-only memory. It is non-volatile, which means it can retain data even without power. It is used mainly to start or boot up a computer. The data in ROM can only be read by CPU but it cannot be modified. The CPU cannot directly access the ROM memory, the data has to

be first transferred to the RAM and then the CPU can access that data from the RAM.

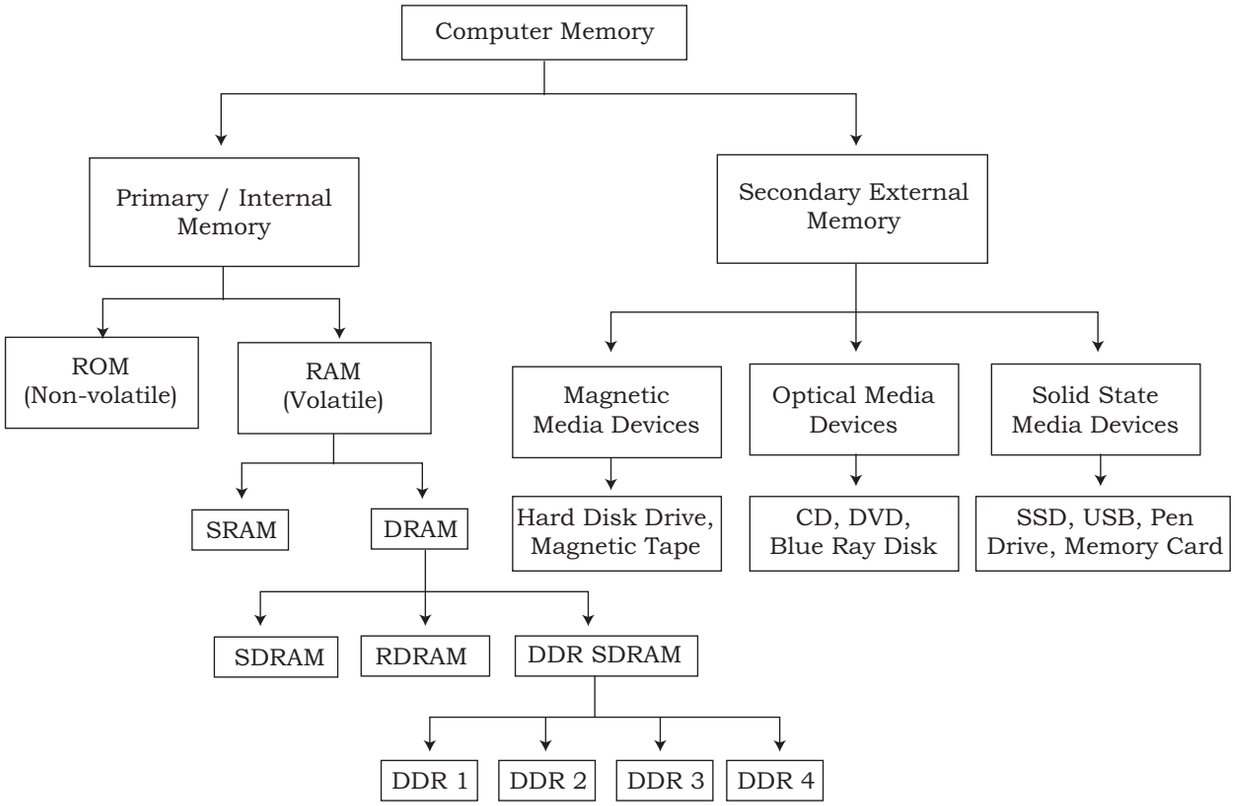

Fig. 9.1: Different types of memory

ROM stores the instructions requires during a process of booting up of the computer (bootstrapping). The content in ROM cannot be modified and the data inside the ROM is retained even after the CPU is switched off.

The capacity of ROM is comparatively smaller than that of RAM, it is slower and cheaper than RAM. There are many types of ROM as given below:

PROM (Programmable read-only memory): It can be programmed by an user. Once programmed, the data and instructions in it cannot be changed.

EPROM (Erasable Programmable read-only memory): It can be reprogrammed. To reprogram it, one has to erase all the previous data. Data can be erased by exposing it to ultraviolet light

EEPROM (Electrically Erasable Programmable read only memory): Only portions of this chip can be erased by applying an electric field.

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RAM

It is random access memory, it means the CPU can directly access any address location of RAM memory. It is quickly accessible memory of the computer and its speed is measured in nanoseconds (billionths of a second).

It is a read-write memory of the computer. The processor can read the instructions from RAM and write the result to the RAM.

It is fast and volatile which means it stores the data temporarily till the power is switched ON while the CPU is executing other tasks. It is therefore important to save data to the storage device before the system is turned off. Modern computers have RAM ranging from 2 GB to 16 GB.

There are two main types of RAM—Dynamic RAM (DRAM) and Static RAM (SRAM).

Dynamic random access memory (DRAM)

It is widely used as a computer's main memory. Each DRAM memory cell is made up of a transistor and a capacitor within an integrated circuit. It uses one capacitor and one transistor to store each bit (binary digit) of information. The capacitor needs to be regularly refreshed to hold the charge. This configuration uses very few components per bit, keeping the cost low but the constant refresh reduces the speed.

Static random access memory (SRAM)

It does not need to be periodically refreshed. It uses switching circuitry instead of capacitors and can hold the charge without constant refresh. It requires more components to store data per bit, so it is more expensive. It is faster, has lower density, and uses less power than DRAM. Due to its speed, SRAM is commonly used for CPU cache but not as the primary RAM due to its higher cost. It is widely used in portable gadgets such as cell phones, where minimum power consumption is important.

Common types of DRAM

1. Synchronised dynamic random access memory (SDRAM): It was the first type of memory to run in sync with the processor bus, the connection between the processor and other components on the motherboard. It is synchronised with a clock for faster speed. Typical SDRAM transfers data at speeds up to 133 Mhz. Almost all primary DRAM used in computers today is SDRAM. Most 168 pin DIMM modules use SDRAM memory. To determine whether a DIMM module contains SDRAM memory, check its speed markings. SDRAM memory is rated by bus speed. PC66 equals 66 MHz bus speed, PC100 equals 100 MHz bus speed, and PC133 equals 133 MHz bus speed.
2. Rambus dynamic random access memory (RDRAM): It takes its name after the company that made it, Rambus. It was popular in the early 2000s and was mainly used for video game devices and graphics cards, with transfer speeds up to 1 Ghz.
3. Double data rated synchronous dynamic random access memory (DDR SDRAM): It is a type of synchronous memory that nearly doubles the bandwidth of a single data rate. DDR SDRAM performs two transfers per clock cycle. 184 pin DIMM memory modules use DDR SDRAM chips. It is rated in Mhz and by throughput (MBps). The speeds for DDR SDRAM are PC1600 (200MHz/1600Mbps), PC2100 (266MHz/2100Mbps) PC2700 (333MHz/2700 Mbps), and PC3200 (400MHz/ 3200Mbps).
   (a) DDR1 SDRAM: It has been succeeded by DDR2, DDR3, and most recently, DDR4 SDRAM. Although operating on the same principles, the modules are not compatible with the earlier modules of RAM. Each generation delivers higher transfer rates and faster performance. The latest DDR4 modules feature fast transfer rates at 2133/2400/2666 and even 3200 MT/s.

Fig. 9.2: DDR1 SDRAM

(b) DDR2 SDRAM: It runs its external data bus at twice the speed of DDR SDRAM and features a four-bit pre-fetch buffer, enabling faster performance. DDR2 SDRAM memory has greater latency than DDR SDRAM memory. Latency is a measure of how long it takes to receive information from memory— the higher the number, the greater the latency. 240 pin memory modules use DDR2 SDRAM. Common speeds for DDR2 SDRAM modules includes PC2-3200 (DDR2-400; 3200Mbps throughput); PC2-5300 (DDR2-667); PC2-6400 (DDR2-800); and PC2-8500 (DDR2-1066).

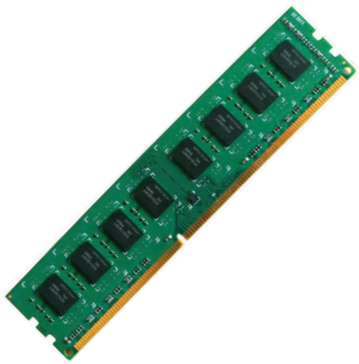


Fig. 9.3: DDR2 SDRAM

(c) DDR3 SDRAM: It runs on lower voltages, has twice the internal banks and most versions run at faster speeds than DDR2. It also has an 8 bit prefetch bus with greater latency than DDR2. Although DDR3 modules also use 240 pins, their layout and keying are different than DDR2, and they cannot be interchanged. The common speeds for DDR3 SDRAM modules include PC3-8500 (DDR3-1066; 8500MBps throughput); PC3-12800 (DDR3-1600); and PC3-17000 (DDR3-2133).

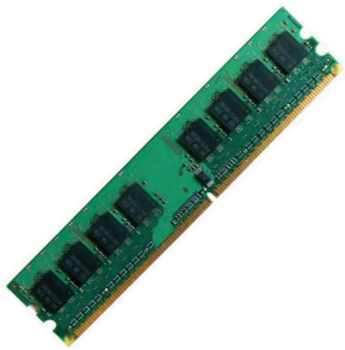


Fig. 9.4: DDR3 SDRAM

(d) DDR4 SDRAM: It was introduced alongside Intel's X99 chipset for Core i-series processors in August 2014 and is the fourth generation of DDR memory. It runs on lower voltage (1.2V) and supports density up to 16 Gb per chip (twice the density of DDR3), twice the memory banks and uses bank groups to speed up access to memory, but uses the same eight-bit prefetch as DDR3. Data rates range from 1600 Mbps to 3200 Mbps, compared to 800 Mbps to 2133 Mbps for DDR3.

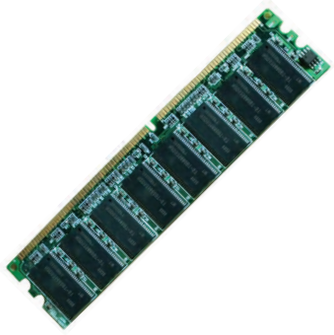
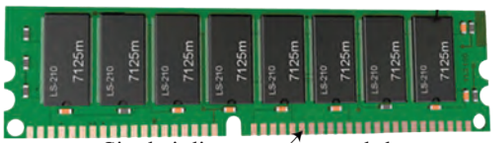


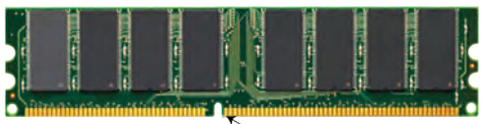
Fig. 9.5: DDR4 SDRAM

Types of DRAM packages

(i) Single in-line memory module (SIMM): These modules were widely used from the late 1980s to 1990s, and are now obsolete. They typically had



Single inline memory module



Dual inline memory module

Fig. 9.6: SIMM and DIMM Modules

Fig. 9.7: SODIMM

32 bit data bus and were available in two physical types—30 and 72 pin.

(ii) Dual in-line memory module (DIMM): Current memory modules come in DIMMs. 'Dual in-line' refers to pins on both sides of the modules. These moduless originally had a 168 pin connector supporting a 64 bit data bus, which is twice the data width of SIMMs. The wider bus means that more data can pass through a DIMM, translating to faster overall performance. Latest DIMMs are based on fourth generation double data rate (DDR4). SDRAM have 288 pin connectors for increased data throughput.

(iii) DIMM and SODIMM: RAM comes on cards plugged into the slots in the motherboard. They are smaller than expansion cards and technicians commonly call them memory cards, sticks. The two most common types of memory sticks are DIMM and SODIMM.

Dual in-line memory module (DIMM) is the circuit board that holds the memory chips. They are long and are used in desktop computers. DIMM have 168, 184, or 240 pins all supporting 64 bit data transfer.

Small outline dual in-line memory module (SODIMM) chips are smaller and are used in smaller devices such as laptop computers and printers. SODIMM have 72, 100, 144, or 200 pins. The 100 pin package supports 32 bit data transfer, while the 144 and 200 pin packages support 64 bit data transfer.

RAM configurations

Almost all systems can be used with a variety of memory sizes. However, systems that are designed to access two or more identical modules as a single logical unit (multi-channel) provide faster performance than systems that access each module as a unit.

Single and multichannel memory modes: Many motherboards and CPUs support single-channel, dual-

channel, and triple-channel memory architectures. Each single channel represents a separate 64-bit line of communication that can be accessed independently. With dual channel, the system can access 128 bits at a time; triple channel gives access to 192 bits at a time.

Using dual and triple channels provides an additional performance enhancement to DDR, DDR2, and DDR3 in addition to double pumping and other enhancements provided by the DDR versions. If you use a dual-channel motherboard with DDR3, it doubles the throughput of DDR3, providing 16 times more data throughput than SDRAM.

If you are upgrading a computer's memory, it is important to understand these channels. You can purchase DIMMs in matched pairs. Where you install each DIMM, determines how many channels your system will use and can affect the performance of RAM.

(i) Single-channel (asymmetric) mode: Originally, all systems that used SDRAM were single-channel systems. Each 64-bit DIMM or SODIMM module was addressed individually. This mode provides single-channel bandwidth operations and is used when only one DIMM is installed or when the memory capacities of more than one DIMM are unequal. When using different speed DIMMs between channels, the slowest memory timing is also used.

(ii) Dual-channel mode: The DDR memory technology supports dual-channel operation. When two identical (same size, speed, and latency) modules are installed in the proper sockets, the memory controller accesses them in interleaved mode for faster access.

Dual-channel motherboards are very common. This mode offers higher memory throughput and is enabled when the memory capacities of both DIMM channels are equal. When using different speed DIMMs, the slowest memory timing is used. If you look at a dual-channel motherboard, you see that it has four memory slots, two slots of one

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colour and two slots of another colour. Figure 9.8 shows a diagram of four memory slots labelled for a motherboard using an Intel based CPU. Slots 1 and 3 are of one color and slots 2 and 4 are of another color.

(i) Slots: Each slot can accept one DIMM.

(ii) Banks: A bank is composed of two slots. Bank 0 includes slots 1 and 3 and these two slots are normally blue. Bank 1 includes slots 2 and 4 and these slots are normally black. This is standard for Intel CPU based another boards.

(iii) Channels: Each channel represents a separate 64-bit communication path. Slots 1 and 2 make up one channel, and slots 3 and 4 make up the second channel.

You can install a single DIMM in slot 2 as shown in Figure 9.8 and the system will have a single-channel RAM. You can purchase DIMMs in matched pairs and it is important to know in which slots to install them. For the best performance, you should install matching DIMMs in the same bank. Install the matched pair of DIMMs in slots 2 and 4 (Bank 1) as shown in Figure 9.9 leaving slots 1 and 3. The system will take advantage of the dual-channel architecture by using two separate 64-bit channels. To achieve dual-channel mode, the following conditions must be met:

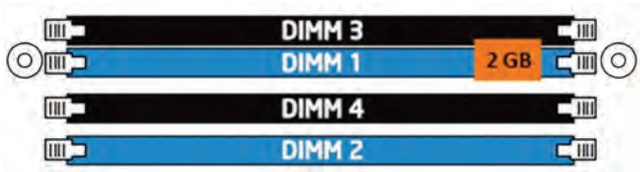

Fig. 9.8: Single-channel with one DIMM

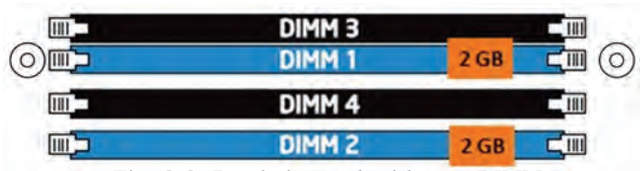

Fig. 9.9: Dual-channel with two DIMMs

- same memory size: 1 GB, 2 GB, 4 GB
- matched DIMM configuration in each channel.
- matched in symmetrical memory slots.

The motherboard uses the same colour for each bank. For Intel-based motherboards, Bank 0 includes slots 1 and 3 with the same colour (black). Bank 1 includes slots 2 and 4 with different colour (blue).

In AMD motherboards, slots 1 and 2 make up Bank 0 and slots 3 and 4 make up Bank 1. Channel 1 includes

slots 1 and 3 and channel 2 includes slots 2 and 4. AMD motherboards also use one color for Bank 0 (slot 1 and 2), and another colour for Bank 1 (slot 3 and 4).

(iii) Triple-channel mode: On some motherboards, there are six DIMM slots instead of four. This indicates the system supports triple-channel memory usage. Triple-channel interleaving reduces overall memory latency by accessing the DIMM memory sequentially. Data is spread through the memory modules in an alternating pattern. Triple-channel mode is enabled when identical matched memory modules are installed in each of the three blue memory slots.

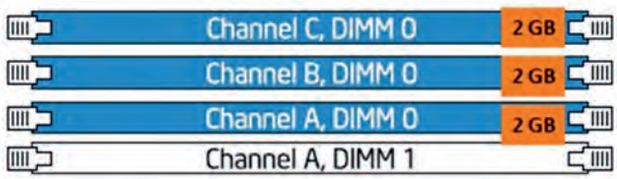

Fig. 9.10: Triple-channel mode

(iv) Quad-channel mode: This mode is enabled when four (or a multiple of four) DIMMs are identical in capacity and speed, and are put in quad-channel slots. When two memory modules are installed, the system operates in dual-channel mode. When three memory modules are installed, the system operates in triple-channel mode.

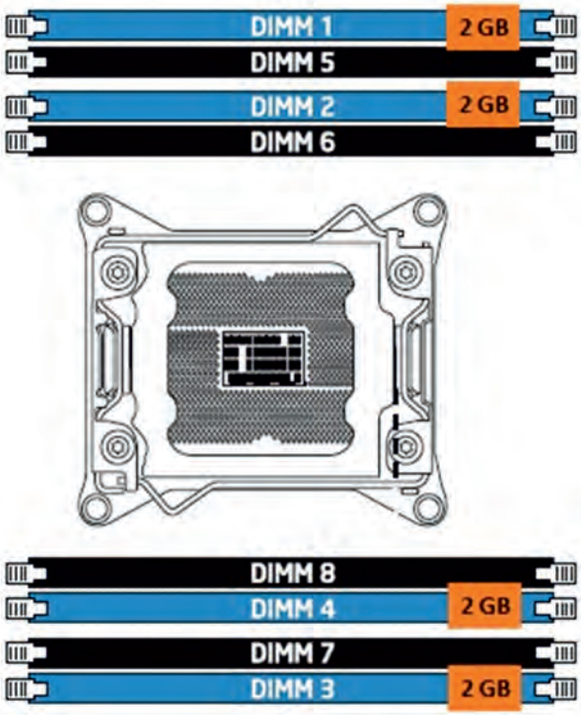

Fig. 9.11: Quad-channel with four DIMMs

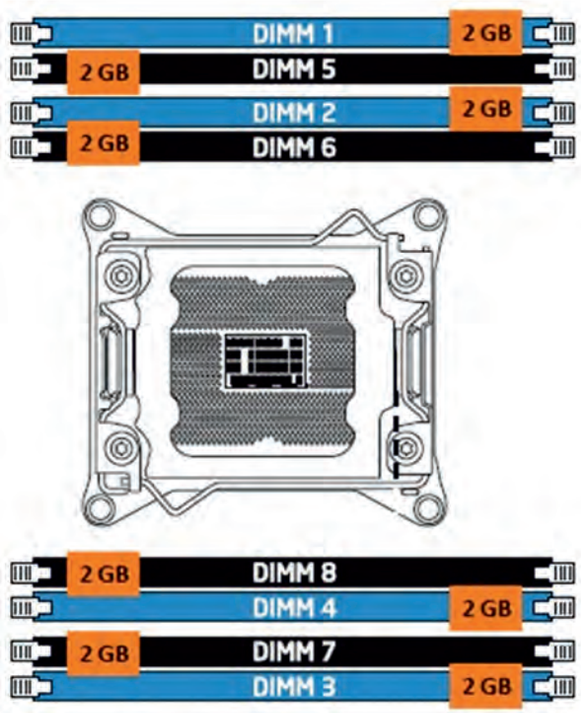

Fig. 9.12: Quad-channel with eight DIMMs

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RAM speed

RAM is accessed by the CPU via the front-side bus (FSB) and the memory bus. The high quality RAM is likely to operate with close to 100% reliability, significantly above the bus speed for which it is rated. The following table shows some comparisons of peak memory performance.

Table 9.1 Performance of various memory modules

Type of RAM	PC rating	RAM speed in MHz	Peak throughput in MB/sec
SDRAM	PC100	100	800
SDRAM	PC133	133	1100
RIMM	PC800	400	1600
RIMM	PC1066	533	2100
DDR	PC1600	200	1600
DDR	PC2100	266	2100
DDR	PC2700	366	2700
DDR	PC3200	400	3200
Dual Channel RIMM	PC800	400	3200
Dual Channel RIMM	PC1066	533	4200
Dual Channel DDR2	PC2-3200	400	6400
Dual Channel DDR2	PC2-4200	533	8400
Dual Channel DDR2	PC2-5300	667	10600
Dual Channel DDR2	PC2-6400	800	12800

Practical Activity

Installation of RAM

- First, open the computer cabinet. To open the case, remove the screws of the left side cover and slide the side cover. Pull the latch to release the side panel. Then lift the side cover out from the chassis.
- To install the RAM, first ensure its compatibility with the motherboard. If DDR3 is mentioned on the motherboard, then DDR3 RAM may be fixed in the memory slot.

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- Press down the side locks of the memory slot. Align the notches on the RAM module to the keys in the slot and press down on the both ends of RAM module until the side lock gets locked.

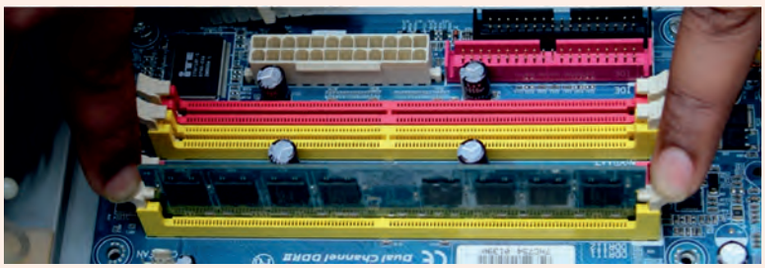

Fig. 1: Press down the memory in slot

- Make sure that the side tabs have locked the RAM module.
- Repeat the above steps to install additional RAM modules.

Fig. 2: Lock the RAM module

Check Your Progress

A. Multiple choice questions

1. Which of the following loses its contents when you shut down the computer?
   (a) Hard disk drive (b) USB flash drive
   (c) RAM (d) ROM
2. Component most likely used for computer static RAM technology is _____.
   (a) primary memory (b) secondary storage
   (c) cache memory (d) CPU registers
3. Which of the following statements is correct about RAM?
   (a) It retains data when PC is turned off.
   (b) It is a type of read and write memory.
   (c) It contains start up instructions.
   (d) It is peripheral.
4. RAM is volatile memory because_____.
   (a) it can be used for both read and write
   (b) any location can be accessed directly into it
   (c) continuous power supply is required for it to retain data
   (d) it does not require continuous power supply

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5. Which of the following is the second largest measurement of RAM?
   (a) Terabyte (b) Megabyte
   (c) Byte (d) Gigabyte
6. _____ consists of volatile chips that temporarily store data or instructions.
   (a) CPU (b) ROM
   (c) RMA (d) RAM
7. What is the meaning of RAM, and what is its primary role?
   (a) Readily available memory; it is the first level of memory used by the computer in all of its operations.
   (b) Random access memory; it is memory that can be reached by any sub-system within a computer, and at any time.
   (c) Random access memory; it is the memory used for short-term temporary data storage within the computer.
   (d) Resettable automatic memory; it is memory that can be used and then automatically reset, or cleared, after being read from or written to.
8. Which of the following is volatile storage?
   (a) ROM (b) RAM
   (c) Secondary storage (d) Hard disk
9. Which is the fastest data storage in a computer?
   (a) Registers (b) RAM
   (c) HDD (d) ROM

B. Fill in the blanks

1. RAM is used as a temporary storage area so that the _____ can access that information more easily.
2. The data in ROM can only be read by _____.
3. Dynamic random access memory (DRAM) is widely used as a computer's _____.
4. Static random access memory (SRAM) does not need to be periodically_____.
5. DDR3 SDRAM runs at lower _____.
6. To install the RAM first ensure its compatibility with _____.
7. In dual channel, the system can access _____ bits at a time.
8. The DDR memory technology supports _____ channel operation.
9. Each channel represents a separate _____ bit communication path.
10. The RAM is accessed by the _____.

C. State whether the statements are True or False

1. Static memory will maintain storage even if power is removed.
2. RAM is non-volatile.
3. RAM has a slow access time relative to other storage devices.
4. RAM can be static or dynamic.
5. RAM holds the BIOS.
6. RAM is part of the hard disk.
7. ROM is volatile.
8. RAM stores programs/data used by the CPU.
9. ROM contains the operating system.
10. RAM stands for readily accessible memory.

D. Short answer questions

1. Why is memory important in a computer?
2. What is RAM?
3. Why are different types of RAM used?
4. What are the different types of RAM?
5. What are the common types of DRAM?
6. Describe different types of DRAM packages.
7. Describe DIMM and SODIMM.
8. What are the differences between single and multichannel memory modes?

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Chapter 10 Installation of Disk Drives

Introduction

The storage device is the most important component in the computer system. A storage device uses magnetic or solid state media. Disks, tapes, and diskettes use magnetic media. CD-ROM and DVD use optical media, and removable flash memory card is an example of solid state media.

Hard disk drive (HDD) is the most popular storage medium used in modern computers for storing and accessing data. HDD has a large storage capacity and is cheaper. It can be attached internally inside the cabinet as well as can be connected externally to the computer. It supports rapid access to random data locations, meaning that data can be written or retrieved quickly for a large number of simultaneous users or applications.

Overview of Hard Disk Drive (HDD)

It is the primary long-term storage device used in personal computers. A hard disk drive fits inside a computer case and is firmly attached with the use of braces and screws to prevent it from being jarred as it spins. Typically it spins at 5,400 to 15,000 RPM. The disk moves at an accelerated rate, allowing data to be accessed immediately. Most hard drives operate on high speed interfaces using serial attached technology (SATA). When the platters rotate, an arm with a read/write head extends across the platters. The arm writes new data to the platters and reads data from them. Most hard drives use Enhanced Integrated Drive Electronics (EIDE) including cables and connectors to the motherboard. All data is stored magnetically, allowing information to be saved when power is shut off.

A hard drive is divided into one or more partitions, which can be further divided into logical drives or volumes. Usually a Master Boot Record (MBR) found at the beginning of the hard drive, which contains a table of partition information. Each logical drive contains a boot record, a File Allocation Table (FAT) and a root

directory for FAT file system or any other file system. The HDD can be internal (fixed) or external.

Fig. 10.1: Hard disk drive

Internal or Fixed HDD

Almost every computer has a fixed HDD. A fixed HDD is built into the case of a computer. It is the main backing storage device of computers since it provides instant and random access to data with high access speed.

External or Portable HDD

A portable HDD can be attached to the computer externally through USB. It is used to store very large amount of data and easy to use in computer just by plugging it in the USB port of computer.

Physical Components of HDD

A hard disk drive uses a rapidly moving arm to read and write data across a flat platter coated with magnetic particles. Data is transferred from the magnetic platter through the read/write (R/W) head to computer. Several platters are assembled together with the R/W head and controller. Data can be recorded and erased on a magnetic disk any number of times.

Key components of a disk drive are platter, spindle, read/write head, actuator arm assembly, and controller (Figure 10.2).

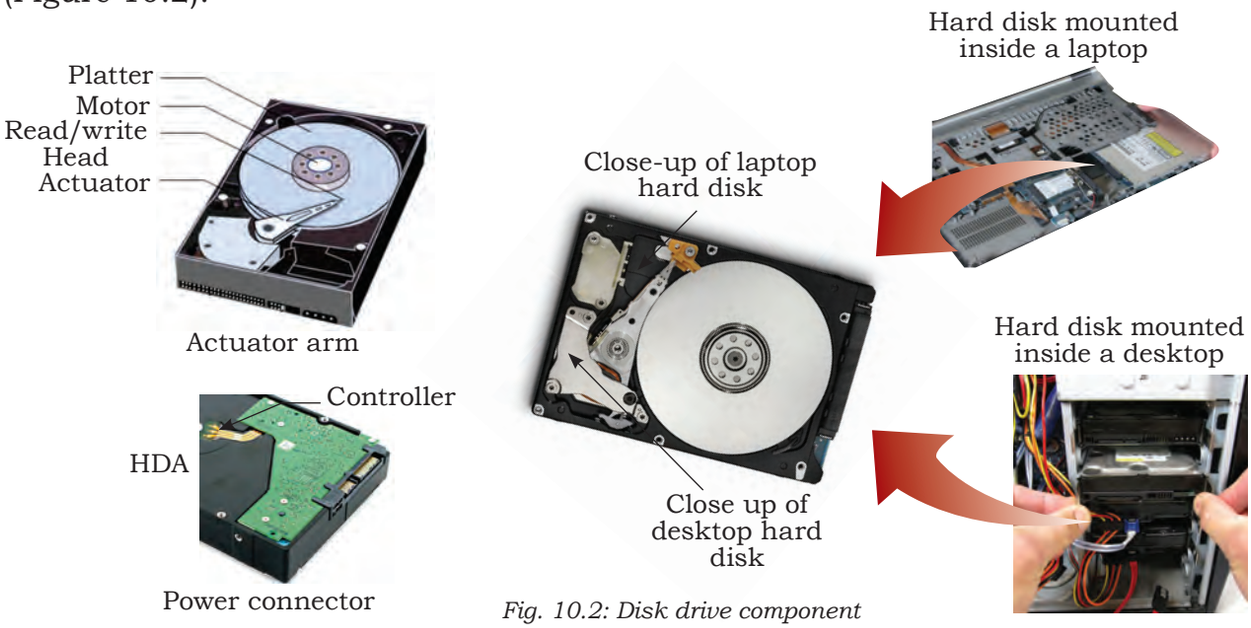

Fig. 10.2: Disk drive component

Platters

A HDD consists of multiple flat circular disks called platters. The data is recorded on these platters in binary codes (0s and 1s). The set of rotating platters is sealed in a case, called a head disk assembly (HDA). A platter is a rigid, round disk coated with magnetic material on top and bottom surfaces. Data can be written to or read from both surfaces of the platter. The number of platters and the storage capacity of each platter determines the total capacity of the drive.

Spindle

It connects all the platters, and is connected to a motor as shown in Figure 10.3. The motor of the spindle rotates with a constant speed. The disk platter spins at a speed of several thousands of revolutions per minute (rpm). Disk drives have spindle speeds of 7,200 rpm, 10,000 rpm, or 15,000 rpm. Disks used on current storage systems have a platter diameter of 3.5" (90 mm). When the platter spins at 15,000 rpm, the outer edge is moving at around 25 percent of the speed of sound. The speed of the platter is increasing with improvements in technology, although the extent to which it can be improved is limited.

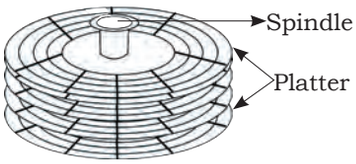

Fig.10.3: Spindle and platter

Read/write head

Read/write (R/W) heads, read and write data from or to a platter. Drives have two R/W heads per platter, one for each surface of the platter. The R/W head changes the magnetic polarisation on the surface of the platter when writing data. While reading data, this head detects magnetic polarisation on the surface of the platter. During read and write, the R/W head senses the magnetic polarisation and never touches the surface of the platter. When the spindle is rotating, there is a microscopic air gap between the R/W heads and the platters, known as the head flying height. This air gap is removed when the spindle stops rotating and the R/W head rests on a special area on the platter near the spindle. This area is called the landing zone. The landing zone is coated with a lubricant to reduce friction

between the head and the platter. The logic on the disk drive ensures that heads are moved to the landing zone before they touch the surface. If the drive malfunctions and the R/W head accidentally touches the surface of the platter outside the landing zone, a head crash occurs. In a head crash, the magnetic coating on the platter is scratched and may cause damage to the R/W head. A head crash generally results in data loss.

Actuator arm assembly

The R/W heads are mounted on the actuator arm assembly, which positions the R/W head at the location on the platter where the data needs to be written or read. The R/W heads for all platters on a drive are attached to one actuator arm assembly and move across the platters simultaneously. There are two R/W heads per platter one for each surface.

Controller

The controller is a printed circuit board, mounted at the bottom of a disk drive. It consists of a microprocessor, internal memory, circuitry, and firmware. The firmware controls power of spindle and speed of motor. It also manages communication between the drive and the host. In addition, it controls the R/W operations by moving the actuator arm and switching between different R/W heads and performs the optimisation of data access.

Logical Components of HDD

Tracks

Each platter of the hard disk is logically divided into many concentric circles known as tracks. The data gets stored on these tracks. On a 3.5 inch hard disk, there are thousands of tracks. The tracks are numbered, starting from zero, from the outer edge of the platter. The outermost track is 0 and the innermost track has the highest number. When the head is positioned over a track, it can read or write data on the track as the platter spins.

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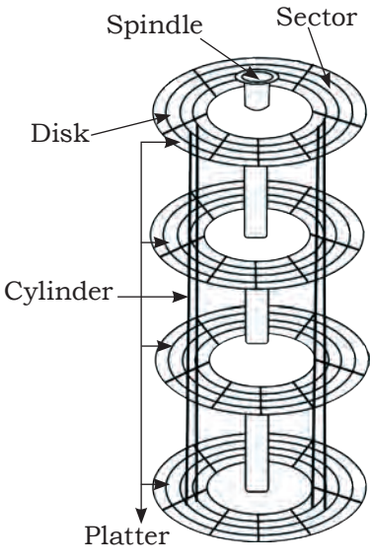

Fig. 10.4: Disk structure: sector, tracks, and cylinders

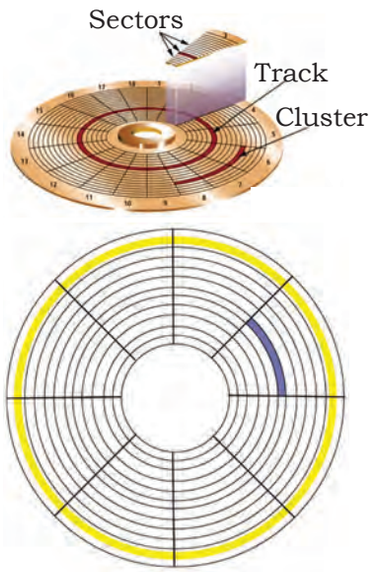

Fig. 10.5: Tracks and sectors

Cylinders

A cylinder is the set of identical tracks on both surfaces of each drive platter. The location of drive heads is referred to by a cylinder number, not by track number. In a hard disk, the data is stored in a cylinder by cylinder method.

If the disk holds 1024 cylinders then the second last cylinder consists of all the tracks at the innermost edge of each side. The tracks near the outer portion of the disk are less densely populated than the tracks located near the center of the disk.

Sectors

Each track is logically divided into sections known as sectors. A sector is the smallest physical storage unit on the disk. It has a data size of power two and usually has 512 bytes storage capacity. Every track has the same number of sectors.

In addition to user data, a sector also stores other information, such as sector number, head number or platter number, and track number. This information helps the controller to locate the data on the drive, but storing this information consumes space on the disk. Hence, there is a difference between the capacity of formatted and unformatted disk. A disk of 500 GB capacity will hold 465.7GB of user data and the remaining 34.3GB is used for metadata.

Clusters

This is a group of multiple sectors. The file system allocates the number of clusters to store file data. Suppose, if each cluster is 512 bytes and file capacity is 800 bytes, then the file system allocates two clusters for the file.

Files

These are written to clusters. If the file is bigger than a single cluster, the file is written to multiple contiguous clusters. However, if other data is already written on an adjoining cluster, the file is fragmented and written to another available cluster.

Working of Hard Disk

The data on the hard disk is stored in the magnetic domains on the magnetic material. It performs the recording function through its concentric circles or tracks.

When you initiate a command to store some data on the disk, the data flows into a cache. From there, the data is encoded using mathematically derived formulae. This is done to detect and correct the possible errors from the data.

Further, free sectors on the disk are selected. Then the actuator moves the heads over those free sectors. These processes are followed just before the writing function.

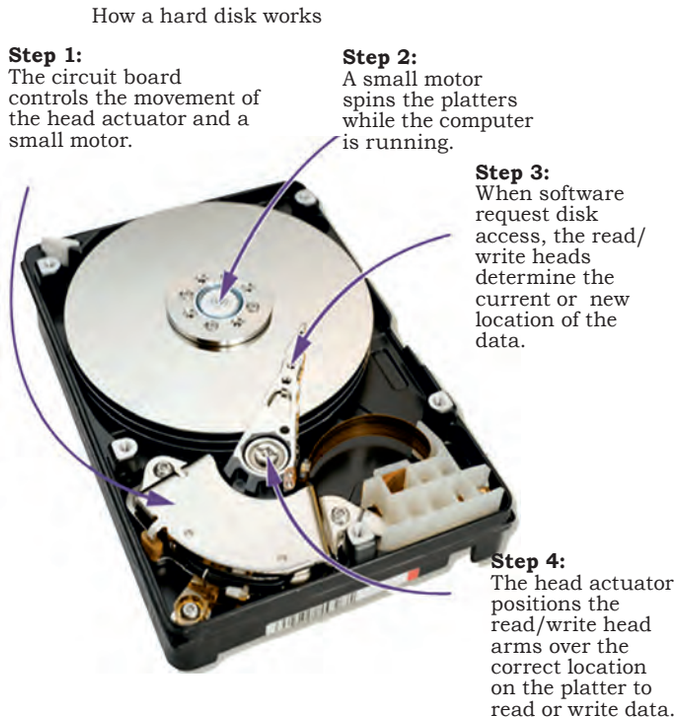

Fig. 10.6: Working of hard disk

When the writing time arrives, a pattern of electrical pulses pass through the writing element coil. This process produces a related pattern of magnetic fields. The fields alter the magnetic orientations of bits and as a result, the bits represent the data.

The reading process continues in a reverse direction. After consulting the locations of the stored data, the actuator moves the head over those tracks, wherein the chosen data is located.

When the sectors receive the correct sensors, the magnetic fields from the bits induce resistivity changes. The changes locate the reading elements. The elements are further connected to electronic circuits. When the current flows from the electronic circuits, it helps in decoding the data stored in the disk.

Disk Drive Performance

A disk drive is an electromechanical device that governs the overall performance of the storage system environment. The various factors that affect the performance of disk drives are seek time, rotational latency, and data transfer rate.

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Seek time

The seek time, also called access time, describes the time taken to position the R/W heads across the platter with a radial movement moving along the radius of the platter. It is time taken to find and send the first byte of the file to CPU. The average seek time on a modern disk is typically in the range of 3 to 15 milliseconds. It has more impact on the read operation of random tracks rather than adjacent tracks. To minimise the seek time, data can be written to only a subset of the available cylinders. This results in lower usable capacity than the actual capacity of the drive. For example, a 500 GB disk drive is set up to use only the first 40 per cent of the cylinders and is effectively treated as a 200 GB drive. This is known as short-stroking the drive.

Rotational latency

To access data, the actuator arm moves the R/W head over the platter to a particular track while the platter spins to position the requested sector under the R/W head. The time taken by the platter to rotate and position the data under the R/W head is called rotational latency. This latency depends on the rotation speed of the spindle and is measured in milliseconds. The average rotational latency is one-half of the time taken for a full rotation. Similar to the seek time, rotational latency has more impact on the reading/writing of random sectors on the disk than on the same operations on adjacent sectors.

Average rotational latency is around 5.5 ms for a 5,400-rpm drive, and 2.0 ms for a 15,000-rpm drive.

Data transfer rate

The data rate is the number of bytes per second that the drive can deliver to the CPU. Rates between 5 and 40 megabytes per second are common.

To understand the data transfer rate, you need to first understand the process of read and write operations. In a read operation, the data first moves from disk platters to R/W heads, and then it moves to the drive's internal buffer. In a write operation, the data moves from internal buffer to the R/W heads. Finally, it moves from the R/W heads to the platters.

The data transfer rates during the R/W operations are measured in terms of internal and external transfer rates, as shown in Figure 10.7.

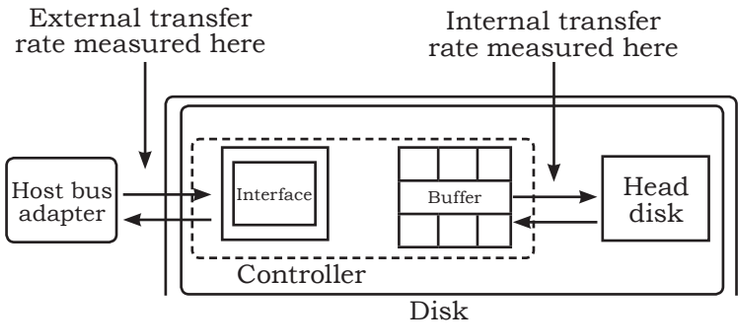

Fig. 10.7: Data transfer rate

Types of HDD

The various types HDD such as, IDE or PATA drives, SATA, SCSI drives are explained below.

IDE drives

The IDE drives or PATA drives is an old technology. It used 40 or 80 pin wide ribbon cables to transfer multiple bits of data. It's data transfer rate was 133 MB/sec. PATA cables were used to connect these drives.

SATA drives

SATA (serial advance technology attachment) are new and currently used drives. These drives have generally seven pins made available with 1 meter data cable. our of seven, four pins are used for sending and receiving data and other three are grounded. It starts with the data transfer rate from 1.5 Gbits/sec. Currently, the fastest drive offers 16 Gbits/sec. SATA cables are used to connect SATA drives. Only one drive can be connected with single data cable. These drives operate with 250 mV. Three generations of SATA are currently in use. The table below outlines the different versions and their speeds.

Table 10.1 Different versions of SATA hard disks

Generation	Bit speed	Byte Speed	Names
SATA1	1.5 Gbits/s	150 MBps	SATA 1.5G, SATA 1.5Gb/s, SATA 1.5Gbits/s, SATA 1.50
SATA2	3.0 Gbits/s	300 MBps	SATA 3G, SATA 3Gb/s, SATA 3 Gbit/s, SATA 300
SATA3	6.0 Gbits/s	600 MBps	SATA 6G, SATA 6Gb/s, SATA 6Gbit/s, SATA 600

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SCSI drives

The small computer system interfaces (SCSI) are among the fastest drives. These drives can be installed both internally and externally. The SCSI drives usually carry 5068 pins. Currently it offers data transfer rate of 3 Gbits/sec. SCSI cables are used to connect these drives.

SCSI-1 (also called narrow SCSI)

Uses a 50-pin cable with a maximum transfer rate of 5 Mbps. Narrow SCSI uses an 8-bit bus and supports a maximum of 8 devices.

SCSI-2

Uses a 25-pin, 50-pin, or 68-pin cable. This was first called fast SCSI because it could transfer data at 10 MBps, twice as fast as SCSI-1. It originally used an 8-bit bus. Fast-wide SCSI is an update that uses a 16-bit bus and supports 16 devices with transfer rates of 20 MBps.

Single connector attachment (SCA)/SCSI-3

SCSI-3 is also called Ultra SCSI and includes several different versions.

SAS drives

Serial attached SCSI (SA) drive is an evolution of parallel SCSI into a point-to-point serial peripheral interface in which controllers are linked directly to disk drives. These drives rotate much faster than SATA drives. Generally, they work twice as fast as the SATA drives. SAS is a performance improvement over traditional SCSI because SAS enables multiple devices (up to 128) of different sizes and types, to be connected simultaneously with thinner and longer cables; its full-duplex signal transmission supports 3.0 Gbits/sec.

Hard Drive Characteristics

As you know that the HDD comes in various sizes, storage capacity, and different types of connectivity. This factor forms the characteristics of HDD. The following are some of the important characteristics of HDD:

Storage capacity

The physical size of the HDD is either 2.5 inch or 3.5 inch. The storage capacity of the HDD is listed as GB or TB. The storage capacity of present HDDs is 500 GB or 1 TB.

Hard drive speeds

The hard drive's speed is measured in terms of its rotation per minute (rpm). Most commonly, the HDDs are available in 5,400, 7,200, 10,000, and 15,000 rpm. Drives with 7,200 rpm are used in standard desktop computers. Other factors also contribute to the speed. For example, seek time refers to the average amount of time it takes to move the read/write head from one track to another track, and lower seek times are better. If you find two drives of the same size with the same rpm speed but one is significantly cheaper, it might be due to a higher seek time, resulting in overall slower performance. The interface can also limit the speed. Imagine a drive spinning at 15,000 rpm with a low seek time. It can read and write data to and from the hard drive, but it is limited as to how much data can actually be transferred between the hard drive and other computer components. The following sections describe common interfaces.

Interface

The interface is how HDD is connected to the system. There are internal HDD and external or portable HDD. The internal HDD is connected by using SATA cable. One end of the connector is connected to the HDD and other end to the power supply unit. The external HDD are connected to the computer system by using USB port, FireWire port, eSATAp port, and RJ-45 Ethernet port.

SCSI cables and connectors come in several different versions. Some are ribbon cables similar to the cables used with PATA drives, and other cables are round. Some examples of SCSI connectors are:

(i) 25-pin: This is a very old SCSI connector, also known as a DB25. It has one row of 13 pins and a second row of 12 pins.

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(ii) 50-pin: Several types of 50-pin SCSI connectors have been used. Some have two rows, and some have three rows. A Centronics 50-pin connector has connectors lined up in slots.

(iii) 68-pin: This includes two rows of pins close together and is referred to as high-density. It is sometimes used for external SCSI connections.

(iv) 80-pin: This is known as a single connector attachment (SCA) connection, and it is used as an alternative to 68-pin connections. It includes pins for both data and power and supports hot-swapping.

Practical Activity

Connect external HDD in different ways to the computer.

Fig. 1: USB connection HDD

Fig. 2: Fire wire connector with external HDD

Fig. 3: eSATA Port to connect HDD

Fig. 4: RJ-45 Ethernet port to connect HDD

Fig. 5: eSATAP port to connect HDD

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Installation of Internal HDD

The process of installing an internal hard drive involves mounting it and connecting a couple of cables.

Drive cages, bays, and mounting options

Internal 3.5-inch hard disk drives are mounted in a drive cage or drive bay. Placement and orientation of the cages or bays will vary from case to case. Drive cages/bays will most often be mounted perpendicular to the bottom of the chassis, while drives mounted in the cages usually sit parallel to the bottom of the case. The drive connectors are on the rear side of the hard disk drive.

Practical Activity

Installation of internal HDD in a computer

Fig. 1: Hard drive with tool less brackets

Fig. 2: Screwing the hard disk drive

Step 1: Fit hard disk into a bay.

To fit a hard disk, identify a spare 3.5 inch drive bay. Four screws are required to secure the drive to a cage on the sides or bottom of the drive. Some drives have screw less fittings. Such hard drive come with tool-less brackets that make mounting hard drives easy. Slide the hard disk into a spare drive bay until the screw holes in the side of the drive line up with the holes in the drive bay. Then secure the disk with four screws, two on either side. Use magnet-tipped screw drivers. The screws are provided with the hard disk or case. Screw them tightly to prevent the drive.

When mounting drives in a system, try to leave as much space between them as possible to maximise airflow over the tops and bottoms. Positioning the drives directly in front of an intake fan also helps.

Step 2: Connect the hard drives with SATA.

Once the drive is mounted, connect it to system. The SATA interface hard drive uses SATA cables. One end of SATA cable is connected to the hard drive and other end to motherboard connector.

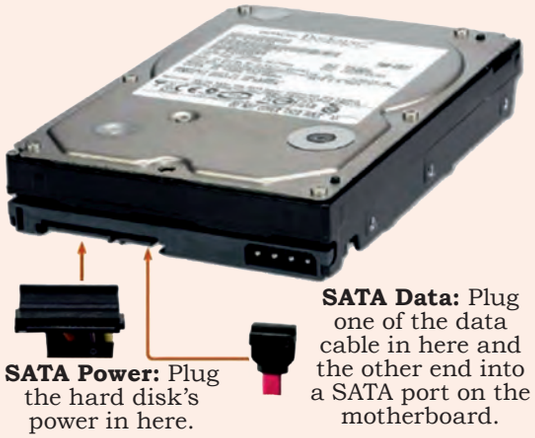

Fig. 3: SATA data and power cable port on hard drive

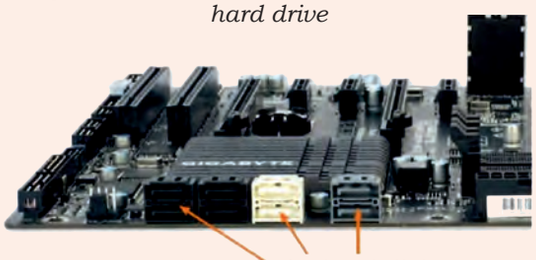

Fig. 4: SATA port on motherboard

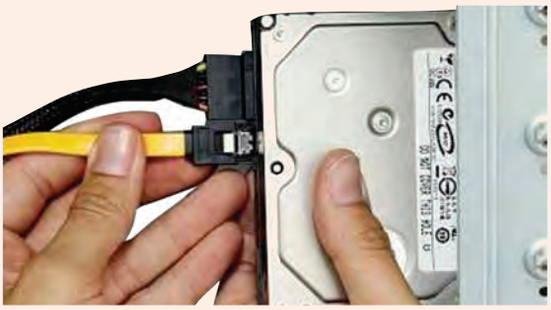

Fig. 5: Connecting SATA-data cable

Step 3: Plug in SATA power.
Locate the correct connector from power supply unit (PSU) and plug it into the back of the hard disk. Be careful when plugging it in, as downward pressure can break the clip surrounding the power connector.

Step 4: Plug in SATA data cable.
Unlike IDE, SATA uses a simple and thin connector to carry data. The motherboard has several SATA cables. Take one of these and plug it gently into the rear of the hard disk. Be careful to plug it in, as downward pressure can break the connector and prevent the SATA cable plugging in.

Step 5. Plug SATA data cable into motherboard.
Next, find a spare SATA port on motherboard. These are usually located at the bottom-right of the board and are numbered. The lowest number has the higher boot order in case of multiple disk. So plug the SATA cable into the lowest-numbered port.

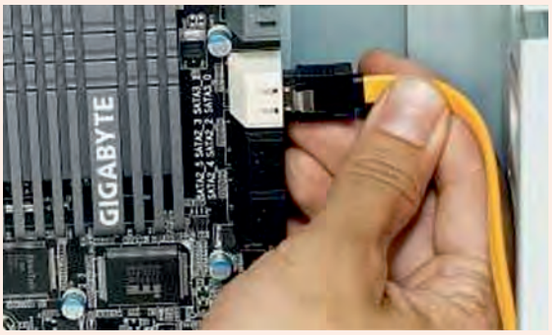

Fig. 6: Plugging SATA data cable into the motherboard

Practical Activity

Installing HDD in a laptop

Different laptops have different methods for accessing the storage drive.

Material required

Laptop, mini screwdriver, anti-static wrist strap, magnifying glass.

Procedure

There are several types of small screws that are used throughout the laptop. Place these in small envelopes and write the component name on the envelope. Be organised and keep track of all the screws. We have to figure out how to remove the back panel.

Step 1: Start the disassembly process by removing the battery.

Turn the notebook upside down and remove all screws securing the bottom case.

There are two screws (green circles) hidden under bottom.

Fig. 1: Remove battery and optical drive

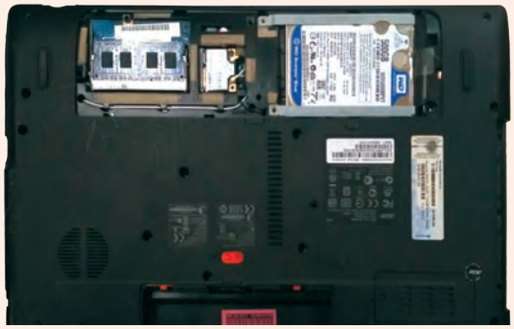

Fig. 2: Back panel of laptop

Step 2: Remove three screws fixing the hard drive bracket to the case. Disconnect the hard drive cable from the motherboard.

Fig. 3: Open connector and release hard drive cable

Fig. 4: Remove old hard drive assembly

Step 3: Remove the old hard drive from the notebook and replace with new hard disk.

Solid State Drives

These do not have any moving components. They use only electronics to store and retrieve data. You can think of a SSD as a huge bank of random access memory (RAM). Most SSDs are non-volatile, meaning that they will not lose data when power is removed. The most common type of memory used with SSDs is flash-based RAM, the same type of non-volatile RAM used in

USB flash drives. SSD drives are lightning-fast when compared with mechanical hard drives. Additionally, they don't require motors to spin the platters and move the actuator, so they are lighter and draw less power. Mobile devices such as tablets, commonly use SSDs, and many hobbyists replace laptop hard drives with SSDs. With the price of memory continuing to fall, SSD drives have become very affordable. For example, you can purchase a 128 GB SSD drive for about the same price as a 2 TB mechanical drive. Some people use a SSD drive for the operating system and applications, and use a mechanical drive for data. Most SSD drives use SATA and will install just like any other SATA drive. In addition to SSD drives and USB flash drives, several types of flash memory are used in digital cameras and recorders, including the following:

Fig. 10.8: Compact flash

Compact flash (CF)

These are manufactured by SanDisk and are very popular. The outer dimensions are 43 x 36 mm. Type I CF devices are 3.3 mm thick, and Type II devices (known as CF2) are 5 mm thick. They can hold up to 128 GB of data.

Fig. 10.9: SD Card

SD (Secure digital)

This is developed by the SD Card Association and is used with many types of portable devices as shown in Figure 10.9. It supersedes Multi Media Card (MMC) which is the same size. The dimensions of SD are 24 x 32 mm. They can hold up to 2 GB of data. Newer versions include SD high capacity (SDHC) and extended capacity (SDXC). SDHC can hold up to 32 GB, and SDXC can hold up to 2 TB of data.

Mini-SD

This is a smaller version of the SD card. The dimensions of mini-SD devices are 21.5 x 20 mm.

Micro-SD

This is the smallest of the three SD sizes. The dimensions of micro-SO devices are 15 x 11 mm.

xD

The xD Picture card is an older flash memory card used in some digital cameras. It was developed by Olympus and Fujifilm, but Olympus cameras are now using SD cards.

OPTICAL DISCS AND DRIVES

The modern PC comes with a DVD writer drive. The common types of discs which can be used in these drives include Blu-ray discs, different types of DVDs, and compact discs. An optical disc drive uses either electromagnetic waves or laser beams very close to the visible spectrum of light to write or read the data on optical discs.

Apart from the general and exclusive applications in a computer, the optical disc drives are used as DVD players, CD players, and DVD recorders. They are most extensively used in computers for various purposes like archiving of data, reading software, recording discs, and to distribute the consumer media for exchange purpose.

Table 10.2 Different types of optical discs and their capacities

Types	Capacity	Comments
CD-ROM	700 MB	The standard size is 12 cm (4.7 inch).
Mini CD-ROM	194 MB	The size is 6 to 8 cm.
DVD-ROM	4.7 GB	Dual sided DVD-ROM holds 4.7 GB on each side.
Dual layer DVD-ROM	8.5 GB	Dual sided dual-layer DVD-ROM holds 8.5 GB on each side.
Blu-ray single layer	25 GB	Blu-ray disk uses a blue laser, and CD and DVDs use a red laser.
Blu-ray double layer	50 GB	This is the common size used for movies. Triple layer holds 100 GB, and quad layer holds 128 GB.

Functioning of Optical Drive

The main components of an optical disc drive consist of an optical path, usually mounted on a pick up head and containing a semiconductor laser, the laser beam guiding lens, and the photodiodes which detect the reflection of light from the surface of the disc.

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With the advent of more recent versions of optical discs, the wavelengths of the laser beams used in the process is changed from 780nm to 405nm in the Blu-ray disc.

The main aspects to be noted for the proper functioning of the CD drive are that, between the disc and the lens, a correct distance has to be maintained. Secondly, the beam should be focused on the laser spots of the disc. The data stored in spiral path will be accessed by moving the head all the way through the radius of the disc and keeping laser beam focused.

The mechanism by which the recorded encode the data on a disc is that by heating selectively the different parts of the dye layer by using the laser beam.

The reflectivity of the dye will be changed during this process leading to the creation of marks, represented by lands and pits on discs. The writer laser is more powerful than the reading laser.

With a higher speed in writing, less time will be taken by the laser to heat an area. The normal power is around 200 MW for the writing beam.

In rewritable discs, instead of dye layer, the crystalline metal complex used to cover the disc is melted with the laser beam. The lands and pits on metal alloy layer differ based on the extent to which the beam is exposed and can cause greater reflectivity.

In dual layered media, a polycarbonate layer separates the first semi-reflective layer and the second layer. The writing starts in the inner edge for the first layer and from the outer edge for the second layer.

Installing Optical Drives

Optical drive comes in different SATA versions such as SATA 1.0, 2.0, 3.0. Ensure that the SATA port is enabled in BIOS. SATA optical drive uses a SATA power connector.

Removing Discs without Power

There might be a time when you need to remove a disc from a drive but don't have any power. It could be that

the drive has failed and won't power up, or it could be you are disposing of an old computer and want to ensure that there isn't a disc left in the system. You can open the drive with a paper clip. All disc drives have a small pinhole in the front. Unbend a paper clip and poke it into the hole to manually open the drive.

Practical Activity

Installation of optical drive

Material required

Computer system, optical drive, screw driver

Procedure

- To install an optical drive, first check the position of the optical drive so that it aligns with the 5.25 inch drive bay.
- Insert the optical drive into the drive bay so that the optical drive screw holes align with the screw holes in the case (Figure 1).
- Secure the optical drive to the case using the proper screws (Figure 2).
- Connect the power cable coming from the SMPS to the power socket of optical drive (Figure 4).
- Connect SATA data cable from optical drive socket to the motherboard socket.
- Connect the SATA data cable to the optical drive as shown in Figure 4.
- Connect the other end of the SATA data cable to the motherboard as shown in Figure 3.

Fig. 1: Insert optical drive

Fig. 2: Tighten screws of optical drive

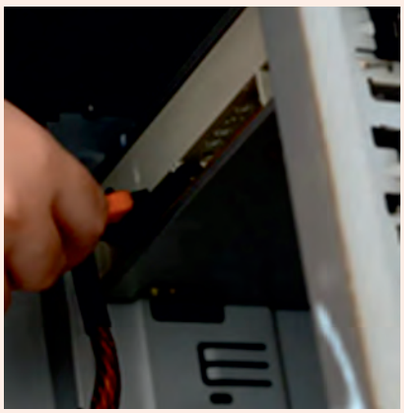

Fig. 3: Connect the SATA data cable

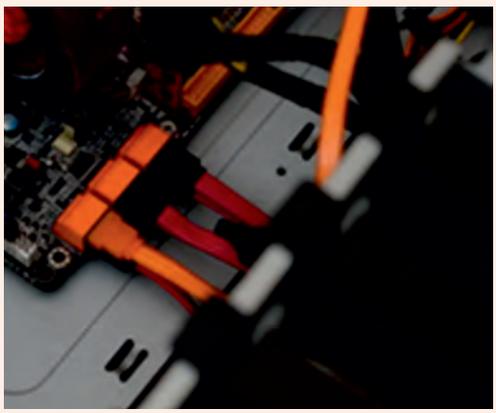

Fig. 4: Connect SATA data cable to the to optical drive motherboard

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Disk Drive Interfaces

IDE/EIDE/PATA drives

Hard drive interfaces have gone through several changes and improvements over the years. Even though you will not see many of the older versions, if you understand a little about them, it makes it easier to understand current versions. The different disk drives are briefly explained below.

Integrated Drive Electronics (IDE)

These appeared in the 1980s and included drive controller electronics on the drive.

Advanced Technology Attachment (ATA)

IDE was standardised as ATA and later became known as ATA-1. The maximum drive size was 137GB. In earlier drives, the maximum was 2.1GB.

Extended IDE (El DE) and ATA-2

Modifications and enhancements of the original IDE were marketed as EIDE and later standardised as ATA-2.

ATA Packet Interface (ATAPI)

Originally IDE and ATA were designed only for hard drives. ATAPI provided standards so that EIDE and ATA versions could be used for other drives, such as CD-ROM and DVD-ROM drives.

Parallel ATA (PATA)

ATA was upgraded regularly to ATA-7, which also introduced Serial ATA (SATA). EIDE versions were renamed to PATA to differentiate it from SATA. PATA drives use direct memory access (DMA) transfers. DMA allows a device to directly access without the central processing unit (CPU), freeing up the CPU for other tasks. Ultra DMA (UDMA) appeared in ATA version 4 (ATA-4) and supported data transfers as high as 44 megabytes per second (MBps). ATA and UDMA were updated several times, and table below identifies the speeds and names for the different versions.

Table 10.3 Speeds of different versions of ATA

Type	Maximum Speed	Comments
ATA4	33MBps	Also called UDMA/33 and Ultra ATA/33.
ATA5	66MBps	Also called UDMA/66 and UltraATA/66.
ATA6	100MBps	Also called UDMA/100 and Ultra ATA/100. Maximum drive size increased to 144 PB.
ATA7	133MBps	Also called UDMA/133 and ultra ATA/133.

PATA

It's drives use ribbon cables similar to the one shown in Figure 10.10. Each ribbon cable includes three connectors, one for the motherboard IDE connection and two for the drives. In the Figure, the two IDE connectors (IDE 1 and IDE 2) are on the left, and the cable is lying on top of the motherboard. A typical PATA-based system would have two ribbon cables connecting a maximum of four drives. Early versions of PATA cables used 40 wires, but this was switched over to 80 wire cables with ATA-4. These extra wires provided signal grounds within the cable and supported the higher UDMA speeds. Even though the number of wires in the cables doubled, the connectors still have 40 pins. The maximum length of an IDE cable is 18 inches.

Fig. 10.10: PATA cables

PATA Connectors and Cables

All PATA connectors are 40-pin rectangular connectors, and they are the same on both the hard drive and the motherboard. Motherboards that support PATA typically have two connectors named IDE1 and IDE 2 as shown in Figure 10.11.

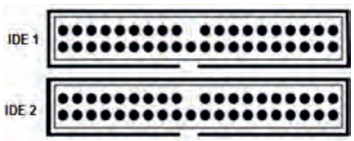

Fig. 10.11: PATA connector cable

Master and Slave Configuration

Each IDE connection supports two drives and these are commonly identified as master and slave drives. The system will try to boot to the master drive, but it does not automatically know which drive to select. Instead, you have to manipulate jumpers on the drive to let the system know which drive is the master and which is the slave. Figure 10.12 shows the back of an EIDE

Fig. 10.12: Back of EIDE drive

drive. You can see that it has a 40-pin connector for the ribbon cable and a Molex connector for power. It also has a set of jumpers used to identify whether the drive is the master or the slave.

If one is replacing or adding a drive, it is important to understand these jumpers. You will find a chart on the back of the drive, similar to the chart as shown in the Figure that identifies exactly how the jumper should be configured for each drive.

Cable Select

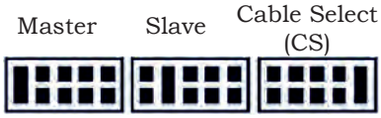

Fig. 10.13: Master and slave cable select

Cable select allows the system to identify the drive based on which connector is used. You can see that the end connector of the ribbon cable is labelled 'Master' and the middle connector is labelled 'Slave'. If you configure the jumpers for both drives to use 'Cable Select', they are identified based on which connector is used. If the drives are jumpered for 'Master' and 'Slave', the connector does not identify the drive.

Serial advanced technology attachment (SATA)

Early data transmissions sent data between components one bit at a time, or serially. Engineers later improved this by sending multiple bits at a time to improve the speed. Therefore, data could be sent using multiple wires so that bits were next to each other or in parallel. The trade-off was that the cable needed more wires to send all the data at the same time. For example, a 40 pin EIDE ribbon cable includes 16 bits for data. If you send 16 bits at a time, you can send as much as 16 times more data than if you send just one bit at a time at the same speed. The idea that parallel is faster than serial held for many years, until a breakthrough with low voltage differential (LVD) signaling occurred. LVD signaling is a standard that transmits data as the difference in voltages between two wires in a pair. These differences can be rather small and engineers discovered they could send data serially along an WO cable quicker than they could with parallel. Many technologies use LVD signaling, including SATA drives, hyper transport used by AMD processors, and FireWire.

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SATA generations

Three generations of SATA are currently in use. It is important to know the capabilities of each and also to recognise the different names that have been used. Table 4 below outlines the different versions and their speeds.

Table 10.4 Different versions of SATA and their speeds

Generation	Bit Speed	Byte Speed	Names
SATA 1	1.5 Gbits/s	150 MBps	SATA 1.5G, SATA 1.5Gb/s, SATA 1.5Gbit/s, SATA 150
SATA 3	3.0 Gbits/s	300 MBps	SATA 3G, SATA 3Gb/s, SATA 3Gbit/s, SATA 300
SATA 3	6.0 Gbits/s	600 MBps	SATA 6G, SATA 6Gb/s, SATA 6Gbit/s, SATA 600

PATA versions are commonly described using speeds rated in bytes per second (Bps), and SATA versions often use bits per second (bps). For example, SATA 1.0 can transfer data at 150 MBps, but it is commonly listed as 1.5 Gbit/s. One of the things that has confused people about SATA is the similarity of the names SATA 3.x and SATA 3G. Some products are marketed as SATA 3G, and customers think they are getting a third-generation SATA product. SATA 3G refers to a transfer rate of 3 Gbits/s provided by the second generation of SATA.

SATA and SSD (Solid State Drive)

Before SATA, hard drives were typically capable of sending data faster than the motherboard could accept it. The interface was the bottleneck. Even though each newer ATA version allowed faster data transfers, the drives were still faster than the interface. It is different with SATA 6G. You will not be able to find a mechanical hard drive that can transfer as much as 6 Gbits/second (or 600 MBps). Some extremely fast and extremely expensive hard drives can transfer data as quickly as 157 MBps. That is, these drives benefit from using

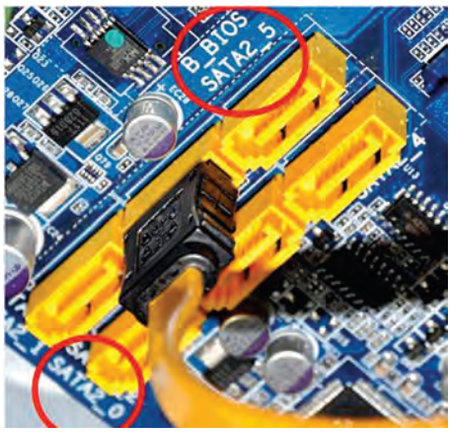

Fig. 10.14: SATA port in motherboard

SATA 3G but they never exceed 300 MBps, so they do not benefit from SATA 6G. You just will not see any performance difference in these hard drives if you plug them into a SATA 3G or SATA 6G port. With this in mind, you might be wondering, why would you want SATA 6G? The answer is, for solid state drives (SSDs). They are discussed later in this chapter, but in short, they don't have any moving parts and are much faster. Such are available that can read and transfer data as fast as 500 MB/s.

SATA data connectors and cables

SATA cables are much smaller than the 80 wire ribbon cables used with PATA. They include only seven wires, and cables can be as long as one meter (about 3.3 feet). A distinctive characteristic of SATA cables is that they have an L-shaped connector, which works as a key. Each drive is connected to a single SATA connector on the motherboard, so you don't have to worry about Master/Slave jumpers on SATA drives. Figure 10.14 shows part of a motherboard with five SATA ports. SATA 5 is on the left as a single unoccupied port. Ports 1 and 2 are stacked and ports 3 and 4 are stacked, allowing more ports in the same amount of space.

The colour coding for the wires is as follows:

(i) orange 3.3V to pins 1, 2, and 3,

(ii) black to pins 4, 5, and 6,

(iii) red 5V to pins 7, 8, and 9,

(iv) black for pins 10, 11 and 12, (pin 11 can be used to delay the startup of the drive or to indicate drive activity),

(v) 17 yellow 12V to pins 13, 14, and 15.

Fig. 10.15: Back of SATA HDD

Figure 10.15 shows the back of a SATA drive, along with the power cable from the power supply. The SATA data connection is on the right, and you can see that both have the distinctive L shaped key, although the power connector is larger. Also, the power connector has a square tip on one side.

Hot-swappable

All versions of SATA drives are hot-swappable, which means that you can plug in or remove the drive while the system is powered on. Several ground pins on the power cable are longer than the pins carrying voltage so that the ground pins connect first. This prevents any damage when they are plugged in. In contrast, you must power down a system before replacing a PATA drive. You are not likely to replace an internal SATA drive while the system is powered on. However, some systems have drive bays that allow you to plug in or remove a drive from the front panel or that are in an external enclosure. If a drive fails, you can swap it out without powering down the system.

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Check Your Progress

A. Multiple choice questions

1. The concentric circles on the platter of hard disk are known as_____.
   (a) tracks (b) circles
   (c) sectors (d) None
2. _____ is used for writing/reading of data to/from a magnetic ribbon.
   (a) Magnetic disk (b) Magnetic tape
   (c) Magnetic frames (d) Magnetic ribbon
3. The disk's surface is divided into a number of invisible concentric circles called_____.
   (a) drives (b) tracks
   (c) slits (d) references
4. Which of the following is not a part of disk address?
   (a) Sector size (b) Sector number
   (c) Track number (d) Surface number
5. Hard disk are organised as_____.
   (a) cylinders
   (b) tracks
   (c) cylinders and tracks
   (d) master boot record
6. Hard disk can have _____ heads.
   (a) one (b) two
   (c) more than two (d) only one

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7. Hard disk drives are considered _____ storage.
   (a) flash (b) non-volatile
   (c) temporary (d) non permanent
8. Which of the following can hold data of at least one GB?
   (a) Hard disk (b) CD-ROM
   (c) Floppy disk (d) None of these
9. The hard disks record information by_____.
   (a) centrifugation (b) propagation
   (c) gravitation (d) magnetisation
10. Reading data is performed in magnetic disk by_____.
   (a) read/write leads (b) sectors
   (c) track (d) lower surface

B. Fill in the blanks

1. The hard disk drive (HDD) is the _____ long-term storage device used in personal computers.
2. A hard drive is divided into one or _____ partitions.
3. A portable HDD can be attached to the computer externally through a _____.
4. Data is transferred from the _____ platter through the read/write (R/W) head to the computer.
5. A HDD consists of multiple flat circular disks called _____.
6. The controller is a printed circuit board, mounted at the bottom of a _____.
7. Each platter of the hard disk is logically divided into many concentric circles known as _____.
8. A cylinder is the set of identical tracks on both surfaces of each drive _____.
9. Each track is logically divided into sections known as _____.
10. The data on hard disk is stored in the magnetic domains on the _____ material.
11. The data rate is the number of bytes per second that the drive can deliver to the _____.

C. State whether the statements are True or False

1. Magnetic disk is a sequential access device.
2. A hard disk drive fits outside a computer case.
3. During the life of a disk, is it true that defragmentation of the file system can significantly improve performance.
4. Serial data access is faster than direct data access.
5. Storage devices are hardware that reads data and programs from storage media.
6. Capacity of a storage device is usually measured in terms of meter.

7. Flash memory cards are credit card sized solid-state storage devices, which are widely used in notebook.
8. Writing is the process of saving information to the secondary storage device.
9. Optical disc storage devices have no moving parts.
10. Capacity of a storage device is usually measured in terms of bytes.

D. Short answer questions

1. What do you understand by a hard disk drive?
2. What are the physical components of a HDD?
3. What are the logical components of a HDD?
4. Explain the working of a hard disk.
5. What are the parameters to measure of disk drive performance?
6. List down the different types of HDD.
7. What are the different versions and the speeds of SATA drive?
8. Describe hard drive characteristics.

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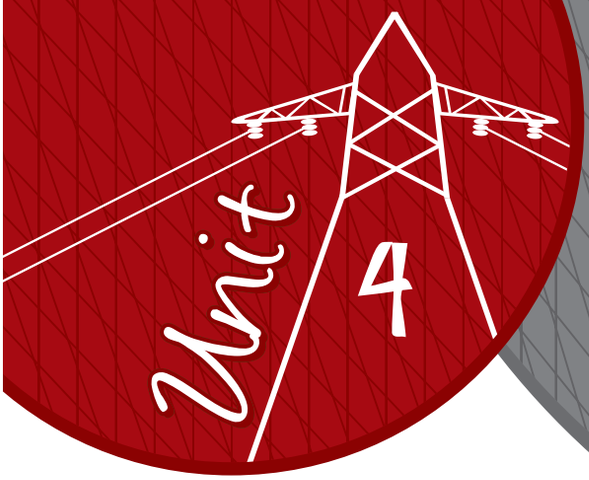

Computer Assembly and Disassembly

Introduction

Computer assembly is a process in which all the internal components of the computer system are fitted to make the computer functional. The main component involves CPU, motherboard, memory, disk drives, etc. There is a proper process of attachment and installation of each and every component. An installation technician should be competent to disassemble and reassemble the computer system. In this Unit, we will understand the step by step process of computer assembly and disassembly as a whole. The assembly and disassembly of the desktop as well as of a laptop computer is demonstrated.

Tools are an essential part of computer assembly and maintenance. It is also important to handle the tools carefully and safely. While installating a computer and its peripherals, you should follow the basic safety guidelines to prevent cuts, burns, electrical shock, and damage to eyesight. The technician has to take care of the tools as well as personal safety. Safe working practice helps to prevent injury to people and damage to computer equipment. In this Unit, we will learn to use various tools required for installation of a computer and peripherals. We will also understand and follow the basic safety precautions while handling tools and equipment during the installation process.

Chapter 11 Tools and Safety

Introduction

Tools are an essential part of computer assembly and maintenance. It is important to handle the tools carefully and safely. The technician has to take care of the tools as well as personal safety. Safe working practice helps to prevent injury to people and damage to computer equipment. A safe workspace is clean, organised, and properly lit. It is necessary to understand and follow safety procedures. In this Chapter, we will understand the safety precautions while handling tools as well as various tools required for installation of the computer.

Using Hardware Tools

For every job, there is a right tool. Use the correct tool for a task. Skilled use of tools and software makes the job less difficult and ensures that tasks are performed properly and safely. A tool kit should contain all the tools necessary to complete hardware repairs. Hardware tools are grouped into four categories—

(i) ESD tools (ii) Hand tools
(iii) Cleaning tools (iv) Diagnostic tools

ESD Tools

There are two ESD tools— the anti-static wrist strap and the anti-static mat.

The anti-static wrist strap protects computer equipment when grounded to a computer chassis. It is used to prevent ESD damage to computer equipment.

The anti-static mat protects computer equipment by preventing static electricity from accumulating on the hardware or on the technician. It is used to stand or place onto the hardware to prevent static electricity from building up.

Fig. 11.1: Different types of electronic cutters

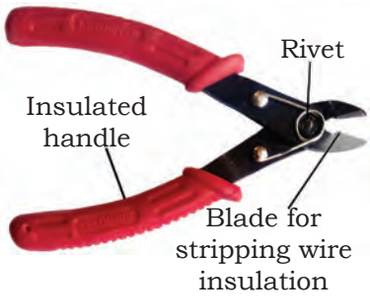

Fig. 11.2: Parts of electronic cutter

Fig. 11.3: Precise screwdriver

Fig. 11.4: Different bits of screwdriver

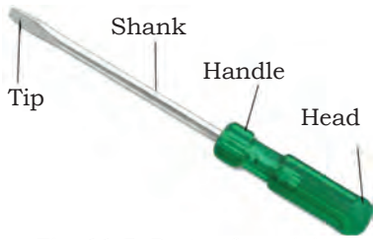

Fig. 11.5: Parts of precision screwdriver

Hand Tools

Most tools used in the computer assembly process are small hand tools. They are available individually or as part of a computer repair tool kit. Tool kits range widely in size, quality, and price.

Electronic cutter

This belongs to the family of pliers and cutter. It is used in printed circuit board and to cut fine wire. It is sharp enough and hence cannot damage the other nearby wires.

Precise screwdriver

Screwdriver is a hand held tool, commonly used for inserting and removing of screw. Screwdriver is made up of a bit and handle. Bits are detachable according to the use and are made up of metal, whereas handle is made up of insulating material.

Different types of precise screw drivers

Screwdrivers are available in different shapes of bit and size. The various bits can be attached to the screwdriver to work in different fashions. Some of the bits are mentioned below.

A Phillips head screwdriver

It is used to tighten or loosen cross-head screws.

A torx screwdriver

It is used to tighten or loosen screws that have a star-like depression on the top, a feature that is mainly found on laptops.

Hex Driver

A hex driver sometimes called a nut driver is used to tighten or loosen nuts in the same way that a screwdriver tightens screws.

Combination pliers

Combination pliers, as the name suggests, perform various operations. It enables the user to perform the

combined operation, that is, cutting and gripping. Some combination pliers have other additions, especially if they are designed for use in particular industries or for specific tasks.

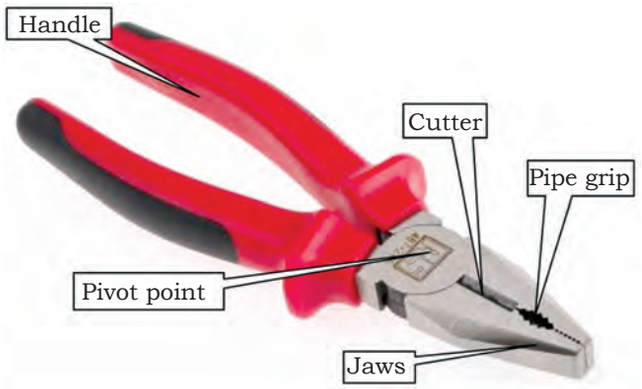

Fig.11.6: Combination pliers

Wire stripper

It is a portable handheld tool used by workers, especially electricians, for removing the protective coating of an electric wire in order to replace or repair the wire. It is also capable of stripping the end portions of an electric wire in order to connect them to other wires or to terminals. A wire stripper is often considered an important tool for professional electricians and other related personnel.

Fig.11.7: Wire stripper and its different parts

Crimper

This is used for the joining of stripped wire and special connector. Stripped wire is inserted through the correctly sized opening of the connector. And then crimper is used to tightly squeeze the opening against the wire.

Tweezers

These are used to manipulate small parts.

Fig. 11.8: Crimping tool for RJ 45 connector

Fig. 11.9: Tweezers

Punch down tool

It is used to terminate a wire into termination blocks. Some cable connectors must be connected to cables using a punch down tool.

Cleaning Tools

Soft lint-free cloth

It used to clean different computer components without scratching or leaving debris.

Compressed air

It used to blow away dust and debris from different computer parts without touching the components.

Cable ties

They are used to bundle cables neatly inside and outside of a computer.

Fig. 11.10: Punch down tool

Parts organiser

It used to hold screws, jumpers, fastners, and other small parts and prevent them from getting mixed up together.

Diagnostic Tools

Digital multimeter

It is used to test the integrity of circuits and the quality of electricity in computer components. A digital multimeter displays the information on an LCD or LED.

Loopback adapter

It is also known as a loopback plug and is used to test the basic functionality of computer ports. The adapter is specific to the port that you want to test.

Toner probe

It is a two-part tool. The toner part is connected to a cable at one end using specific adapters such as an RJ-45, coaxial, or metal clips. The toner generates a tone that travels the length of the cable. The probe part

traces the cable. When the probe is in near proximity to the cable to which the toner is attached, the tone can be heard through a speaker in the probe.

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Safety

While installing computer and peripherals, you should follow the basic safety guidelines to prevent cuts, burns, electrical shock, and damage to eyesight. As a best practice, make sure that a fire extinguisher and first aid kits are available in case of fire or injury. Place the cables in conduit or cable trays to prevent hazards. Some basic safety precautions to be followed when working on a computer are as below:

Basic safety guidelines

- Remove your watch and jewellery.
- Turn off the power and unplug equipment before installation.
- Never open a power supply or a CRT monitor.
- Do not touch the computer and the printer's part that use high voltage.
- Know about the location of fire extinguisher and its use.
- Take necessary precautions when lifting heavy objects to avoid injury.
- Keep food and drinks out of your workspace.

Electrical safety

Follow electrical safety guidelines to prevent electrical fires and injuries. Power supplies and CRT monitors contain high voltage.

Precautions

Do not wear the anti-static wrist strap when repairing power supplies or CRT monitors. Some components retain a high voltage even after the printer is turned off. Check the printer manual for the location of high-voltage components.

Fire safety

Follow fire safety guidelines to protect yourself and equipment. To avoid an electrical shock and to prevent

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damage to the computer, turn off and unplug the computer before beginning installation.

Fire can spread rapidly. Proper use of a fire extinguisher can prevent a small fire from getting out of control. When working with computer components, be aware of the possibility of an accidental fire and know how to react. Be alert for odours emitting from computers and electronic devices. When electronic components overheat or short out, they emit a burning odour. In case of fire, follow the following safety procedures—

- Never fight a fire that is out of control.
- Keep a planned fire escape route before beginning any work.
- Get out of the building quickly.
- Contact emergency services for help.
- Read the instructions on the fire extinguishers in workplace before you have to use them.

Be familiar with the types of fire extinguishers. Each type of fire extinguisher has specific chemicals to fight different types of fires (causes)—paper, wood, plastics, cardboard, gasoline, kerosene, organic solvents, electrical equipment, or combustible metals.

It is important to know how to use a fire extinguisher. Use the memory aid P-A-S-S to remember the basic rules of fire extinguisher operation:

P — pull the pin.

A — aim at the base of the fire, not at the flames.

S — squeeze the lever.

S — sweep the nozzle from side to side.

Protecting Equipment

Electrostatic discharge (ESD)

Electrostatic discharge (ESD) and poor-quality sources of electricity can cause damage to computer equipment. Follow proper handling guidelines, be aware of environmental issues, and use equipment that stabilises power to prevent equipment damage and data loss.

Static electricity is an electric charge resting on a surface. ESD occurs when this build-up charge jumps

to a component and causes damage. ESD can be destructive to the electronics in a computer system.

At least 3,000 volts of static electricity must build up before a person can feel ESD. For example, static electricity can build up on you as you walk across a carpeted floor. When you touch another person, you both receive a shock. If the discharge causes pain or makes a noise, the charge was probably above 10,000 volts. By comparison, less than 30 volts of static electricity can damage a computer component.

ESD can cause permanent damage to electrical components. Follow these recommendations to help prevent ESD damage:

- Keep all components in anti-static bags until you install them.
- Use grounded mats on workbenches.
- Use grounded floor mats in work areas.
- Use anti-static wrist straps when working on computers.

Electromagnetic interference

It is the intrusion of outside electromagnetic signals in a transmission media, such as copper cabling. In a network environment, EMI distorts the signals so that the receiving devices have difficulty interpreting them.

EMI does not always come from expected sources, such as cellular phones. Other types of electric equipment can emit a silent, invisible electromagnetic field. There are many sources of EMI:

- Any source designed to generate electromagnetic energy.
- Man-made sources like power lines or motors.
- Natural events such as electrical storms, or solar and interstellar radiations.

Wireless networks are affected by radio frequency interference (RFI). RFI is caused by radio transmitters and other devices transmitting in the same frequency. For example, a cordless telephone can cause problems with a wireless network when both devices use the same frequency. Microwaves can also cause interference when positioned in close proximity to wireless networking devices.

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Climate

This affects the computer equipment in variety of ways:

- If the environment temperature is too high, equipment can overheat.
- If the humidity level is too low, the chance of ESD increases.
- If the humidity level is too high, equipment can suffer from moisture damage.

Power fluctuations

Voltage is a measure of work required to move a charge from one location to another. The movement of electrons is called current. Computer circuits need voltage and current to operate electronic components. When the voltage in a computer is not accurate or steady, computer components might not operate correctly. Unsteady voltages are called power fluctuations.

The following types of AC power fluctuations can cause data loss or hardware failure:

- Blackout — complete loss of AC power. A fuse, damaged transformer, or downed power line can cause a blackout.
- Noise — interference from generators and lightning. Noise results in poor quality power, which can cause errors in a computer system.
- Spike — sudden increase in voltage that lasts for a short period and exceeds 100 per cent of the normal voltage on a line. Spikes can be caused by lightning strikes, but can also occur when the electrical system comes back on after a blackout.
- Power surge — dramatic increase in voltage above the normal flow of electrical current. A power surge lasts for a few nanoseconds, or one-billionth of a second.

Power protection devices

To help shield against power fluctuation problems, use devices to protect the data and computer equipment:

- surge suppressor — It diverts extra electrical voltage that is on the line to the ground. It helps to protect against damage from surges and spikes.

- Uninterruptible power supply (UPS) — It provides a consistent quality of power when power supply goes off. It helps to protect against potential electrical power problems by supplying a consistent level of electrical power to a computer or other device. The battery is constantly recharging while the UPS is in use. Never plug in a laser printer into a UPS because the printer could overload the UPS.

Proper Disposal to Protect Environment

To protect the environment it is essential to properly dispose or recycle the hazardous computer components.

Batteries

They contain rare earth metals that can be harmful to the environment. Batteries from portable computer systems contain lead, cadmium, lithium, alkaline manganese, and mercury. These metals do not decay and they remain in the environment for many years. Mercury is commonly used in the manufacturing of batteries and is extremely toxic and harmful for human beings. Hence, recycling of batteries should be adopted as a standard practice.

Monitors

They contain glass, metal, plastics, lead, barium, and rare earth metals. They must be disposed off in compliance with environmental regulations. CRT monitors must be handled with care. Extremely high voltage can be stored in these monitors, even after being disconnected from a power source.

Toner kits, cartridges, and developers

Used printer toner kits and printer cartridges must be disposed of properly or recycled. Some toner cartridge suppliers and manufacturers take empty cartridges for refilling. Some companies specialise in refilling empty cartridges. Kits to refill inkjet printer cartridges are available but are not recommended, because the ink might leak into the printer causing irreparable damage.

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Chemical solvents and aerosol cans

Contact the local sanitation company to learn how and where to dispose of the chemicals and solvents used to clean computers. Never dump chemicals or solvents down a sink or dispose them in a drain that connects to public sewers.

The cans or bottles that contain solvents and other cleaning supplies must be handled carefully. Make sure that they are identified and treated as special hazardous waste. For example, some aerosol cans explode when exposed to heat if the contents are not completely used.

CHECK YOUR PROGRESS

A. Fill in the blanks

1. The anti-static wrist strap _____ the computer equipment when grounded to a computer chassis.
2. Electronic cutter belongs to the family of pliers and _____.
3. Screwdriver is a hand held tool, commonly used for inserting and removing of _____.
4. Crimping tools is used for the joining of stripped wire and special _____.
5. Tweezers are used to manipulate _____ parts.
6. A punch down tool is used to terminate wire into termination _____.
7. Do not wear the anti-static wrist strap when repairing power supplies or _____ monitors.
8. Electrostatic discharge (ESD) and poor-quality sources of electricity can cause damage to the _____ equipment.
9. Keep all components in anti-static bags until you _____ them.
10. Voltage is a measure of work required to move a charge from one location to _____.
11. A surge suppressor diverts extra electrical voltage that is on the line to the _____.
12. UPS provides a consistent quality of power when power supply goes _____.

13. Batteries contains rare earth metals that can be harmful to the _____.
14. Used printer toner kits and printer cartridges must be disposed of properly or _____.
15. The cans or bottles that contain solvents and other _____ supplies must be handled carefully.

B. Short answer questions

1. What do you understand by a tool?
2. What are hardware tools?
3. What are the categories of hardware tools?
4. Define—
   (a) ESD tools (b) Hand tools
   (c) Cleaning tools (d) Diagnostic tools
5. What are the basic safety guidelines for installation of computer and peripherals ?
6. What is protecting equipment?

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Chapter 12 Computer Assembly and Disassembly

Introduction

Computer assembly is an essential job of a computer installation technician. The technician has to work in a logical, methodical manner while handling various computer components and peripherals. The technician can improve the computer assembly skills with practice. Computer assembly is a process in which all the internal components required for the computer system are fitted so as to make the computer functional. There is a proper sequence of attachment of each and every component into the computer system. To establish proper connectivity, one has to use the tools. Proper handling of tools is also required by the technician. It is required that students learn the steps of installation of each component. The main component involves installing CPU, motherboard, drives, video, graphics card, sound card, modem and adapter, and connectors, and system panel connector. In this Chapter, we will understand the step by step process of assembling a computer. It also covers the need for adequate system resources to efficiently run the customer's hardware and software.

Computer Assembly

As we know, computer assembly is a systematic process. First, arrange the computer parts. The sequence for assembly and working of the computer listed below is as:

- Open the case.
- Install the power supply.
- Attach the components to the motherboard.
- Install the motherboard.
- Install internal drives.
- Connect all internal cables.
- Install motherboard power connections
- Connect external cables to the computer.
- Boot the computer for the first time.

Prepare the workspace before starting installation of the computer. There should be adequate lighting, good ventilation, and a comfortable room temperature. The workbench or table should be accessible from all sides. Avoid cluttering the surface of the workbench or table with tools and computer components. An anti-static mat on the table will help to prevent physical and electrostatic discharge (ESD) damage to equipment. Small containers can be used to hold small screws and other parts as they are being removed.

Fig. 12.1: Unscrew cabinet

Material Required

- Computer case, with power supply installed
- Motherboard
- CPU
- Heat sink/fan assembly
- Thermal compound
- RAM module(s)
- Motherboard standoffs and screws
- Anti-static wrist strap and anti-static mat
- Tool kit

Fig. 12.2: Pull cabinet side cover

Procedure

Step 1: Open the case

- The first step in assembling a computer is to open the computer case (see Figure 12.1). There are different methods for opening cases.
- The computer comes with various types of cabinets. The method for opening the case is different based on the manufacturer.
- To open the case, first remove the screws of the left side cover and slide the side cover (see Figure 12.3).

Fig. 12.3: Unscrew bolts

Step 2 : Install the power supply

The next step is to install a power supply (see Figure 12.4). There are usually four screws that attach the power supply to the case. Power supplies have fans that can vibrate and loosen screws that are not secured. When installing a power supply, make sure that all of the screws are used and that they are properly tightened.

Fig. 12.4: Insert power supply

- Insert the power supply into the case.
- Align the holes in the power supply with the holes in the case.
- Secure the power supply to the case using the proper screws.

Fig. 12.5: Installing CPU on the motherboard

Step 3: Attach the components to motherboard

The motherboard has to be prepared before its installation. To prepare the motherboard, you first need to install the CPU, then the heat sink on the CPU and CPU fan.

CPU

The CPU and motherboard are sensitive to electrostatic discharge. So place them on a grounded anti-static mat and wear an anti-static wrist strap while handling the CPU. When handling a CPU, do not touch the CPU contacts at any point. The CPU is secured to the socket on the motherboard with a locking assembly.

Thermal compound which is used to conduct heat away from the CPU is applied on the top of CPU. In case of an old CPU, first clean the top of the CPU, and then apply the thermal compound. Clean the top of the CPU and the base of the heat sink with isopropyl alcohol and a lint-free cloth. This removes the old thermal compound. Then apply a new layer of thermal compound (see Figure 12.6).

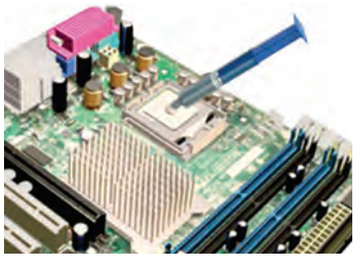

Fig. 12.6: Applying thermal compound on CPU

Fig. 12.7: Screw the heat sink

Heat sink and fan assembly

Heat sink and fan assembly is a two-part cooling device. The heat sink draws heat away from the CPU. The fan moves the heat away from the heat sink. The assembly has a 3-pin power connector.

To install a CPU and heat sink and fan assembly, follow these steps:

- First, open the CPU load plate. Align the CPU orientation so that the notches on the CPU are aligned with the orientation keys on CPU socket.
- Place the CPU gently into the socket.
- Close the CPU load plate.
- Close the load lever.
- Apply a small amount of thermal compound to top of the CPU (see Figure 12.6).

Fig. 12.8: Screw the heat sink fan assembly

- Screw the CPU fan on the heat sink.
- Align the heat sink and fan assembly with the holes on the motherboard.
- Place the assembly onto the CPU socket carefully.
- Screw the assembly on the motherboard (see Figure 12.8).
- Connect the assembly power cable to the CPU fan connector on the motherboard.

Installation of RAM

It is better to install the RAM first on the motherboard and then fix the motherboard in the case. To install RAM, first ensure its compatibility with the motherboard. If DDR3 is mentioned on the motherboard, then DDR3 RAM may be fixed in the memory slot. To install RAM, follow these steps.

Fig. 12.9: Memory slot

- Press down the side locks of the memory slot (see Figure 12.9). Align the notches on the RAM module to the keys in the slot and press down on both ends of RAM module until the side lock gets locked.
- Make sure that the side tabs have locked the RAM module.
- Repeat the above steps to install additional RAM modules.

Step 4: Install motherboard

After preparing the motherboard, you can install the computer case, as shown in Figure 12.10. Plastic and metal standoffs are used to mount the motherboard and to prevent it from touching the metal portions of the case. To install the motherboard, follow these steps:

Fig. 12.10: Lay the motherboard over the standoffs

- Lay the motherboard over the standoffs to mount it on the holes.
- Align the screw holes of the motherboard with the standoffs.
- Then screw the board using a standard screwdriver.
- Tighten all the motherboard screws.
- Connect the 4-pin ATX power connector from the power supply to the motherboard.

Fig. 12.11: Tighten all the motherboard screws

Fig. 12.12: Insert hard disk

Fig. 12.13: Tighten screws of HDD

Fig. 12.14: Insert optical drive

Fig. 12.15: Tighten screws of optical drive

Fig. 12.16: Connect cable IN to HDD

Step 5: Install internal drives

Hard drive

The hard drive is the device which stores all the data. It is 3.5 inch wide and needs to be mounted so that access to the cable connections on the back is gained. Drives that are installed in internal bays are called internal drives. A hard disk drive (HDD) is an example of an internal drive. To install HDD, follow these steps:

- Position the HDD so that it aligns with the 3.5 inch drive bay.
- Insert the HDD into the drive bay so that the screw holes in the drive line up with the screw holes in the case (see Figure 12.12).
- Secure the HDD to the case using proper screws (see Figure 12.13).

Optical drive

- Position the optical drive so that it aligns with the 5.25 inch drive bay.
- Insert the optical drive into the drive bay so that the optical drive screw holes align with the screw holes in the case (see Figure 12.14).
- Secure the optical drive to the case using the proper screws (see Figure 12.15).
- Connect the power cable coming from the SMPS to the power socket of optical drive.
- Connect SATA data cable from optical drive socket to the motherboard socket.

Step 6: Connect all internal cables

Power cables are used to distribute electricity from the power supply to the motherboard and other components. Data cables transmit data between the motherboard and storage devices, such as hard drives.

Step 7: Install motherboard power connections

Just like other components, motherboards require power to operate. The Advanced Technology eXtended (ATX) main power connector will have either 20 or

24 pins. The power supply may also have a 4-pin or 6-pin auxiliary (AUX) power connector that connects to the motherboard. A 20-pin connector will work in a motherboard with a 24-pin socket. Follow these steps for motherboard power cable installation:

- Align the 20-pin ATX power connector with the socket on the motherboard.
- Gently press down on the connector until the clip clicks into place (see Figure 12.18).
- Align the 4-pin AUX power connector with the socket on the motherboard.
- Gently press down on the connector until the clip clicks into place (see Figure 12.19).

Fig. 12.17: Press cable socket for proper connection

Fig. 12.18: Plug-in 20-pin ATX power connector to motherboard

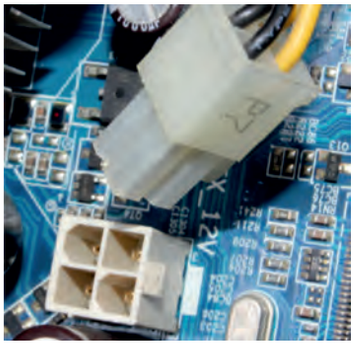

Fig. 12.19: Plug-in 4-pin AUX power connector to motherboard

SATA power connectors

SATA power connectors use a 15-pin connector (see Figure 12.20). Serial advanced technology attachment (SATA) power connectors are used to connect to hard disk drives, optical drives, or any devices that have a SATA power socket.

Step 8: Connect external cables to the computer

Setting up the computer system involves the complete process of establishing the proper connectivity of various parts of the computer system—input and output devices, connectivity of computer with the surge power supply. Reattach the side panels to the case. The process of connecting the external cables given below:

Fig. 12.20: Plug-in 15-pin connector to HDD

Locate the monitor cable

Locate the two power cable and one VGA cable or monitor cable (see Figure 12.21). The VGA cable is used to connect to monitor and another point on to the back side of the cabinet. If you are having trouble finding these, refer to the instruction manual of or the computer. You can skip to 'Step 3', in case of all-in-one computer that is built into the monitor.

Fig. 12.21: Display cable and ports

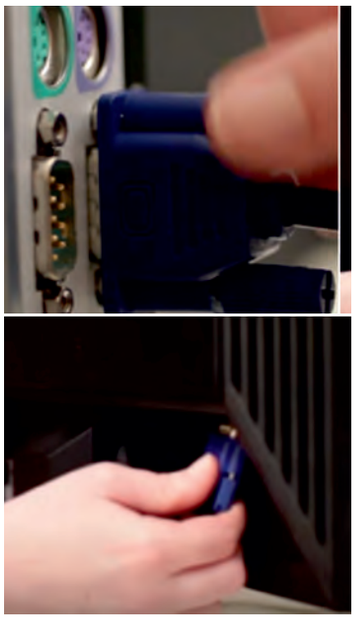

Fig. 12.22: Connecting VGA or monitor cable to the port on back panel of computer

Connecting monitor

Connect one end of the cable to the monitor port on the back of the computer case and the other end to the monitor. In case of VGA cable as shown in Figure 12.22 tighten the screws on the monitor cable to secure it.

The cables will only fit in a specific way. If the cable does not fit, do not force it, otherwise the connectors might get damaged. Make sure the plug aligns with the port, then connect it. So, first identify all the cables, ports, and connectors.

Connecting keyboard

Unpack the keyboard and determine whether it uses a USB (rectangular) connector or a PS/2 (round) connector. If they have colour coded plugs that are light green and lavender, plug them into the corresponding colour-coded ports, it is more likely if they use round PS/2 connectors. If it uses a USB connector, plug it into any of the USB ports on the back of the computer. The following Figures 12.23 and 12.24 shows connecting keyboard in PS/2 connector and USB connector.

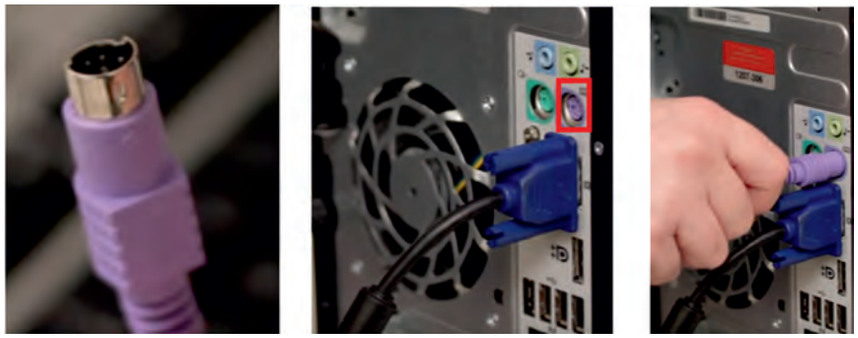

Fig. 12.23: Connecting keyboard in PS/2 port

Fig. 12.24: Connecting keyboard in USB port

Connecting mouse

Unpack the mouse and determine whether it uses a USB or PS/2 connector. If it uses a USB connector, plug it into any of the USB ports on the back of the computer. If it uses a PS/2 connector, plug it into the green mouse port on the back of the computer. In case of wireless mouse or keyboard, connect a Bluetooth dongle (USB adapter) in one of the USB ports of the computer. However, it is not necessary to connect an adapter for the modern computers which have built-in Bluetooth.

Fig. 12.25: Connecting mouse (a) in PS/2 port (b) in USB port

Connecting headphones or speakers, and microphone

Connect the external speakers or headphones, to computer's audio port (either on the front or back of the computer case). The modern computers have colour-coded ports. Speakers or headphones connect to the green port, and microphones connect to the pink port. The blue port is the line-in, which can be used with other types of devices. They can be also connected to the USB port. Some speakers, headphones, and microphones have USB connectors instead of the usual audio plug. Connect them to any USB port. Some computers have speakers or microphones built into the monitor.

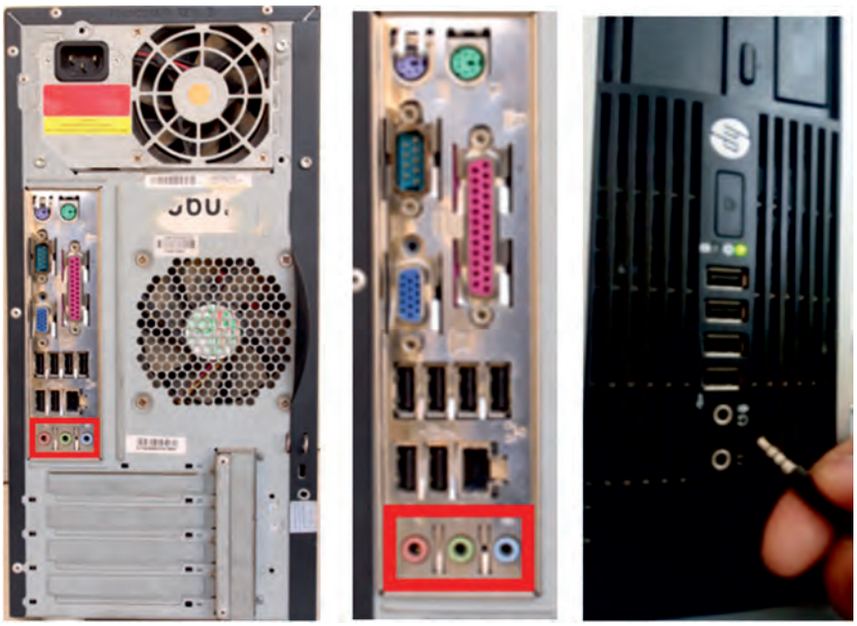

Fig. 12.26: Connecting speakers or headphones, and microphone

Fig. 12.27: Plug the surge protector into a wall outlet

Connect the computer to a power supply

Locate the two power supply cables that came with the computer. Plug the first power supply cable into the back of the computer case and then into a surge protector. Then, using the other cable, connect the monitor to the surge protector. It is better to use an uninterruptable power supply (UPS), which acts as a surge protector and provides the back up when the power goes off.

Ups (uninterruptible power supply)

While working on computer, its power supply should not be interrupted. UPS is like a power bank which gives power to the computer system. So make sure to plug power cable of monitor and cabinet into the UPS power output socket. Ensure the connection is proper.

Fig. 12.28: UPS

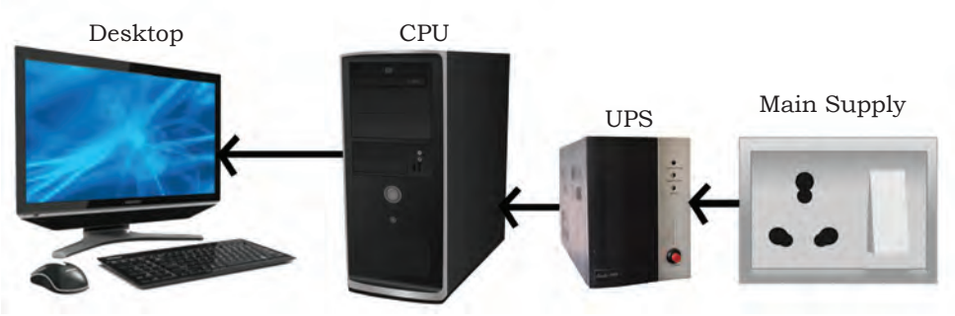

Fig. 12.29: Power connection (CPU through UPS)

Plug the surge protector

Plug the surge protector into a wall outlet after finishing the connectivity of all the parts and peripherals, plug the surge protector into the main power supply. You may also need to turn on the surge protector if it has a power switch.

Connecting printer, scanner, webcam

To connect the peripherals such as printer, scanner, webcam, identify the respective connectors of the cable and port on the cabinet. Plug in the connectors of these peripherals in respective ports. Correctly plugging in will recognise the peripherals as they are plug and play devices.

It may be required to install their software drivers for them to function properly. Use the instructions included with the device to install them if necessary. Installation of peripherals is optional, and it be can added at any time; it may not be required during the initial setup of your computer.

Checklist the following before starting the computer:

- VGA cable of monitor is connected to the cabinet or not.
- Power cable of monitor and cabinet has been plugged into the UPS power output socket. Make sure monitor is connected to the power supply or not.
- Keyboard and mouse both are connected to their proper ports.

Fig. 12.30: Proper connectivity of parts of computer system

Step 9: Starting the computer

To start the computer, it is necessary to follow the correct sequence to start up. Now push the power button on the CPU to start the computer. Practically when we start our vehicle, we always check that the light or air conditioner (AC) is off. Otherwise it will consume more power compared to normal start up.

Always remember that the first step is to push power button of the CPU than the monitor's. Because the monitor consumes more electricity when powered. An operating system or system software like Window or Linux will start loading as shown in Figure 12.31, 12.32, and 12.33 and the home window will appear as shown in Figure 12.34, 12.35, and 12.36. Now your computer is ready to use.

Fig. 12.31: Starting window of Windows 10

Fig. 12.32: Starting window of Windows 7

Fig. 12.33: Starting window of Ubuntu

NOTES

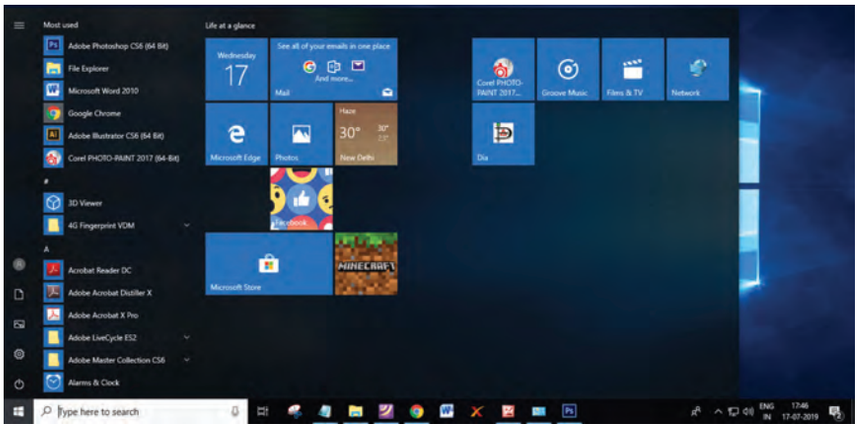

Fig. 12.34: Home window of Windows 10

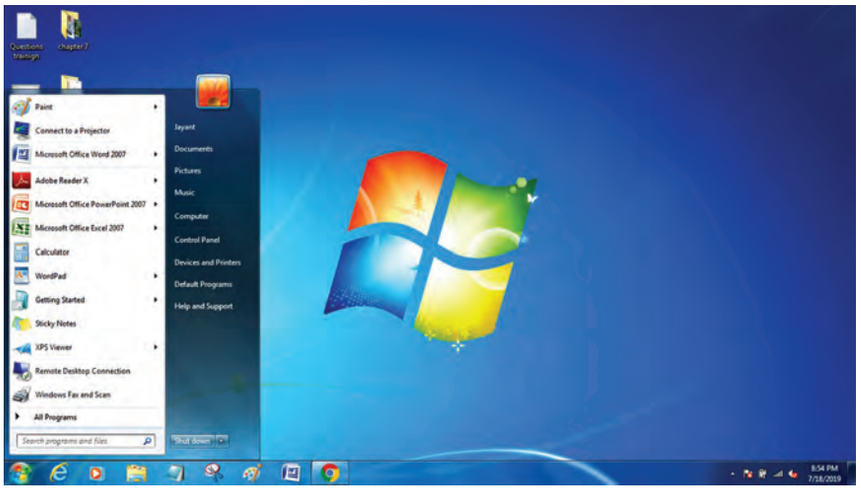

Fig. 12.35: Home window of Windows 7

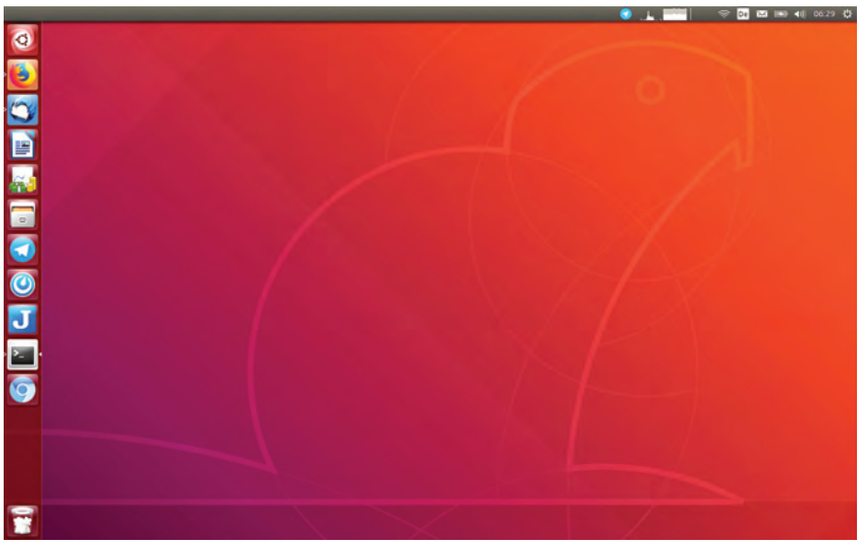

Fig. 12.36: Home window of Ubuntu

Computer Disassembly

Disassembly is the process of breaking down a device into separate parts. Disassembly of any device is required to determine a problem, to replace a part, or take the parts and use them in another device. A computer is also an electronic device which requires disassembly for such issues. For example, if a RAM gets dysfunctional in a computer, then it requires disassembling the computer to take out the dysfunctional RAM and replace it with new RAM chips. As we know, computers have standard internal components, but the way of placement may vary as per the PC tower case and different brands of computer. The best way is to refer to the manufacturer instructions manual. But in general there is a standard process of computer disassembly, which is demonstrated in this session. Just like computer assembly, the disassembly is a standard process. The process involves unplugging of all the cords and cables connecting a component to other components, then removing the part from the case or frame. Components can be attached to the case with special clips, screws, or by insertion into a holder. A small amount of force is required to remove each part of the computer system.

Fig. 12.37: CPU

Material Required

- One working PC
- An anti-static wrist strap
- An anti-static mat
- Anti-static bags of various sizes
- Technician's toolkit
- A plastic cup or box to organise screws, nuts, and bolts

Procedure

The disassembly procedure of computer is demonstrated as below.

Step 1: Unplugging

- Unplug the power cord from the PC and from the wall socket to prevent any injuries and damage of the PC from electrostatic discharge (ESD).

- Unplug all the peripherals attached to the computer, such as the keyboard, mouse, monitor, headphones, and any external drives.
- Wear a grounding strap to discharge any static electricity.

Step 2: Open the case

The computer comes with various types of cabinets. The methods of opening the case are different based on the manufacturer.

- To open the case, first remove the screws of the left side cover and slide the side cover.
- Pull the latch to release the side panel. Then lift the side cover out from the chassis.

To remember connectivity of internal cables, take the photographs of internal circuitry. It will help to assemble back the system.

Fig. 12.38: Unscrew cabinet

Fig. 12.39: Pull cabinet side cover

Step 3: Disconnect all the connectors

Disconnect all the connectors connected to the motherboard. These include SATA power cable and data cable of HDD as well as SATA cable of optical drive.

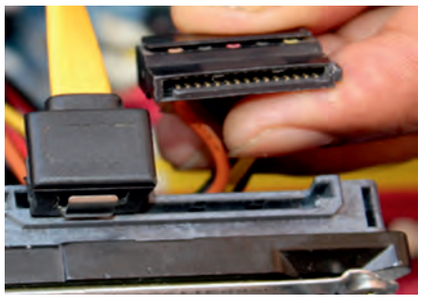

Fig. 12.40: Unplug 15-pin connector from HDD

Fig. 12.41: Unplug 7-pin connector from HDD

Step 4: Remove the fan

Remove the fan now. Most computers have two fans—the system fan and CPU fan. The system fan is located at the back side of the computer to blow air into the computer. The CPU fan is located on top of the CPU heat sink. The fans and its connectors are labelled with their names.

To remove the system fan, first, disconnect its connector from the motherboard. Then, unscrew it from the outside of the back of the case and lift the fan out of the system (see Figure 12.43).

To remove the CPU fan from the heat sink, first, disconnect its connector from the motherboard. Then remove the four screws securing it (see Figure 12.44).

Fig. 12.42: Unscrew fan

Fig. 12.43: Remove the system fan

Fig. 12.44: Unscrew heat sink

Step 5: Remove the power supply

The power supply is connected to the motherboard by a 20-pin connector and 4-pin connector. It is also connected to hard disk drive and the optical drive. Firstly, disconnect hard disk drive and the optical drive connectors from the motherboard (see Figure 12.47).

Fig. 12.45: Unplug 20-pin ATX

Fig. 12.46: Unplug 4-pin AUX power connector from power connector from motherboard

Fig. 12.47: Unplug SATA cables from motherboard

- Disconnect the power cable of the hard disk and optical drive which connects to the SMPS (see Figure 12.48).
- Remove the screws that secure the power supply unit to the chassis (see Figure 12.49).
- Carefully lift the power supply out of the chassis (see Figure 12.50).

Step 6: Removing HDD and optical drive

- Remove the SATA cable connecting to the HDD and motherboard.

Fig. 12.48: Unplug power cable from optical drive and HDD

Fig. 12.49: Remove the screws

Fig. 12.50: Unscrew the SMPS and remove it from cabinet

- Then unscrew the four screws securing it in place and pull out the HDD (see Figure 12.52).

Fig. 12.51: Unscrewing of HDD

Fig. 12.52: Remove HDD

Step 7: Remove RAM (random access memory) modules

Fig. 12.53: Unplug the RAM from slot

RAM allows for the transfer of information to and from the CPU. Computer runs fast with more RAM. Most computers have four RAM slots, and two RAM chips.

To remove the RAM, push down on both tabs holding the RAM in place, which are located at both ends of

the RAM. It will cause the module to pop up for easy removal.

Step 8: Remove expansion cards

The modern motherboards are integrated with the audio, video and network cards. However, if your computer has the expansion card as shown in Figure 12.54, insert into the expansions slot to increase the functionality. The expansion card is screwed with a single screw on top of expansion card slot.

- To remove the expansion cards, disconnect the cables attached to it.
- Remove the screws securing the card in the slot.
- Carefully take out the card from the slot.

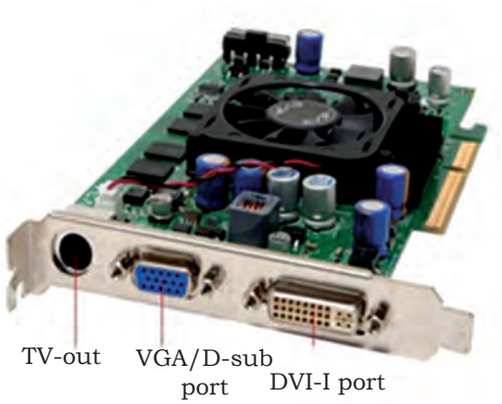

Fig. 12.54: Expansion card

Step 9: Remove motherboard

Every part of the computer is attached to the motherboard. The CPU, RAM, and expansion cards are directly attached to the motherboard.

To remove the motherboard, disconnect all the cables from the motherboard. It has seven screws holding it to the frame. Remove these screws and then lift the motherboard out of the frame.

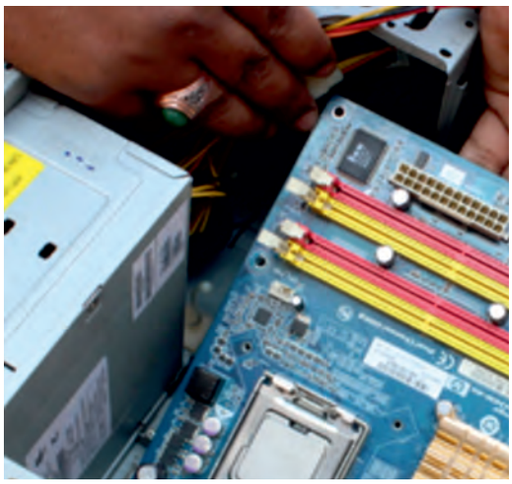

Fig. 12.55: Removing the motherboard

Step 10: Reassemble the components

- Identify every component and take its photograph.
- After identification of each component, put all the components back in their place and ensure that all cables and wires are connected at the right place to avoid further troubleshooting.
- Close the case and put the screws back in their place.
- Lastly, connect every external device such as the keyboard, mouse, monitor, etc., and turn on the computer to see everything is working fine after assembled.

NOTES

Practical Exercise

Identify and list the various internal components of the computer system:

- Form a group of 35 students.
- Take any old computer system.
- Disable the computer system as per the procedure.
- Identify and name the various internal components of the computer system.
- Identify their brands and list the specifications.
- Test the compatibility of the components with the motherboard.

ASSEMBLING OF LAPTOP

Material Required

- Laptop
- Mini screwdriver
- Anti-static wrist strap
- Magnifying glass

Procedure

Step 1: Keep track of screws

There are several types of small screws that are used throughout the laptop. Place these in small envelopes and write the component name on the envelope. Be organised and keep track of all the screws. We have to figure out how to remove the back panel.

Fig. 12.56: Back panel of a laptop

NOTES

Step 2: Installation of processor

First component to be installed is the processor. Take extreme care not to touch the pins in the socket during the process (see Figure 12.57 and 12.58).

Fig. 12.57: Unscrew the socket

Fig. 12.58: Fit processor in the socket

Step 3: Pop in the video card

First, find the baggie with three larger silver screws and two small black screws to install the graphics card. Hold the card at about a 30-degree angle as you insert its edge connector into the video-card slot near the center of the motherboard. Press the card in and downward, and then use the two small black screws to secure it in place.

Step 4: Set up the drive

The motherboard SATA connectors are along the front, right edge, and under the lip of the laptop's shell. Drop the drive into place and then carefully use your thumb to push the drive into the SATA connectors. Now use the remaining two screws to secure the drive in place.

Step 5: Add memory

To install memory, locate the memory slots on the motherboard. Align the notches on the memory module with the ridge in the slot. Firmly push the module until the clips on the side of the slot snap into place.

Step 6: Final assembly

Now that all the hardware components are installed, find the four screws you removed from the ACE door,

slide the door back into place, and replace the screws. To prepare for power up, pop in the notebook's battery pack, connect the power brick and plug it into a wall outlet. Finally, open the laptop's cover with one hand, use your other hand to press the power button.

Disassembly of Laptop

Procedure

Step 1: Removal of battery

Start the disassembly process by removing the battery (see Figure 12.59). Remove one screw securing the optical CD/DVD drive. Pull out the optical drive and remove it. Remove all the screws securing the bottom case. There are two screws hidden under the two laptop bottom feet. Remove the bottom screws. Peel off the bottom from the case to access the hidden screws. Remove the hidden screws from both sides of the notebook.

Fig. 12.59: Remove battery and optical drive

Fig. 12.60: Separate palm rest from bottom case

Step 2: Separation of palm rest

Using a plastic case opener, separate the palm rest from the bottom case as shown in Figure 12.60.

Step 3: Removal of bottom case

Turn the notebook upside down and remove the bottom case.

Step 4: Disconnecting the hard drive cable from the motherboard

Remove the three screws fixing the hard drive bracket to the case. Disconnect the hard drive cable from the motherboard.

Fig. 12.61: Remove screws from the hard drive and disconnect it

Fig. 12.62: Open the connector and release hard drive cable

Step 5: Remove the hard drive

Remove the hard drive assembly from the notebook. If you are going to replace it with another hard drive or SSD, you will have to transfer the mounting bracket and the SATA cable.

Fig. 12.63: Remove hard drive assembly

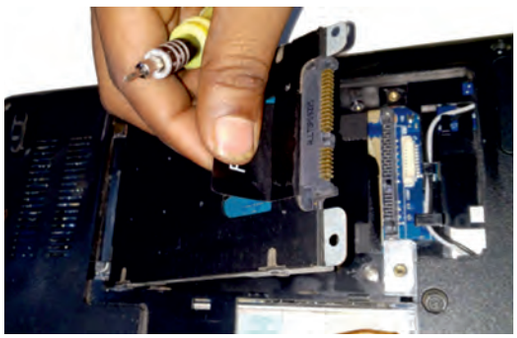

Fig. 12.64: Disconnect SATA cable

Step 6: Removal of RAM

A notebook PC motherboard has two memory slots. Remove both RAM modules if necessary.

Fig. 12.65: Remove RAM memory modules

Step 7: Disconnection of cable

Remove the one screw fixing the USB LED status board. Disconnect the cable from the motherboard.

Step 8: Removal of USB LED status board

Remove the USB LED status board.

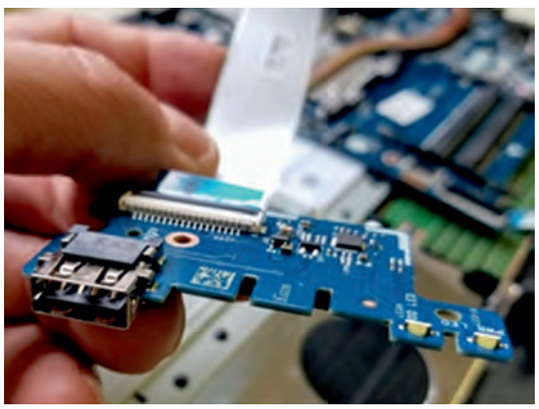

Fig. 12.66: Remove USB LED status board

Fig. 12.67: Remove optical CD DVD drive connector board

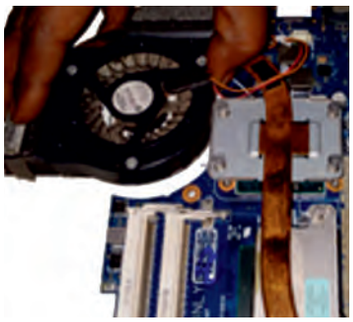

Fig. 12.68: Remove cooling fan

Step 9: Removal of screw fixing the optical CD/DVD drive connector board

Remove the one screw fixing the optical CD/DVD drive connector board. Disconnect the cable from the motherboard.

Step 10: Removal of the cooling fan

Remove the two screws fastening the cooling fan to the case. Unplug the fan cable from the motherboard and remove the cooling fan (see Figure 12.68).

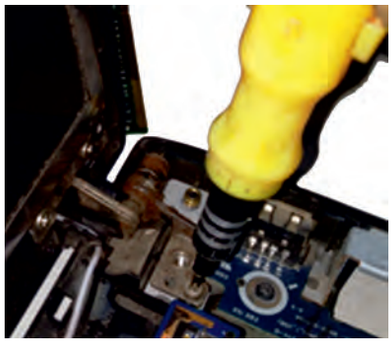

Fig. 12.69: Remove screws fastening display hinge

Fig. 12.70: Open the hinge and remove DC power jack

Step 11: Removal of DC power jack

In a notebook PC, the DC power jack is mounted under the hinge. Remove it. Disconnect the Wi-Fi antenna cable from the wireless card. Disconnect the DC power jack harness from the motherboard. Move all cables aside and remove the two screws from the display hinge. Open up the hinge and remove the DC power jack.

Fig. 12.71: DC power jack mounted under display hinge

Fig. 12.72: Disconnect Wi-Fi Module

Step 15: Removal of screw securing the board

The power button board is also mounted under the same hinge. Remove the one screw securing the board and unplug the cable from the motherboard.

Step 12: Removal of motherboard

Separate the motherboard from the top case and remove it. The other side of the motherboard is shown in Figure 12.74.

In a notebook PCs, the keyboard is permanently attached to the top case with rivets. When the keyboard fails, it is necessary to replace the top case. The touchpad is glued to the top case but the touchpad button board can be removed.

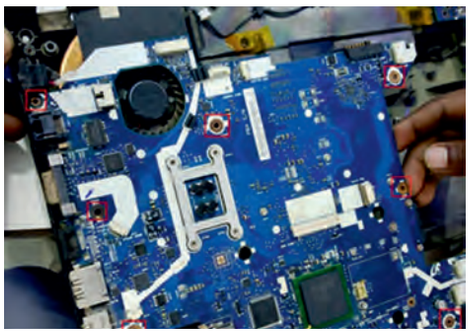

Fig. 12.73: Disconnect cables from motherboard and remove screws

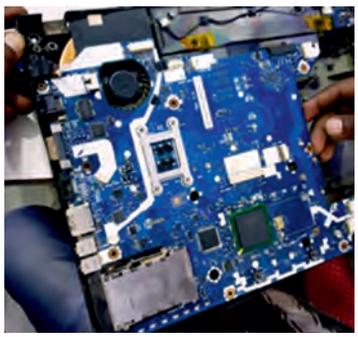

Fig. 12.74: Remove the motherboard from notebook case

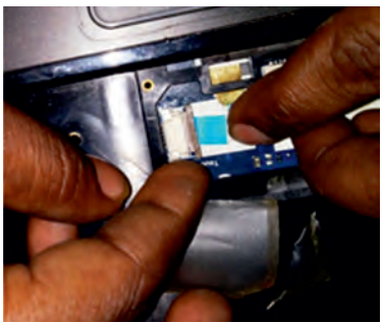

Fig. 12.75: Keyboard permanently attached to top case

Laptop LCD Screen Removal

Procedure

It is possible to disassemble the LCD screen of a laptop independently. Previous steps are not required for disassembling the display, you only need to disconnect the battery before you start.

Step 1: Separate the display bezel from the back cover. You will have to wiggle the bezel to unfasten it from the cover. Start on the top and move to the sides for the display assembly.

Step 2: On the bottom, the bezel is attached to the LCD screen with adhesive tape. Carefully separate it from the screen.

Step 3: Remove the bezel completely.

Step 4: Remove the four screws securing the LCD screen to the side brackets (see Figure 12.77).

Fig. 12.76: Notebook PC LCD screen removal

Fig. 12.77: Remove the four screws securing LCD screen

Step 5: Separate LCD screen from the back cover and place it the front side down on the keyboard.

Fig. 12.78: Remove screen bezel

Fig. 12.79: Separate LCD screen from back cover

Step 6: Now you can access the video cable connector (see Figure 12.80).

Step 7: Peel off the grounding tape from the screen.

Step 8: Peel off the clear tape securing the connection and unplug the video cable from the screen.

Fig. 12.80: Disconnect video cable from screen

Fig. 12.81: Remove and replace LCD screen

Step 9: Remove the LCD screen completely and replace if necessary (see Figure 12.81).

Step 10: You can find a new LCD screen using the model number from the original one.

Practical Exercise

Visit the different manufacture's websites for assembly and disassembly of various models of laptops from different brands.

Check Your Progress

A. Multiple choice questions

1. What type of compound is used to maintain heat distribution between the CPU and heat sink?
   (a) Silicon spray (b) Graphite paste
   (c) Glue (d) Thermal compound
2. Which is one of the following tools would be helpful in building a computer?
   (a) Hammer (b) Allen wrench
   (c) Screwdriver (d) Duct tape
3. Who makes the most popular processors?
   (a) Microsoft (b) AMD
   (c) Intel (d) Apple
4. The speed of a processor is measured in _____.
   (a) Gigabytes (GB) (b) Gigahertz (GHz)
   (c) Megabytes (MB) (d) Kilobytes (Kb)
5. The CPU fan
   (a) is self-powered
   (b) is powered directly by the power supply
   (c) is plugged into the motherboard for power
   (d) is not powered, runs on gravity
6. Which is the most popular operating system?
   (a) UNIX (b) Microsoft Windows
   (c) Linux (d) DOS
7. UPS stands for _____.
   (a) universal power supply
   (b) uninterrupted power supply
   (c) unique power supply
   (d) united parcel service
8. The CPU is also known as _____.
   (a) the brain
   (b) the processor
   (c) the central processing unit
   (d) All of the above.
9. Which smaller unit of the CPU directs and coordinates all activities within it and determines the sequence in which instructions are executed, sending instructions sequence to other smaller unit?
   (a) CU (b) ALU
   (c) Processor (d) All of the above.

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10. Which of these is a not a computer manufacturer?
    (a) Microsoft (b) IBM
    (c) Apple (d) Sun
11. Which is the most common type of RAM architecture used by laptops.
    (a) RIMM (b) DIMM
    (c) USDRAM (d) SODIMM
12. What is a common resolution on today's laptops?
    (a) 2048x1536 (b) 640x480
    (c) 1280x800 (d) 800x600
13. Which of the following pointing device is used in laptops?
    (a) Touchpoint (b) Touchball
    (c) Touchway (d) Touchpad

B. Fill in the blanks

1. Disassembling is the process of breaking down a device into _____ parts.
2. The tools and equipments required for computer disassembly are the same as that of computer _____.
3. Power cables are used to distribute electricity from the _____ supply to the motherboard and other components.
4. The cable of monitor port on the back side of the _____ case.
5. USB cable connector can plug it into any of the _____ ports.
6. UPS is like a power bank which gives power to the _____ system.
7. Every part of the computer is attached to the _____.
8. To remove the CPU fan from the heat sink, first disconnect its connector from the _____.
9. The CPU, RAM, and expansion cards are directly attached to the _____.
10. The modern motherboards are integrated with the audio, video, and _____cards.
11. The power supply is connected to the motherboard by a 20 pin connector and _____ pin connector.
12. The ____ is the first component to be installed on the motherboard of laptop.
13. The ____ case opener is used to open the case of laptop.
14. In a notebook, the _____ power jack is mounted under the hinge.
15. A notebook motherboard has ___ memory slots.
16. It is possible to _____ the LCD screen of a laptop independently.

C. Short answer questions

1. What does somebody need to know before setting out to assemble or disassemble a computer?
2. What are the necessary tools and accessories required for assembly or disassembly?
3. Describe different computer cables for building a computer.
4. What is the role of anti-static wrist wrap?
5. What is the necessity of applying thermal solution on the processor?
6. What are the necessary precautions to assemble or disassemble a computer?
7. How will you protect your computer's motherboard?
8. List the steps for installing a new processor.
9. How is it tested that a computer is ready for use?
10. What is ESD?

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