Draft Study Material

FIELD TECHNICIAN COMPUTING PERIPHERALS

(Job Role)

(Qualification Pack: Ref. Id. ELE/Q4601)

Sector: Electronics

(Grade XI)

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NCERT

PSS CENTRAL INSTITUTE OF VOCATIONAL EDUCATION

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Preface

Vocational Education is a dynamic and evolving field, and ensuring that every student has access to quality learning materials is of paramount importance. The journey of the PSS Central Institute of Vocational Education (PSSCIVE) toward producing comprehensive and inclusive study material is rigorous and time-consuming, requiring thorough research, expert consultation, and publication by the National Council of Educational Research and Training (NCERT). However, the absence of finalized study material should not impede the educational progress of our students. In response to this necessity, we present the draft study material, a provisional yet comprehensive guide, designed to bridge the gap between teaching and learning, until the official version of the study material is made available by the NCERT. The draft study material provides a structured and accessible set of materials for teachers and students to utilize in the interim period. The content is aligned with the prescribed curriculum to ensure that students remain on track with their learning objectives.

The contents of the modules are curated to provide continuity in education and maintain the momentum of teaching-learning in vocational education. It encompasses essential concepts and skills aligned with the curriculum and educational standards. We extend our gratitude to the academicians, vocational educators, subject matter experts, industry experts, academic consultants, and all other people who contributed their expertise and insights to the creation of the draft study material.

Teachers are encouraged to use the draft modules of the study material as a guide and supplement their teaching with additional resources and activities that cater to their students' unique learning styles and needs. Collaboration and feedback are vital; therefore, we welcome suggestions for improvement, especially by the teachers, in improving upon the content of the study material.

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Date: 09 Oct. 2024

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TABLE OF CONTENT

Module 1 FUNDAMENTAL OF COMPUTER AND ITS PERIPHERALS

Module Overview

Computer has become indispensable in today's life. It has become difficult to imagine the world without computer. Everywhere computers are used whether it is office, bank, school, college, business, hospitals etc. You must have seen Computers at your home, school or office.

Computer is an electronic device which accepts input, processes it and produces the desired results. Computer is a machine which performs mathematical operations and logical decisions at an extremely fast speed. Computer not only do calculations but also handles different applications at a time. In this unit, you will learn about computers, its parts, and its uses in real life.

Learning Outcomes

After completing this module, you will be able to:

- Understand the key roles, tasks, and responsibilities of a field technician specializing in computing and peripherals.
- Explain the core functions of a computer system and the interaction of its main components.
- Identify and explain the operation of various input and output devices in a computer system.
- Understand the types, functions, and installation processes of storage and peripheral devices.

Module Structure

Session 1. Role and responsibilities of a Field Technician Computing and Peripherals

Overview of the Electronics Industry

The electronics industry is a broad field that plays a crucial role in our everyday lives. It's a key sector that includes everything from the devices we use daily, like computers and smartphones, to the components that power these devices. Here's a simplified overview of the size and scope of the electronics industry and its sub-sectors, specifically tailored for students in the Field Technician

Computing and Peripherals class.

The electronics industry involves designing, producing, and maintaining electronic devices. These devices can range from small components like chips to larger systems like computers and home appliances. Almost every device we use today has some form of electronic component, making this industry critical for the modern world.

The Electronics Industry is made up of companies that manufacture, design, manufacture, assemble, and service electronic products. These products consist of materials, parts, components, subassemblies, and equipment that use the principles of electronics to perform their major functions.

Products can range from discrete components like integrated circuits; consumer electronics like TVs, smartphones, and personal computers; medical equipment like heart-rate monitors and dialysis machines; industrial equipment like robots; to communication and networking equipment like routers and switchboards. Industries that are supported by the electronics industry include automotive, aviation, defence, telecommunications, entertainment, and healthcare.

The Electronics Industry is driven by innovation and a lot of money and effort goes into research and development to design and make improved parts and products, as well as improve manufacturing processes.

Sub-sectors of Electronic Industry

The electronics industry is focused on developing products whose primary function is to process information. These items are generally classified into six sub-sectors:

Computers: encompasses most of the items used in homes and offices, such as computers, printers, photocopiers, monitors, and even network servers.

Electronic components: diodes, transistors, and integrated circuits, among others.

Communicators: telecommunications equipment, fax machines, smartphones, etc.

Audio and video: Audio visual file players such as DVD, home theatre, radios, televisions, video game consoles, cameras, and camcorders.

Medical equipment and precision and measuring instruments: covers equipment used in hospitals.

Its technical characteristics and constant evolution, the electronics industry is one of the most complex branches. As a sector feeds different industrial branches, it requires specialized workers.

Two main categories within the electronic components are determined according to their materials and use: active and passive components. The primary function of active components is to control, store information, or interpret electrical signals; these devices are manufactured from semiconductors. On the other hand, passive components serve as a complement within the circuits and are manufactured from chemical substrates.

Scope of the electronics industry

The electronics sector produces electronic equipment and consumer electronics and manufactures electrical components for a variety of products. Common items in the electronics sector include mobile devices, televisions, and circuit boards. Industries within the electronics sector include telecommunications, networking, electronic components, industrial electronics, and consumer electronics.

The electronics industry in the global landscape

The semiconductor crisis and production bottlenecks, the electronics industry remained underperforming, even suffering declines in sales and manufacturing during 2020. However, this trend was quickly overcome. In 2021, the development of new products and a rise in prices led to significant growth in the electronics sector. Another factor that boosted the industry was its large number of production hubs. This branch includes companies that manufacture everything from 4K monitors or touch screens to resistors or circuit boards.

Another critical milestone demonstrating the industry's rapid and constant innovation is the large-scale production of new nanotechnology, particularly 5nm technology. These processors and semiconductors are more energy-efficient and faster in information processing. Since 2020, it has become a standard in various industries, such as telecommunications and computing. Although the crisis in this sector was recent globally, the outlook seems quite positive. The broad base of industries linked to electronics, digitization processes in almost all industrial sectors, and the constant search for innovation give companies great encouragement.

Practical Activity: Identify and name the various Computer Peripherals and basic software.	
Monitor	
Keyboard	
Mouse	
Printer	
Scanner	
Speakers	
Operating System	
Windows	
Antiviruses	

Role and Responsibilities of a Field Technician

Field technicians install, repair, and maintain electronic devices and systems. They ensure that all these devices work correctly and efficiently. Without field technicians, many of the electronic devices we rely on wouldn't function properly, leading to disruptions in daily life and business operations.

The electronics industry is vast, and as a field technician, you'll play a crucial role in keeping it running smoothly. Whether you're fixing a computer or setting up a network, your skills will be in high demand.

A field technician in computing and peripherals installs, repairs, and maintains desktop computers and computer peripherals at customer locations. They may also handle upgrades and other tasks. Some of the skills and responsibilities of a field technician in computing and peripherals include:

Troubleshooting

Identifying and diagnosing problems with computer systems and peripherals, and using diagnostic tools to find solutions. They may also help employees recover lost data, reinstall programs, and diagnose software issues.

Time management

Scheduling upgrades, installations, and troubleshooting to minimize downtime for the organization.

Communication

Understanding others and taking in information from users who may not know the proper terminology or be able to thoroughly describe their problem.

Experience

Having proven experience as a computer technician or similar role, and knowledge of computer systems, IT components, internet security, and data privacy principles.

List the Roles and responsibilities of a Field Technician

1. Set up hardware
2. Install software
3. Maintain and repair technological equipment
4. Manage software in computers and networks
5. Ensure privacy and data protection
6. Perform regular upgrades
7. Perform troubleshoot activities
8. Install well-functioning LAN/WAN and other networks
9. Manage network components (servers, IPs, etc.)
10. Manage and implement security solutions
11. Create records of repairs and fixes
12. Provide technical support
13. Train and collaborate with other team members

Employment opportunities for a Field Technician Computing and Peripherals.

a field technician, especially in computing and peripherals, it's important to understand the sub-sectors:

A) Computing Devices

These devices are central to personal and professional life. Field technicians often troubleshoot hardware issues, install software, and maintain systems. Computing devices are a large part of the electronics industry, with millions of units sold every year globally.

Examples: Desktops, laptops, tablets, and servers.

B) Peripherals

Peripherals are essential accessories that enhance the functionality of computing devices. Field technicians work on setting up, repairing, and maintaining these devices. With the rise of remote work and gaming, the demand for reliable peripherals has grown.

Examples: Keyboards, mice, printers, scanners, and external storage devices.

C) Networking Equipment

Networking equipment connects devices within homes, schools, and businesses to the internet and each other. Field technicians ensure these devices are correctly installed and functioning. As more homes and businesses require high-speed internet, the need for networking equipment and its maintenance increases.

Examples: Routers, modems, switches, and network cards.

D) Storage Devices

These devices store data for computers and other electronic devices. Field technicians help in installing, upgrading, and troubleshooting storage devices. With the rise of digital content, the demand for efficient and large-capacity storage solutions is growing.

Examples: Hard drives, SSDs, USB drives, and cloud storage services.

E) Power Supplies and UPS Systems

Power supplies are critical for the functioning of electronic devices, and UPS systems provide backup power during outages. Field technicians ensure these systems are reliable and properly maintained. Ensuring uninterrupted power is vital for businesses and personal use, especially with the increasing reliance on electronics.

Examples: Power adapters, batteries, and uninterruptible power supplies (UPS).

Check Your Progress

A. Multiple-choice questions (MCQs)

1. What is one of the main sub-sectors of the electronics industry? (a) Automotive Manufacturing (b) Semiconductor Manufacturing (c) Textile Industry (d) Agriculture
2. What is the primary scope of the electronics industry? (a) Developing new agricultural techniques (b) Writing software programs (c) Creating and maintaining electronic devices and components (d) Manufacturing clothing
3. In the global landscape, how does the electronics industry impact the economy? (a) It contributes significantly to global trade and technological advancements (b) It only affects local businesses (c) It has no global relevance (d) It is unrelated to economic growth
4. Which of the following is a key responsibility of a Field Technician in Computing and Peripherals? (a) Designing new software (b) Teaching coding skills (c) Managing a company's finances (d) Installing and maintaining peripheral devices
5. What is an employment opportunity for a Field Technician in Computing and Peripherals? (a) Medical doctor (b) IT support technician (c) Professional chef (d) Business analyst

B. Fill in the Blank

1. The electronics industry is primarily concerned with the design, production, and maintenance of __________ and electronic devices.
2. A significant sub-sector of the electronics industry is the __________ industry, which focuses on the development of semiconductors and integrated circuits.
3. The scope of the electronics industry encompasses a variety of products, including consumer electronics and __________ equipment used in industrial applications.
4. In the global landscape, the electronics industry is a key driver of __________ and technological innovation across various sectors.
5. A Field Technician in Computing and Peripherals is responsible for the installation and

__________ of computer hardware and peripheral devices.

C. Ture or False

1. The electronics industry only focuses on consumer electronics and does not include industrial applications.
2. One of the sub-sectors of the electronics industry is the semiconductor industry, which manufactures integrated circuits.
3. The scope of the electronics industry is limited to manufacturing and does not include services like installation or maintenance.
4. Field Technicians in Computing and Peripherals primarily work in offices and do not interact with customers.
5. The electronics industry plays a significant role in the global economy by contributing to technological advancements and trade.

D. Short Questions

1. What are the primary functions of the electronics industry?
2. Name one major sub-sector of the electronics industry.
3. How does the electronics industry contribute to the global economy?
4. What is one key responsibility of a Field Technician in Computing and Peripherals?
5. List one employment opportunity available for a Field Technician in the electronics industry.

Session 2. Basic Functionality of Computer System

2.0 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.

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.

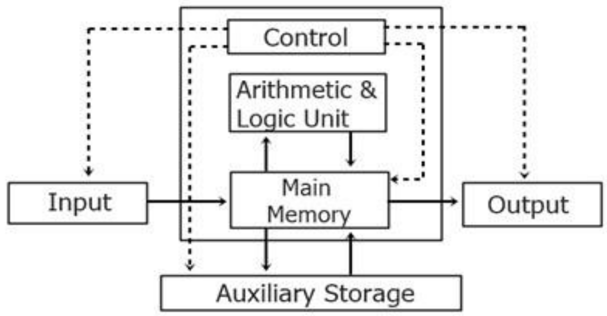

Fig. 2.1: Block diagram of computer system

2.2.1 CHARACTERISTICS OF A COMPUTER

Speed: Computers work at very high speed and are much faster than humans. Computers can process millions (1,000,000) of instructions per second. The time taken by computers for their operations is microseconds and nanoseconds.

Storage: Computer can store large amount of data (text, video, picture etc) permanently. we can use this data at any time. computer memory storage capacity is measured in Bytes, Kilobytes (KB), Megabytes (MB), Gigabytes (GB), and Terabytes (TB).

Accuracy: When a computer performs a computation or operation, the chances of errors occurring are low. Errors in a computer are caused by human's submitting incorrect data. A computer can do a variety of operations and calculations fast and accurately.

Communication: Today's Computers have capability of communicating with other Computers. we can connect two or more computers.

Automatic: A computer as a machine cannot start itself but it can perform some work without human intervention. For example, our have large amount of data and we want to perform some calculation on it. For getting the result, we have to run the appropriate software and all the calculation will be done by Computer.

Diligence: Unlike human being, computer is free from dullness and lack of concentration. It can work for hours without any error until job is finished.

Versatility: Versatility is a most important characteristic of computer. we may use computer to prepare salary slip and at the same time we can use the same computer for paying electricity bill and etc. It means we can perform completely different type of work on a single computer simultaneously.

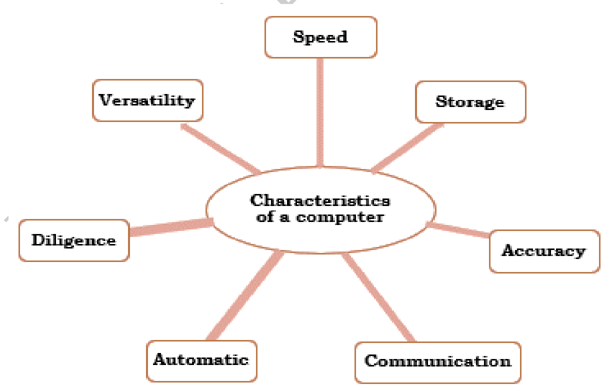

Fig. 2.2 Characteristics of a computer

2.2.2 Development of Computers

Computation has been done since earlier times with the aid of devices, when generally there was interaction at one-to-one level utilizing fingers. A form of tally stick was possibly the first counting device. Later, people in the Fertile Crescent region began record keeping by using calculi with aids such as clay spheres and cones. These aids were, possibly, representations of items such as livestock or containers of grains. Counting rods and stones were used with passing of time. People, gradually, began to follow certain steps to calculate with stones, giving birth to digital counting devices. These proved to be the predecessor of the first device invented for calculation, called as the ABACUS. With the evolution of human intellect and the advancement of technology, more computing devices were produced. There are mechanical calculators used by humans before computers. Some of the most famous mechanical calculators are:

1. Abacus
2. Pascal's Calculator
3. Leibniz calculator
4. Arithmometer
5. Comptometer & Comptograph
6. Difference Engine
7. Analytical Engine
8. The Millionaire

The ABACUS

Abacus was used to do quick additions and subtractions mechanically. Although it was initially developed in the 10th century by the Egyptians, it was the Chinese who gave it its proper shape in the 12th century. It comprised of a wooden frame with rods fitted from one end to the other. The rods had round beads slid onto them, which represented different numbers according to their position. The abacus had an upper section called Heaven and a lower section called Earth.

NAPIER'S BONES

Napier Bones was invented by John Napier of Scotland in the year 1617. This device had bone rods with numbers printed on them and enabled easy calculations.

PASCAL'S CALCULATOR

Pascal's calculator was invented by Blaise Pascal of France in the year 1642. It was an adding machine which had gears on it to represent the position of the digits.

LEIBNZ CALCULATOR

Leibnz calculator was a modification of the Pascal's calculator and could do multiplication and division operations. It was devised by Gottfried Leibniz of Germany in the year 1672.

Difference Engine

Charles Babbage, known as the "Father of Modern Computer designed the Difference engine in the early 1820s. The Difference Engine was a mechanical computer that could perform simple calculations. It was a steam-driven calculating machine designed to solve tables of numbers like logarithm tables.

ANALYTICAL ENGINE

Sir Charles Babbage of England, also called father of the computer, invented the Analytical engine in the year 1833. It is considered as the first mechanical computer, which could safeguard data. Charles Babbage added such features in it which are similar to the present day computer language.

Tabulating Machine

Herman Hollerith, an American statistician invented the Tabulating Machine in the 1890s which was a mechanical tabulator based on punch cards that was capable of tabulating statistics and recording or sorting data or information.

Differential Analyzer

The Differential Analyzer was the first electronic computer introduced in the United States in 1930. It was an analog device invented by Vannevar Bush. This machine could perform 25 calculations in a few minutes.

Mark I

The major changes in the history of computers began in 1937 when Howard Aiken aimed to invent a machine that could perform calculations of larger numbers. In 1944, IBM and Harvard partnered to build the Mark I computer. The Mark 1 was the first programmable digital computer.

The Von Neumann model

The architecture of computer has been modified many times over the last 20 years according to new developments. The way the algorithms are mapped to the hardware of a computer has been modernized and the quantity of circuits which can be added to the silicon wafers too has changed. However, the basic concept of computer design has remained unchanged. Von Neumann devised the computer architecture in such a way so as to enable it to store the program instructions and data in its memory.

Earlier, every computing device was made for a single, specific purpose. The programming entailed the circuits to be rewired manually and snags were difficult to detect or rectify.

Von Neumann's architecture had the computer with three main components:

- A central processing unit (CPU)
- Memory
- Input/output (I/O) interfaces

2.2 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.

1. First Generation Computers (1940-1956)
2. Second Generation Computers (1956-1963)
3. Third Generation Computers (1964-1971)
4. Fourth Generation Computers (1971-Present)
5. Fifth Generation Computers (Present and Beyond)

Fig. 2.3: Generation of a computer

1. First Generation Computers (1940-1956):

The 1st Generation Computers were introduced using the technology of vacuum tubes which can control the flow of electronics in a vacuum. These tubes are usually used in switches, amplifiers, radios, televisions, etc. The First Generation of Computer was very heavy and large and were not ideal for programming. They used basic programming and didn't have an operating system, which made it tough for users to do programming on them. The 1st Generation Computers required a big room dedicated to them and also consumed a lot of electricity.

Some of examples of first-generation computers are-

ENIAC: Electronic Numerical Integrator and Computer, built by J. Presper Eckert and John V. Mauchly which contained 18,000 vacuum tubes.

EDVAC: Electronic Discrete Variable Automatic Computer, designed by Von Neumann.

UNIVAC: Universal Automatic Computer, developed by Eckert and Mauchly in 1952.

IBM-701: The first computer generation of representative systems is IBM-701, designed by Nathaniel Rochester.

IBM-650: The IBM 650 Magnetic Drum Data-Processing Machine is one of IBM's early computers came into market in 1953, invented by Frank E. Hamilton.

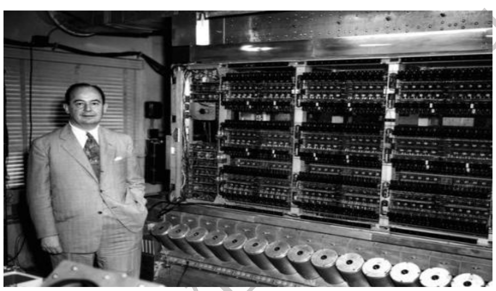

Fig. 2.4: First Generation of a computer

2. Second Generation Computers (1956-1963):

The Second Generation of Computers revolutionized as it started using the technology of transistors instead of bulky vacuum tubes. Transistors are devices made of semiconductor materials that open or close a circuit. These transistors were invented in the Bell Labs which made the Second Generation Computer powerful and faster than the previous ones. Transistors made these computers smaller and generated less heat compared to the vacuum tubes they replaced. The Second Generation of Computers also introduced the use of CPU, memory and input/output units. The programming languages used for the second-generation computers were FORTRAN (1956), ALGOL (1958), and COBOL (1959).

Some of examples of Second-generation computers are- PDP-8, IBM1400 series, IBM 7090 and 7094, UNIVAC 1108, CDC 3600, etc.

Fig. 2.5: Second Generation of a computer

3. Third Generation Computers (1964-1971):

The evolution of Third Generation Computers took place with a shift from transistors to integrated circuits also called IC. The Third Generation of Computer was very fast and reliable. The ICs used in these computers were made from silicons and were called silicon chips. A single IC has many transistors, registers, and capacitors built on one thin slice of silicon. This generation of computers has increased memory space and efficiency. Higher-level languages like BASIC (Beginners All-purpose Symbolic Instruction Code) were used and the Minicomputers were introduced in this era. High-level languages (FORTRAN-II TO IV, COBOL, PASCAL PL/1, BASIC, ALGOL-68 etc.) were used during this generation.

Some of examples of Third Generation Computers are- IBM 360, IBM 370, PDP-11, NCR 395, B6500, UNIVAC 1108, etc.

Fig. 2.6: Third Generation of a computer

4. Fourth Generation Computers (1971-Present):

The period from 1972 to 2010 is considered the period of the fourth generation of computers. Microprocessor technology was used to develop the Fourth Generation of Computers. The foremost advantage of these computers is that the microprocessor can contain all the circuits required to perform arithmetic, logic, and control functions on one chip. In the Fourth Generation, computers became very small in size and also became portable.

Technologies like multiprocessing, multiprogramming, time-sharing, operating speed, and virtual memory were also introduced by then. During the fourth generation, private computers and computer networks became a reality. All the high-level languages like C, C++, DBASE etc., were used in this generation

Some of examples of Third Generation Computers are- IBM PC, STAR 1000, APPLE II, Apple Macintosh, Alter 8800, etc.

Fig. 2.7: Fourth Generation of a computer

5. Fifth Generation Computers (Present and Beyond):

In the fifth generation, the VLSI technology became ULSI (Ultra Large-Scale Integration) technology, resulting in the production of microprocessor chips having ten million electronic components. This generation is based on parallel processing hardware and AI (Artificial Intelligence) software used for Robots designing. Some of the applications of AI have been seen in features like voice recognition, entertainment, etc. The speed of the Fifth Generation of Computers is the highest while the sizes are the smallest. A big improvement has been noticed so far over the years in the various generations of computers in the aspect of speed, accuracy dimensions, etc.

Examples of 5th Generation Computers are Desktops, laptops, tablets, smartphones, etc.

Fig. 2.8: Fifth Generation of a computers

2.3 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, Ubuntu, Microsoft Office, LibreOffice, Photoshop and Tally are some examples of software.

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

Fig. 2.9: Hardware and Software

Practical Activity: 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	
Tally	
MS Paint	

2.4 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 2.10 below.

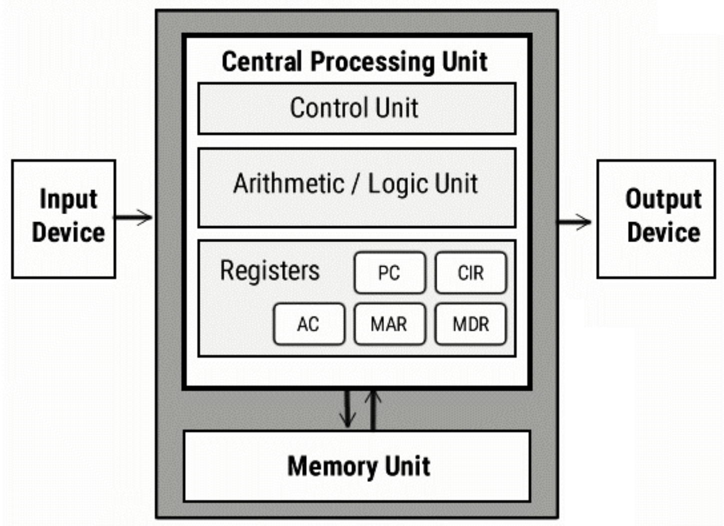

Fig: 2.10 John von Neumann architecture

John von Neumann proposed the first usable draft of a working computer. It consists of some functional unit namely input/output unit, central processing unit (CPU), and memory.

A computer has the following three main components—

A. Input/output unit

B. Central processing unit

C. Memory unit

2.4.1 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.

2.4.2 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-

A. Arithmetic logic unit (ALU)

B. Control unit (cu)

C. Clock

D. Registers

E. Buses

A. **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 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.

B. 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.

C. 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.

D. 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.

E. 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 synchronization with the clock pulse. The clock speed of a CPU is measured in terms of megahertz or millions of cycles per second. The clock speed of a CPU varies from one model to another.

2.4.3 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 nonvolatile 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.

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2.5 Classification of Computers

Generally, the word computer refers to a personal computer such as a desktop or laptop. However, we see different types of computers in our daily lives performing various tasks, for example while operating an ATM, purchasing groceries at the store, Customer servicing KIOSK available in Banks, Shopping Mall or at Railway Station. 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.
- Special purpose computers: These computers are designed to perform scientific applications, weather forecasting, space applications, etc.

A. Based on Working principle

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

1. **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. 2.11: Analog Computer

2. **Digital computers:**

These operate on digital data. Input and output are 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.

Fig. 2.12: Digital Computer

3. **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. 2.13: Hybrid Computer

B. Classification of computers according to size and storage capacity

1. 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.

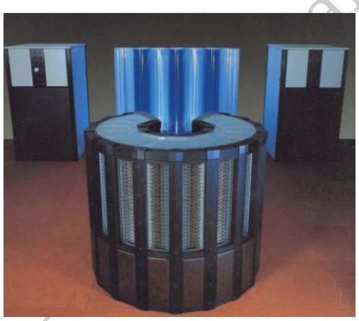


Fig. 2.14: Super Computer

2. 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 a 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.2.15: main frame Computer

3. Minicomputer

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. 2.16: mini Computer

4. Microcomputer

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 categorized as below

5. 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.

Fig 2.17: Desktop Computer

6. All in one computer

All in one computer 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. 2.18: All in one computer

7. 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 minimizes 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 depend on battery life status. A laptop has a power cable and AC adapter designed to be used with specific type of laptop. The laptop also has 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.

Fig. 2.19: Laptop Computer

8. Mobile computers

Many mobile devices work as specialized 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 categorized as—tablets, smartphones, wearable devices, vehicle-mounted, handheld computers, e-book readers, etc. The most common are tablets and smartphones, which are discussed here.

(i) **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 specialized operating systems such as Android, Windows, and iOS. The iPad is an example of a tablet.

(ii) **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. 2.20: 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.2.21: PDA

Internal Component of Computer System

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 paragraph, we will understand the main features of the motherboard, types of motherboard, motherboard form factors, and various components of motherboard.

Note: We have to introduce all internal components first here then start from Motherboard.

2.5 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 2.22.

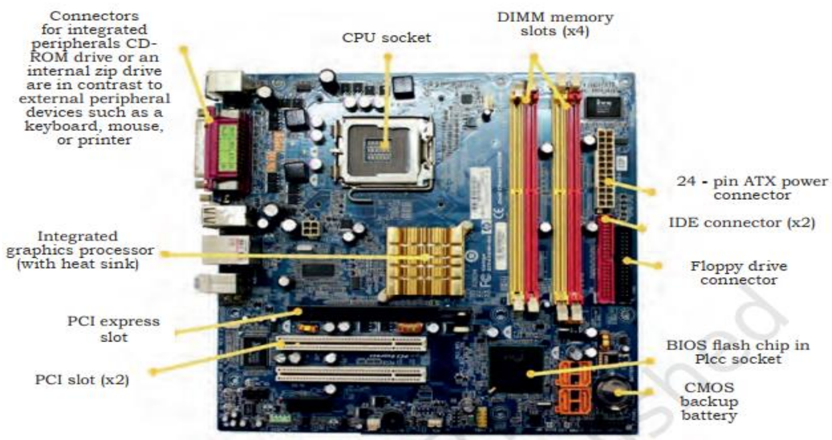


Fig. 2.22: Motherboard

2.5.1 Types of Motherboard

Motherboards are classified as either integrated or nonintegrated.

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. The integrated structure of a motherboard is shown in the Figure 2.23.

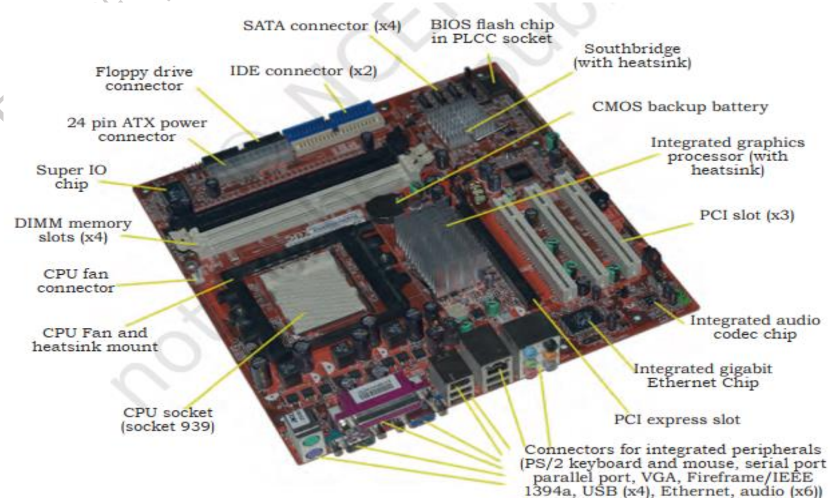


Fig. 2.23: Integrated Motherboard

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.

2.5.2 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 front side bus, main memory, and peripheral buses.
- non-volatile memory chips usually flash ROM in modern motherboards, containing the system's firmware or BIOS.
- 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.

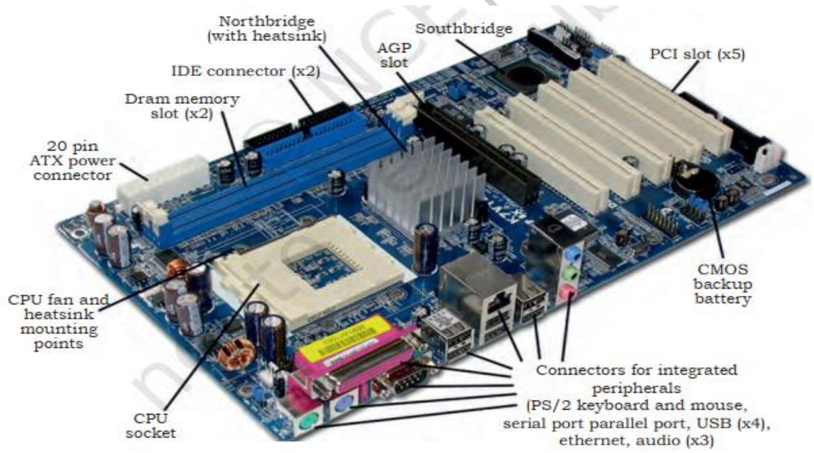


Fig. 2.24: Motherboard components

2.5.3 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.

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.

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 15.2" wide and 8.2" deep.

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.

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.

LPX motherboards are typically integrated and most have the video and sound components builtin. 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 card 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.

The BTX form factor allows for more integrated onboard components because it is larger than ATX. The airflow path is optimized 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.

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.

2.6 CPU (Central Processing Unit)

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.

2.6.1 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 number of peripherals are fabricated on a single chip.

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

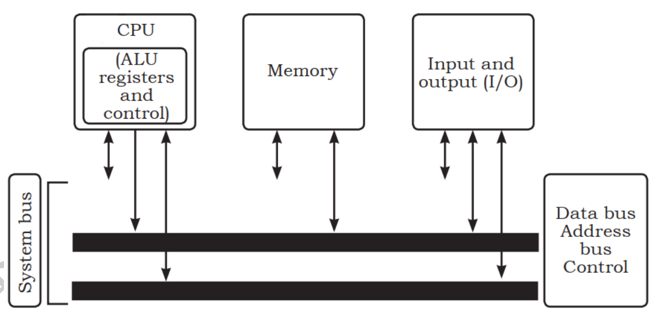


Fig. 2.25: Architecture of CPU

2.6.3 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 ZilogsZ80 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:

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.

Fig. 2.26: Intel Celeron processor

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. 2.27: Pentium Celeron 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. 2.28: Xeon processor

2.6.4 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.

2.6.5 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 5.
3. carry out the actions specified by the instruction stored in the IR.

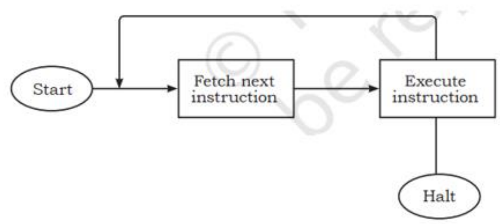


Fig. 2.29: Basic instruction cycle

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 2.29.

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.

2.6.6 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.

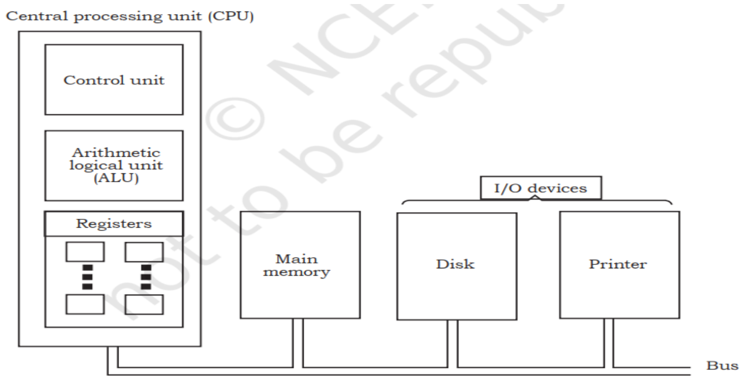


Fig. 2.30: Major components of the CPU

2.6.7 Types of CPU

CPU can be categorized 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.

2.6.8 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 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

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 1. Installation/Connectivity 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.2.31: Installing CPU on the motherboard

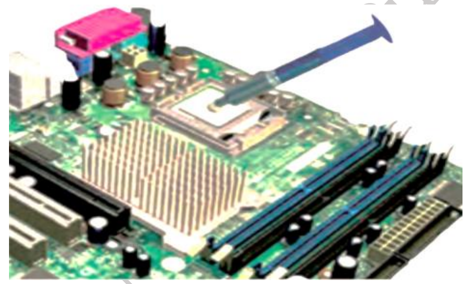


Fig. 2.32: Applying thermal compound on CPU

2.6.9 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 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.

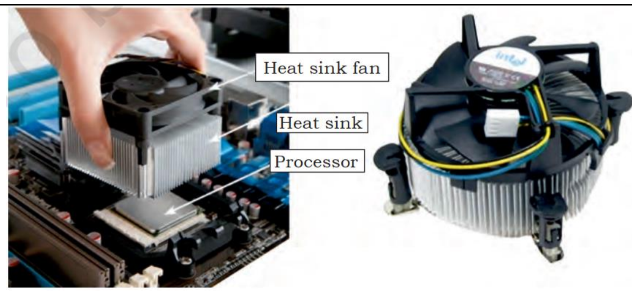


Fig. 2.33: Heat sink with cable and connector

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 heat sinks, 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.

Practical Activity 2. 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.

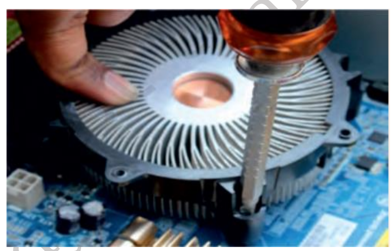


Fig. 2.34.: Screwing the heat sink

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.

Graphics card

A graphics card, also known as a video card or graphics processing unit (GPU), is a hardware component responsible for rendering and displaying images, videos, and animations on your computer monitor. It accelerates the graphics processing capabilities of your computer, enabling you to enjoy smooth and high-quality visuals in games, videos, and other graphic-intensive applications. The graphics card works with the central processing unit (CPU) to process and output visual data.

Fig. 2.35 Graphics card

Needs a graphics card

If you use your computer for tasks such as gaming, video editing, three-dimensional (3D) modeling, or other graphic-intensive activities, a dedicated graphics card is essential. It offloads the graphical processing from the central processing unit (CPU), resulting in improved performance and smoother visuals. Integrated graphics found in most CPUs are generally not as powerful as dedicated graphics cards, so if you want to experience the best visuals and performance, a graphics card is necessary.

There are two types of graphics cards:

Integrated graphics

Built into the motherboard, these graphics cards make laptops lightweight, thin, and power-efficient. While you can play games with integrated graphics, it might not be as easy as with a dedicated graphics card.

Dedicated graphics cards

Also called display adapters or GPUs, these cards have a separate graphics processor with its own memory reserve, which usually makes them faster than integrated graphics. However, they can be expensive, large, and use more power, which can make it difficult to fit them into a laptop.

Sound Card

A sound card is a hardware component in a computer that provides an interface for audio input and output. A typical sound card includes at least two 3.5mm audio jacks — one for analog stereo output and one for line-in or microphone input. It uses a digital-to-analog converter (DAC) to convert digital audio into analog signals for playback through speakers and headphones; it also includes an analog-to-digital converter (ADC) to digitize analog input from microphones. It may also include an interface for digital audio output, typically using a Toslink optical connector.

Many computer motherboards integrate a sound card directly, providing a set of 3.5mm audio jacks alongside the rest of the ports on the I/O panel. Dedicated cards that plug into a computer's PCIe expansion slot can add more input and output connections, improve audio processing performance, and improve audio quality when paired with high-end speakers. External sound cards that connect to a computer over USB, also known as audio interfaces, can include larger ports than would fit on an internal card's backplate, like ¼-inch audio inputs and XLR jacks for musical instruments and high-end microphones.

Fig. 2.36 Sound card

For most computer users, a motherboard's integrated sound card is enough to use with stereo speakers, headphones, or a headset with a microphone. However, there are several reasons that you may want a dedicated sound card. They often include a higher-quality DAC, which can produce cleaner sound with less noise. They may also provide better amplification to improve sound quality when used with high-impedance headphones. Dedicated sound cards often support higher resolutions and sampling rates (up to 32-bit / 384 KHz), and may even include hardware encoding and decoding for surround sound formats like Dolby Digital and DTS.

Power supply Unit

A power supply is a hardware component that supplies power to an electrical device. It receives power from an electrical outlet and converts the current from AC (alternating current) to DC (direct current), which is what the computer requires. It also regulates the voltage to an adequate amount, which allows the computer to run smoothly without overheating. The power supplies an integral part of any computer and must function correctly for the rest of the components to work.

Fig. 2.37 Power supply unit

You can locate the power supply on a system unit by simply finding the input where the power cord is plugged in. Without opening your computer, this is typically the only part of the power supply you will see. If you were to remove the power supply, it would look like a metal box with a fan inside and some cables attached to it. Of course, you should never have to remove the power supply, so it's best to leave it in the case.

While most computers have internal power supplies, many electronic devices use external ones. For example, some monitors and external hard drives have power supplies that reside outside the main unit. These power supplies are connected directly to the cable that plugs into the wall. They often include another cable that connects the device to the power supply. Some power supplies, often called "AC adaptors," are connected directly to the plug (which can make them difficult to plug in where space is limited). Both of these designs allow the main device to be smaller or sleeker by moving the power supply outside the unit.

Since the power supply is the first place an electronic device receives electricity, it is also the most vulnerable to power surges and spikes. Therefore, power supplies are designed to handle fluctuations in electrical current and still provide a regulated or consistent power output. Some include fuses that will blow if the surge is too great, protecting the rest of the equipment. After all, it is much cheaper to replace a power supply than an entire computer. Still, it is wise to connect all electronics to a surge protector or UPS to keep them from being damaged by electrical surges.

Check Your Progress

A. Multiple-choice questions (MCQs)

1. What is one key characteristic of a computer? (a) Ability to cook food (b) High-speed data processing (c) Physical strength (d) Ability to sleep
2. Which generation of computers is characterized by the use of microprocessors? (a) First Generation (b) Second Generation (c) Third Generation (d) Fourth Generation
3. What is the primary function of the CPU (Central Processing Unit)? (a) Store data (b) Perform calculations and execute instructions (c) Connect to the internet (d) Display graphics
4. Which of the following is an example of hardware? (a) Microsoft Word (b) Windows Operating System (c) Hard Drive (d) Adobe Photoshop
5. What does the motherboard do in a computer system? (a) It stores data permanently (b) It generates power (c) It connects all the components of the computer (d) It displays the output

B. Fill in the Blank

1. A computer is known for its ability to process data at __________ speeds.
2. The __________ generation of computers used vacuum tubes as the primary technology for processing data.
3. The main function of the CPU, or Central Processing Unit, is to execute __________ and perform calculations.
4. Hardware refers to the physical components of a computer, while __________ refers to the programs and applications that run on it.
5. The __________ is the main circuit board in a computer that connects all other components, including the CPU, memory, and storage.

C. Ture or False

1. The main characteristic of a computer is its ability to perform tasks without human intervention.
2. The first generation of computers used transistors instead of vacuum tubes.
3. The CPU is often referred to as the "brain" of the computer.
4. Software refers to the physical components of a computer, such as the keyboard and monitor.
5. The motherboard is responsible for connecting all the main components of a computer system.

D. Short Questions

1. What are three key characteristics of a computer?
2. Briefly explain the development of computers from their early forms to modern devices.
3. What are the five generations of computers?
4. What is the difference between hardware and software?
5. What are the main components of a computer system, and what is the role of the CPU?

Session 3. Input and Output Devices

3.0 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.

3.1 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.

3.1.1 Text Input Devices

These are the devices which are commonly used to give text input to the computer like alphabets, numbers and other special symbols etc.

1. **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 recognized 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 as shown in Figure 3.5. 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. 3.1: Keyboard

2. 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 as shown in Figure 3.2.

Fig. 3.2: Numeric Keyboard

3. 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 as shown in Figure 3.3.

Fig. 3.3: PIN pad

3.1.2 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).

1. 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, as shown in Figure 3.4, 3.5 and 3.6. Whereas a wireless mouse communicates with the computer via radio waves.

Fig. 3.4: Wireless Mouse

Fig 3.5: USB port Mouse

Fig. 3.6: PS2 Port Mouse

2. **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, and fashion designers for Computer Aided Designing (CAD) and other drawing purposes.

Fig. 3.7: Light pen

3. **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 are the most common hardware interface for electronic gadgets.

Fig. 3.8: Touch Screen

4. **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.3.9: Graphic tablet

5. **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. 3.10 Touchpad

6. 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.

Fig. 3.10 Joystick

3.1.3 Audio Visual Input Devices

Audio-visual input devices are essential components of modern computing systems, facilitating the interaction between users and computers through audio and visual mediums. These devices capture and transmit data in the form of sound, images, or video, enabling users to communicate, create, and interact with digital content.

1. 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 flatbed 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 Scanner

2. 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 digitized 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 recognizable commands.

Fig. 3.12 Microphone

3. 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. 3.13 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.

4. 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. 3.14 Webcam

5. Closed circuit TV (CCTV)

CCTV captures the images and videos fed as input to the computers. (Figure 3.15). CCTVs are commonly used to maintain road safety and the security on premises.

Fig. 3.15 Closed Circuit TV

3.1.4 Input card Readers

1. Smart card or chip 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.

Fig. 3.16 Smart card or chip reader

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.

2. Magnetic strip reader

The credit cards have a magnetic strip. This strip stores the user's data in the form of magnetized 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.

Fig. 3.17 Magnetic strip reader

3.1.5 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.

1. Barcode & 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 3.18). 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.

0 20357 12268 2

Fig. 3.18: Bar Code

Fig. 3.19: Quick Response (QR) Code

QR codes are similar to barcodes. Barcodes are single dimensional, whereas QR codes are two dimensional as shown in Figure 3.19. 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.

2. Optical Mark Reader (OMR)

It is an input device that recognizes 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 3.20).

Fig. 3.20: Optical Mark Reader (OMR)

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 3.20). For accuracy of results, good quality paper and accurate alignment of printing is essential.

3. 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.

Fig. 3.21: Magnetic Ink Character Reader (MICR)

4. 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 analyzed by the OCR software. The result is such that it seems the text has been typed by hand.

Fig. 3.22: Optical Character Recognition (OCR)

3.1.6 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 3.23 shows a biometric sensor.

Fig. 3.23 Biometric sensor

3.2 Output Devices

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

1. Soft copy
2. Hard copy
3. Sound output

3.2.1 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 monitors

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. 3.24: Flat panel monitor

Liquid crystal display (LCD): This display consists of liquid crystals sandwiched between two plastic plates. These crystals rearrange to form an image when an electric current pass 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.

Fig. 3.25: Liquid crystal display (LCD) monitor

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. 3.26: Light emitting diode (LED) monitor

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.

Fig. 3.27: Plasma monitor

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. 3.28: Organic light emitting diode (OLED) monitors

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.

Fig. 3.29: LCD projector

3.2.2 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.

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 consist 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.

Fig. 3.30: Dot matrix printer

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 up to 3,000 lines per minute (Figure 3.31).

Fig. 3.31: 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 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.

Fig. 3.32 Laser printer

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.

Fig. 3.33 Thermal printer

The features of all the above printers are summarized in the Table 3.5.

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. Colored pens are used to produce color 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.

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 drawing arm that holds a set of colored 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. 3.34: Drum 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 colored 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.

Fig. 3.35: Flatbed plotter

3.2.3 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. 3.36: Speaker

Check Your Progress

A. Multiple-choice questions (MCQs)

1. Which of the following is an example of a text input device? (a) Microphone (b) Keyboard (c) Monitor (d) Printer
2. What type of device is a mouse? (a) Pointing device (b) Audio device (c) Text input device (d) Output device
3. Which of the following is considered an audio-visual input device? (a) Webcam (b) Scanner (c) Hard drive (d) Joystick
4. Input card readers are commonly used to read information from __________. (a) Audio files (b) RFID cards or magnetic strips (c) Printed documents (d) Photographs
5. Which of the following is an example of a hard copy output device? (a) Monitor (b) Printer (c) Speaker (d) Projector

B. Fill in the Blank

1. A __________is an example of a text input device used to enter letters, numbers, and symbols into

a computer.

2. A mouse is an example of a __________ device that allows users to interact with graphical elements on a screen.
3. A __________ is an audio-visual input device commonly used for video conferencing or capturing images.
4. Input card readers are devices used to read data from cards with magnetic strips or __________ chips.
5. A monitor is an example of a __________ output device, while a printer is an example of a hard copy output device.

C. Ture or False

1. A keyboard is an example of a text input device.
2. A mouse is an audio input device.
3. Webcams are considered audio-visual input devices.
4. Input card readers are used to read information from printed documents.
5. A printer is an example of a soft copy output device.

D. Short Questions

1. What are some common examples of input devices, and how do they help in interacting with a computer system?
2. Explain the role of text input devices in computing. How do they differ from pointing devices?
3. How do audio-visual input devices like webcams and microphones capture and transmit data to a computer?
4. What is the function of input card readers, and in which industries are they most commonly used?
5. What is the difference between soft copy output devices and hard copy output devices? Provide examples of each.

Session 4. Storage and Peripheral Device

Digital Data Storage Devices

The digital storage devices market has experienced remarkable growth in recent years, driven by the exponential increase in data generation and the growing demand for data storage and management solutions. Characterized by a diverse range of products, including hard disk drives (HDDs), solid-state drives (SSDs), USB flash drives, and memory cards, this industry has seen significant advancements. SSDs, in particular, have surged in popularity due to their superior performance, faster data transfer speeds, and enhanced reliability compared to traditional HDDs. Furthermore, the need for higher storage capacities and compact devices has fueled the development of microSD cards and NVMe SSDs. Furthermore, with the widespread adoption of cloud computing and the Internet of Things (IoT), the digital storage devices sector is poised for further expansion and innovation.

Definition

Computer Storage Device: A hardware device which can be used to store digital data and applications which may be in the form of images, video, audio, etc. is called a storage device. It is a key component of a computer and the hard drive is one of its examples.

Memory: Memories are made up of registers. Memory refers to the location of short-term data. Each register in the memory is one storage location. Storage location is also called as memory location. Memory locations are identified using Address. The total number of bits a memory can store is its capacity. Memory is a vital component of a computer system, as it allows the computer to store and access data quickly and efficiently.

Memory are of three type:

1. Primary Memory: Also known as main memory or internal memory, primary memory is the memory that a computer uses to store data temporarily while the CPU is processing it. The two main types of primary memory are Random Access Memory (RAM) and Read-Only Memory (ROM).

2. Secondary Memory: Secondary memory refers to external storage devices that can be used to store data for long-term use, even when the computer is turned off. Examples of secondary memory include hard disk drives (HDDs), solid-state drives (SSDs), USB flash drives, and memory cards.

4. Cache Memory: Cache memory is a small amount of memory that a computer uses to store frequently accessed data for quick retrieval. It acts as a buffer between the CPU and main memory, helping to speed up data access times. Cache memory is typically built into the CPU or located on a separate chip on the motherboard.

Storage: Storage allows you to store and access data on a long-term basis. Data remains the same and nothing changes in the hard disk drive: everything gets pulled off into the main memory. Storage allows you to access and store your applications, operating system and files for an indefinite period of time.

Storage devices can be classified into two categories: internal storage and external storage. Internal storage devices are located within the computer, such as the hard drive, solid-state drive, or flash memory. External storage devices, on the other hand, are connected to the computer via an external port, such as a USB or Thunderbolt port.

The capacity of a storage device is measured in bytes, with larger units being kilobytes (KB), megabytes (MB), gigabytes (GB), terabytes (TB), and so on. When choosing a storage device, it’s important to consider the capacity, speed, and durability of the device, as well as the compatibility with the device you plan to use it with.

For Example:

1. HDD

2. SDD

4. SD Cards

4. CD, DVD, etc

The difference between Memory and Storage:

MEMORY	STORAGE
Memory is an electronic component that is capable of storing data and information on a temporary basis.	Storage refers to physical storage devices.
It is temporary data storage.	Data is stored both temporarily and permanently.
Memory is faster than storage.	Storage is slower than memory
Memory can access data and information instantly.	Storage cannot access or modify data as fast as the memory.
It is a collection of computer chips installed in memory modules.	It is a technology consisting of core components of a computer.
When the computer loses the power, Data is lost.	No data is lost.
The memory module is expensive than storage.	Storage devices are cheaper.
Their size is not much larger and goes up to GBs.	Their size is much larger than memory and goes up to TBs.
It is used when data is stored for short time.	It is used when data is stored for long term.

Measuring Units of Memory

Capacity and measuring unit of Memory

In the realm of computing, memory capacity is a crucial concept often discussed in terms of various measuring units. Memory capacity refers to the amount of data that a memory storage device can hold. It is typically measured in units such as bytes, kilobytes (KB), megabytes (MB), gigabytes (GB), terabytes (TB), and beyond. These units represent increasing orders of magnitude, with each subsequent unit being exponentially larger than the previous one. For instance, a byte is the smallest unit of memory, capable of storing a single character, while a kilobyte can hold approximately a thousand bytes of data, and so on. Understanding memory capacity and its measuring units is essential for effectively managing digital data and selecting appropriate storage devices to meet specific needs.

The storage capacity of the memory is expressed in various units of memory. These are as follows:

Bit: A microprocessor uses binary digits 0 and 1 to decide the OFF and ON state respectively, of various circuits. Furthermore, a bit is the smallest unit of representation in the binary language.

Nibble: A nibble is a collection of 4 bits.

Byte: A byte is the representation of a group of 8 bits. Moreover, a byte is a unit that expresses any word, symbol, or character in the computer language. Besides, computer memory is always in terms of multiples of bytes.

Word: A computer word is similar to a byte, as it is also a group of bits. Moreover, a computer word is fixed for each computer. At the same time, it varies from computer to computer. Besides, the length of a computer word is the word-size or word length. Therefore, a computer stores information in the form of computer word.

Kilobyte: It is the most common unit of memory which is the smallest of all. But, it is greater than the byte. The abbreviation for kilobytes is 'KB'. It contains 1000 bytes. Besides, it is synonyms to kibibytes which contain 1024 (2^{10}) bytes.

Megabyte: The abbreviation for megabyte is 'MB'. It contains 1000,000 bytes. Besides, it is synonyms to mebibytes which contains 1048576 (2^{20}) bytes.

Gigabyte: The abbreviation for the gigabyte is 'GB' or 'gigs'. It contains 1000,000,000 bytes. Besides, it is synonyms to gibibytes which contain 1073741824 (2^{30}) bytes.

Terabyte: The abbreviation for terabytes is 'TB'. It contains one trillion bytes. Besides, it is synonyms to tebibytes which contains 2^{40} bytes.

Petabyte: The abbreviation for petabyte is 'PB'. It contains 10^{15} bytes. Besides, it is synonyms to pebibytes which contains 2^{50} bytes. Petabytes usually measure the total data storage in large networks or server farms. For example, the data in Google or Facebook data servers is around more than 10 PBs.

Exabyte: The abbreviation for exabyte is 'EB'. It contains 10^{18} bytes. Besides, it is synonyms to exbibytes which contains 2^{60} bytes. The exabyte unit is so large that it does not even measure the storage of large cloud servers. Rather, it can be used to measure the amount of data transfer over the internet for a certain time limit.

Zettabyte: The abbreviation for zettabyte is 'ZB'. It contains 10^{21} bytes. Besides, it is synonyms to zebibytes which contains 2^{70} bytes. It can measure a huge amount of data. In fact, the whole data in the world is just a few zettabytes.

Yottabyte: The abbreviation for yottabyte is 'YB'. It contains 10^{24} zettabytes. Besides, it is synonyms to yobibytes which contains 2^{80} bytes. It is a tremendously huge unit of measurement. Therefore, it has no practical use.

Table 4.1 for Computer Data Storage Memory Unit.

Unit	Description
Bit (Binary Digit)	A binary digit is logical 0 & 1
Nibble	1 Nibble = 4 bits
Byte (B)	1 Byte = 8 bits
Kilobyte (KB)	1 KB = 1024 B
Megabyte (MB)	1 MB = 1024 KB
Gigabyte (GB)	1 GB = 1024 MB
Terabyte (TB)	1 TB = 1024 GB
Petabyte (PB)	1 PB = 1024 TB
Exabyte (EB)	1 EB = 1024 PB
Zettabyte (ZB)	1 ZB = 1024 EB
Yottabyte (YB)	1 YB = 1024 ZB

Memory System

Memory in a computer system is required for the storage and subsequent retrieval of instruction and data. A computer system uses a variety of devices for storing instructions and data required for its operations. Normally, the information to be stored on a computer is classified in two basic categories – data and instructions.

Although a memory system is a very simple system, it exhibits a wide range of technology. But unfortunately, faster memory is costlier. On the other hand, memories with smaller cost have very high access time. This is the time taken by the CPU to access a location in memory. This results in slower operation of the CPU. Thus, the cost versus access time has led to a hierarchy of memory where we supplement fast memories with larger, cheaper and slower memories. Therefore, memory system may have different types, costs, organizations, technologies and performances. (Figure 4.1)

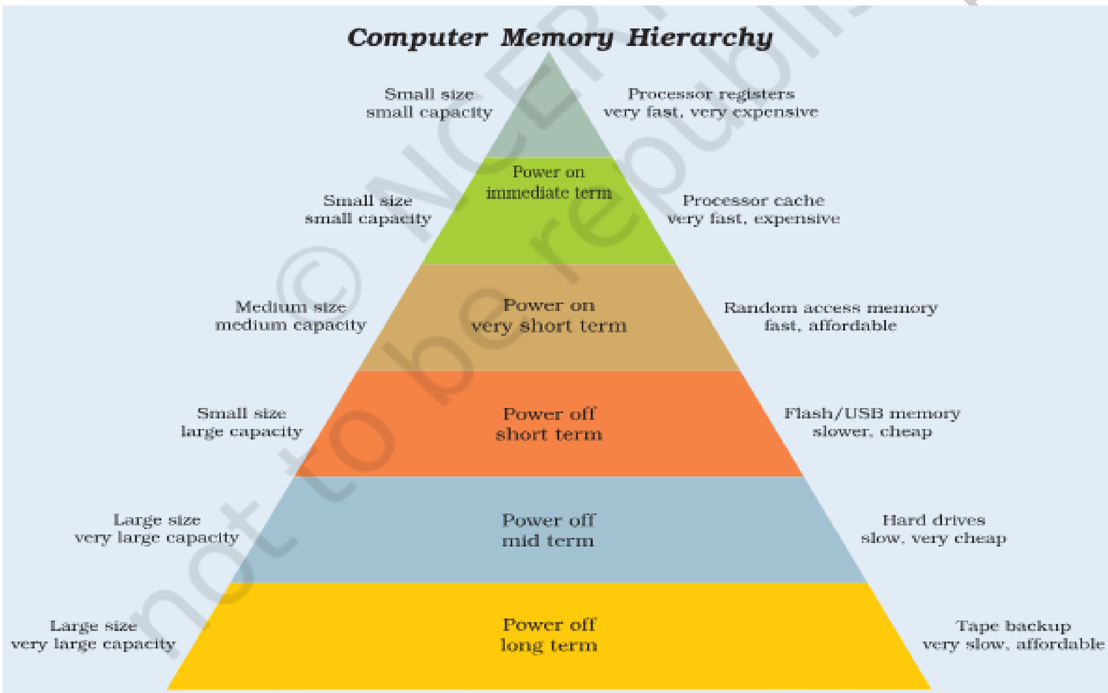


Fig. 4.1: The Memory Hierarchy

Types of Memory

A memory system can be considered to consist of three types of memories. These are as follows:

1. Internal processor memories
2. Primary memory or main memory
4. Secondary or auxiliary memory

Any storage unit of a computer may have the following characteristics:

Storage capacity is the amount of information/data a storage unit can hold. Accessing the data to/from these memories may be fast or slow.

The speed and availability of inexpensive memory has had enormous impact on computer technology. The high speed memory devices are more expensive and occupy less space in comparison to the slow speed memory devices.

Internal Processor Memories

These consist of the small set of high-speed registers and high speed buffer memory (cache) which are internal to a processor and are used as temporary locations where actual processing is done.

Register is a small amount of storage available on the CPU whose contents can be accessed more quickly than storage available elsewhere. Processor registers are at the top of the memory hierarchy and provide the fastest way for a CPU to access data.

The important registers, within the CPU are:

Program Counter (PC) A program counter keeps track of the next instruction to be executed.

Instruction Register (IR) is a register which holds instruction to be decoded by the control unit.

Memory Address Register (MAR), is a register which points to the memory location which the CPU plans to access, either for reading or for writing.

MBR (memory buffer register) which is also referred to as memory data register (MDR) is used for storage data either coming to the CPU or data being transferred by the CPU.

Acculmular (ACC) is a general purpose register used for storing variables, temporary results and results produced by arithmetic logic unit of the CPU.

Besides these, a processor can have many other registers. But these are the most basic and most essential registers necessary for any CPU.

Cache Memory

Cache memory is a small high speed buffer memory used to hold instructions temporarily during processing.

The CPU of a computer system commonly uses cache memory (Figure 4.2) where it holds or buffers the contents of the main memory because the CPU runs much faster than the main memory. Thus, to reduce the waiting time of the CPU the cache is used. Cache memory reduces traditional system bottlenecks because system RAM is much slower than CPU. This prevents the processor from having to wait for a program and data from slower main memory.

A cache typically operates by retaining copies of blocks of storage, each containing recently used information. This memory (or caches) is usually transparent or invisible to the processor.

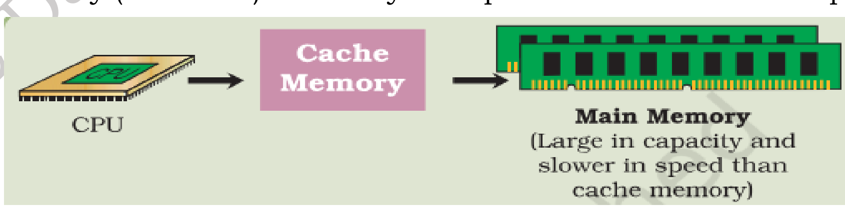


Fig. 4.2: Cache memory

Cache is a collection of data duplicating original values stored elsewhere or computed earlier, where the original data is expensive to fetch (owing to longer access time) or to compute, compared to the cost of reading the cache. In other words, a cache is a temporary storage area where frequently accessed data can be stored for rapid access. Once the data is stored in the cache, future use can be made by accessing the cached copy rather than refetching or recomputing the original data, so that the average access time is reduced.

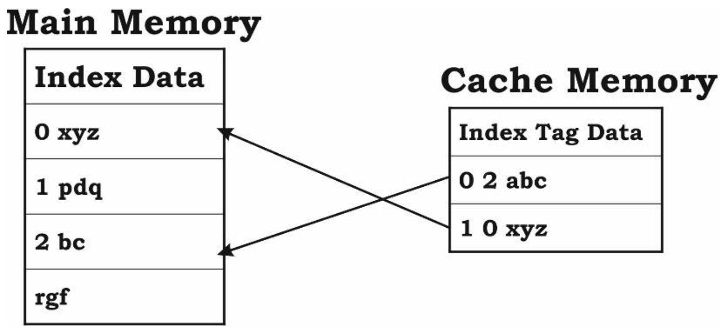


Fig. 4.3: CPU memory cache

Primary Memory It is a large memory which is fast but not as fast as an internal processor register. The processor directly accesses this memory. It is mainly based on integrated circuit. The primary memory or the main memory is part of the main computer system. The processor or the CPU directly stores and retrieves information from it. This memory is accessed by the CPU, in a random fashion. That means any location of this memory can be accessed by the CPU to either read information from it, or store information in it. The primary memory itself is implemented by two types of memory technologies. The first is called Random Access Memory (RAM) and the other is read only memory (ROM). A more appropriate name for RAM is RWM (read write memory), the CPU can write and read information from any primary memory location implemented using RAM. The other part of primary memory is implemented using ROM which stands for Read Only Memory.

There are two types of built-in memory, permanent and temporary, known as ROM and RAM, respectively, details of each given below:

Read Only Memory (ROM)

As we know, in the computer terminology, read means transferring data instruction from an input source to the computers, main memory (or CPU) and write is transferring data/instruction from computer's main memory to an output device. Therefore, read only means data/ instruction can be retrieved from the ROM chip but cannot be modified.

Types of ROM

Basically, there are two types of ROM, namely, manufacturer programmed and user-programmed.

Manufacturer–Programmed Read Only Memory

Manufacturer-programmed ROM is one in which data is stored in it permanently by the manufacturer of the ROM. For example, a computer manufacturer may store the system boot program permanently in the ROM chip used on the motherboard.

User–Programmed Read Only Memory

User-programmed ROM is one in which the user can load and store "read-only" programs and data. Such a ROM is commonly known as PROM (programmable read-only memory), because, a user can program it. PROM (programmable read-only memory) is a memory chip on which we can store a program. But once the PROM has been used, we cannot wipe it clean and use it to store something else. Like ROMs, PROMs are non-volatile.

Other kinds of user-programmed ROM are EPROM and EEPROM. Both of these are special types of PROM. EPROM (erasable programmable read-only memory) can be erased by exposing it to ultraviolet light while EEPROM (electrically erasable programmable read-only memory) can be erased by exposing it to an electrical charge.

Flash EEPROM memory works much faster than traditional EEPROMs because instead of erasing one byte at a time, it erases a block or the entire chip, and then rewrites it. The electrons in the cells of a Flash-memory chip can be returned to normal ("1") by the application of an electric field, a higher-voltage charge.

Random Access Memory (RAM)

RAM chips are meant for primary storage. They hold temporarily (a) software/program instructions and (b) data before and after processing.

"Random Access" means that any location can be referenced in the same time and in the same manner, as it is independent of the address or location in the memory. It is a volatile memory. It holds data and instructions, during their execution. The additional RAM chip can be plugged into the special socket on the motherboard known as Single In-Line Memory Module (SIMM). Random Access Memory capacity ranges from 16 MB to 4 GB on personal computers.

Types of RAM

RAM chips are of two types, namely, static RAM (SRAM) and dynamic RAM (DRAM).

Static RAM (SRAM)

The SRAM can store data as long as power is applied, without the need for periodically rewriting the data into memory. Contents (memory cell) of this RAM will stay in a given state (store a bit) indefinitely, provided that power to the memory circuit is not interrupted. The main applications of SRAM are in areas where only small amounts of memory are needed or where high speed is required.

Advantage

SRAM can provide very high speed.

Disadvantage

SRAM is costly and has low power packing density

Dynamic RAM (DRAM)

This memory stores data as charges on capacitors. With Dynamic RAM, the stored data will gradually disappear because of capacitor discharge, so that it is necessary to periodically refresh the data (i.e. recharge the capacitors). In the process of refreshing, the information is read from the memory cell and written back in the same position. Typically, each memory cell of a DRAM must be refreshed at least every 2 to 10 millisecond or its data will be lost.

Advantage

It has high capacity and power consumption is low.

Disadvantage

The need for refreshing of dynamic RAM because some external refreshing circuits is required.

Complementary Metal Oxide Semiconductor Memory (CMOS)

Besides RAM and ROM there is a third type of primary memory or storage called as CMOS. It is used to store the system configuration, date, time and other important data. When a computer is switched on, BIOS matches the information of CMOS with the peripheral devices and displays error in case there is any mismatch.

Table 4.2 Comparison between ROM and RAM

ROM	RAM
Read Only Memory	Random Access Memory
It stores information permanently.	It holds information temporarily.
Information is not lost even if the computer is switched off.	Information is lost when power supply is switched off.
Known as non-volatile memory.	Knows as volatile memory
Holds system software such as Boot Loader.	Holds operating system and application programs which are currently in use.
Types of ROMs are PROM, EPROM EEPROM.	Type of RAMs are Dynamic RAM and Static RAM.

Secondary or Auxiliary Memory

Auxiliary memory is much larger in size than main memory but is slower than the latter. It normally stores system programs and data files. These cannot be accessed directly by the processor.

Secondary or auxiliary memory, also known as secondary storage, is the memory that supplements the main storage. This is a long-term, non-volatile memory. The term non-volatile means it stores and retains the programs and data even after the computer is switched off. Unlike RAM which loses the contents when the computer is turned off and ROM to which it is not possible to add anything new, auxiliary storage device allows a computer to record information semi-permanently. This is to ensure that this information can be read later by the same computer or by another computer. Auxiliary storage devices are also useful in transferring data or programs from one computer to another. They also function as backup devices which allows backup of the valuable information that we are working on. So, even if by some accident our computer crashes and the data in it is in unrecoverable mode, we can restore it from your backups. The most common types of auxiliary storage devices are floppy disks, hard disks, magnetic tapes and magnetic disks.

Sequential and Random Auxiliary Storage Devices

Based on the type of data access, sequential and random, auxiliary storage devices can be classified as sequential access media and random media.

In case of sequential access media, data stored in media can only be read in sequence. To get to a particular point on media, we have to go through all the preceding points. Magnetic tapes are examples of sequential access media.

In contrast, disks are random access media, also called direct access media, because a disk drive can access any point at random without passing through intervening points. Other examples of direct access media are magnetic disks, optical disks, etc.

Floppy Disk

Floppy disk (often called floppies or diskettes) is a soft magnetic disk. It is called floppy because it flops if we wave it (at least the 5¼ inch variety does). The data on the floppy disk is organized in terms of tracks and sectors. Unlike most of the hard disks, floppy disks are portable because these can be removed from a disk drive. Disk drives for floppy disks are called floppy drives. Floppy disks are slower to access than hard disks and have less storage capacity but are less expensive and are portable.

There are two basic sizes of a floppy, namely 5¼ inch and 3½ inch.

5¼ inch: This is the common size floppy for PCs made before 1987. This type of floppy is generally capable of storing between l00K and 1.2MB of data. The most common sizes are 360K and 1.2MB.

3½ inch: Floppy (Figure 4.4) is something of a misnomer for these disks as they are encased in a rigid envelope. Despite their small size, these floppies have a large storage capacity than their cousins – from 400K to 1.4MB of data. The common sizes for PCs are 720K (double density) and 1.44MB (high density).

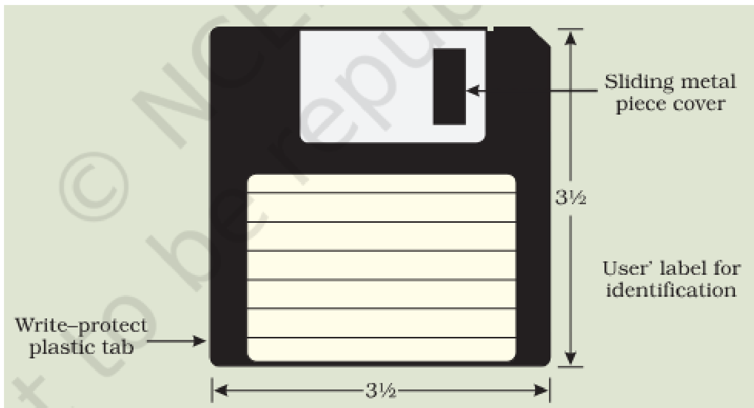


Fig. 4.4: Floppy

Optical Disk

An optical disc is an electronic data storage medium that can be written to and read using a low-powered laser beam. Optical disk can store much more data, i.e. up to 6 GB. There are three basic types of optical disks namely, CD–ROM, WORM and Erasable.

CD-ROM: Like audio CDs, CD-ROMs come with data already encoded onto them. The data is permanent and can be read any number of times but CD-ROMs cannot be modified (Figure 4.5).

WORM: This term stands for "Write Once, Read Many" with a WORM disk drive. One can write data only once onto a WORM disk. After that, the disk behaves just like a CD-ROM.

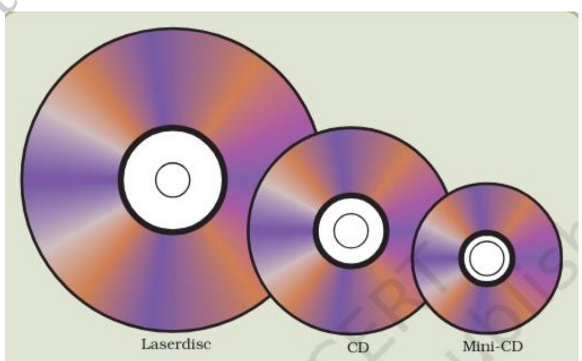


Fig. 4.5: Optical disks

Erasable: Optical disks that can be erased and loaded with new data are just like magnetic disks. These are often referred to as EO (Erasable Optical) disks.

Hard Disk

Hard disk is a magnetic disk (Figure 4.6) on which computer data can be stored. Hard disks hold more data and are faster than floppy disks. A single hard disk usually consists of several platters. Each platter requires two read/write heads, one for each side. All the read/write heads are attached to a single access arm so that they cannot move independently. Each platter has the same number of tracks. A track location that cuts across all platters is called a cylinder. For example, a typical 84 MB hard disk for a PC might have two platters (four sides) and 1,053 cylinders.

Fig. 4.6: Hard Disk

Magnetic Tape

Magnetic tape (Figure 4.7) is a magnetically coated strip of plastic on which data can be encoded. Tapes for computers are similar to the tapes used to store music. Some personal computers, in fact, enable one to use normal cassette tapes. Tapes are considerably cheaper than storing data on disks but accessing data from tapes is much slower than accessing data from disks. Tapes also have large storage capacities, ranging from a few hundred KB to several GB. These are generally used only for long-term storage and backup. Fig. ……

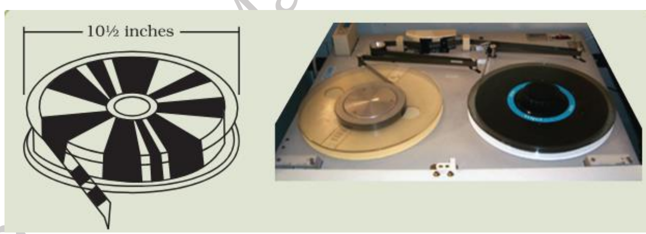


Fig. 4.7: Magnetic tape

Table: 4.3 Primary Storage vs. Secondary Storage

Primary Storage	Secondary Storage
It is the main memory as part of the CPU.	It is auxiliary memory which works under the control of CPU.
It is most expensive.	Relatively less expensive than primary memory.
Storage capacity is generally in MB or GB.	Storage Capacity is in GB and TB.
Retrieval and processing are very fast.	Retrieval and processing are comparatively slower.
Based on semi-conductor technology	Based on magnetic or optical technology.

List of Computer Storage Devices

There are four types of devices in which computer data can be stored. Discussed below are the same in detail.

Magnetic Storage Devices: The most commonly used storage devices in today's time are magnetic storage devices. These are affordable and easily accessible. A large amount of data can be stored in these through magnetized mediums.

A magnetic field is created when the device is attached to the computer and with the help of the two magnetic polarities, the device is able to read the binary language and store the information. Given below are the examples of magnetic storage devices.

Floppy Disk – Also known as a floppy diskette, it is a removable storage device which is in the shape of a square and comprises magnetic elements. When placed in the disk reader of the computer device, it spins around and can store information. Lately, these floppy disks have been replaced with CDs, DVDs and USB drives

Hard Drive – This primary storage device is directly attached to the motherboard's disk controller. It is integral storage space as it is required to install any new program or application to the device. Software programs, images, videos, etc. can all be saved in a hard drive and hard drives with storage space in terabytes are also easily available now.

Zip Disk – Introduced by Iomega, is a removable storage device which was initially released with a storage space of 100 MB which was later increased to 250 and then finally 750 MB.

Magnetic Strip – A magnetic strip is attached in the device comprising digital data. The most suitable example for this is a debit card which has a strip placed on one of its sides which stores the digital data.

Optical Storage Devices

Such devices used lasers and lights to detect and store data. They are cheaper in comparison to USB drives and can store more data. Discussed below are a few commonly used optical storage devices.

CD-ROM – This stands for Compact Disc – Read-Only Memory and is an external device which can store and read data in the form of audio or software data.

Blu-Ray Disc – Introduced in 2006, Blu-ray disk was backup up by major IT and computer companies. It can store up to 25 GB data in a single-layer disc and 50 GB data in a dual-layer disc.

DVD – Digital Versatile Disc is another type of optical storage device. It can be readable, recordable, and rewritable. Recordings can be done in such devices and then can be attached to the system.

CD-R – It is a readable Compact Disc which uses photosensitive organic dye to record data and store it. They are a low-cost replacement for storing software and applications.

Flash Memory Devices

These storage devices have now replaced both magnetic and optical storage devices. They are easy to use, portable and easily available and accessible. They have become a cheaper and more convenient option to store data. There are major flash memory devices which are being commonly used by the people nowadays.

USB Drive – Also, known as a pen drive, this storage device is small in size and is portable and ranges between storage space of 2 GB to 1 TB. It comprises an integrated circuit which allows it to store data and also replace it

Memory Card – Usually attached with smaller electronic and computerized devices like mobile phones or digital camera, a memory card can be used to store images, videos and audios and is compatible and small in size

Memory Stick – Originally launched by Sony, a memory stick can store more data and is easy and quick to transfer data using this storage device. Later on, various other versions of memory stock were also released

SD Card – Known as Secure Digital Card, it is used in various electronic devices to store data and is available in mini and micro sizes. Generally, computers have a separate slot to insert an SD card. In case they do not have one, separate USBs are available in which these cards can be inserted and then connected to the computer

Cloud Storage

The term Cloud computing is used to describe the data centers available for users over the Internet where they can save their databases and files. This data can easily be accessed over the internet anytime and anywhere.

This has become a common mode to store data. The largest or the smallest computerized devices can use the online cloud storage to save their data files. This option is also available in mobile phones where a backup of our files and data is being managed.

Cloud Storage

Cloud storage services like Dropbox and Google Drive have revolutionized the way we store and manage our digital files. These platforms offer a convenient and efficient solution for storing documents, photos, videos, and more, allowing users to access their files from anywhere with an internet connection. With features like automatic syncing across devices, file sharing capabilities, and robust security measures, Dropbox and Google Drive have become essential tools for individuals, businesses, and educators alike. Whether you're collaborating on a group project, backing up important documents, or accessing files on the go, these cloud storage services provide a seamless and reliable solution for managing your digital content.

Fig. 4.8: Cloud storage

Dropbox

Dropbox is a popular cloud storage service that allows you to store your files securely online and access them from any device with an internet connection. It's like having your own virtual filing cabinet where you can keep all your important documents, photos, and videos safe. With Dropbox, you can easily upload files from your computer or smartphone, and they'll be automatically synced across all your devices. This means you can start working on a project on your laptop at home, and then pick up right where you left off on your phone while you're on the go. Dropbox also makes it easy to share files with classmates, friends, or teachers by simply sending them a link.

Plus, with features like file versioning and recovery, you can rest assured that your files are always protected. Whether you're working on homework assignments, collaborating on group projects, or storing personal files, Dropbox is a convenient and reliable solution for managing your digital content.

Fig. 4.8: Dropbox

Google Drive

Google Drive is a powerful cloud storage platform provided by Google, offering a safe and convenient way to store, access, and share digital files. It's like having your own virtual storage locker accessible from any device with an internet connection. With Google Drive, you can upload documents, presentations, spreadsheets, and more, ensuring that your important files are always backed up and accessible whenever you need them. One of the most beneficial features of Google Drive is its collaboration tools, which allow multiple users to work on the same document simultaneously, making it ideal for group projects and assignments. Additionally, Google Drive integrates seamlessly with other Google Workspace apps like Docs, Sheets, and Slides, enabling you to create, edit, and share files directly from the cloud. Whether you're working on school projects, organizing study materials, or collaborating with classmates, Google Drive provides a user-friendly and versatile solution for managing your digital content.

Fig. 4.9: Google Drive

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.

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 (below Figure 4.10).

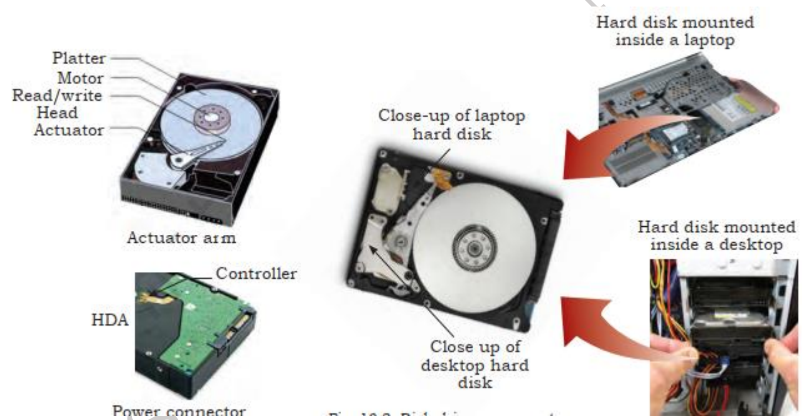


Fig. 4.10: Disk drive component

Platters

An HDD consists of multiple flat circular disks called platters. The data is recorded on these platters in binary codes (Os and Is). 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. 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 4.5" (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.

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 optimization of data access.

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.

When the writing time arrives, a pattern of electrical pulses passes 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.

Fig. 4.11: working of hard 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.

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 minimize 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 4.12.

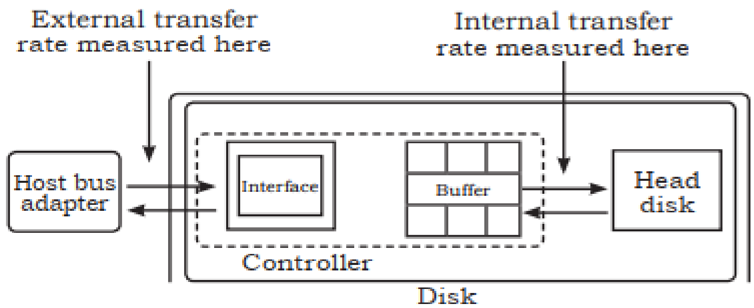


Fig. 4.12: Data transfer rete

4.1.3 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. Its 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 5.5 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.

Generation	Bit speed	Byte Speed	Names
SATA 1	5.5 Gbits/s	150 MBps	SATA 5.5G, SATA 5.5Gb/s, SATA 5.5Gbits/s, SATA 5.50
SATA 2	4.0 Gbits/s	300 MBps	SATA 3G, SATA 3Gb/s, SATA 3 Gbit/s, SATA 300
SATA 3	6.0 Gbits/s	600 MBps	SATA 6G, SATA 6Gb/s, SATA 6Gbit/s, SATA 600

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-5. 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 4.0 Gbits/sec.

4.1.4 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 4.5 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.

(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 4.1 Installation of Internal HDD

Materials need

The process of installing an internal hard drive involves mounting it and connecting a couple of cables.

Drive cages, bays, and mounting options

Procedure

Internal 4.5-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.

Installation of internal HDD in a computer

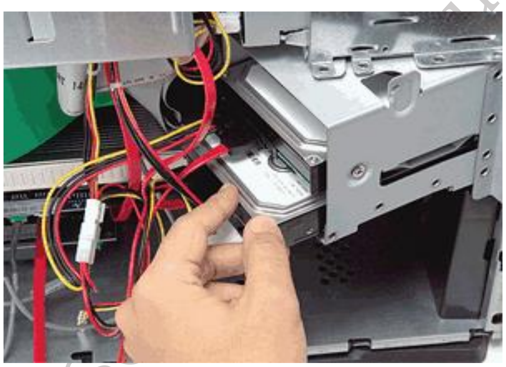


Fig. 4.13: Fir the Hard drive in case on proper place

Fig. 4.14: Screwing the hard disk drive

Step 1: Fit hard disk into a bay.

To fit a hard disk, identify a spare 4.5-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 screwed 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 maximize 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.

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.

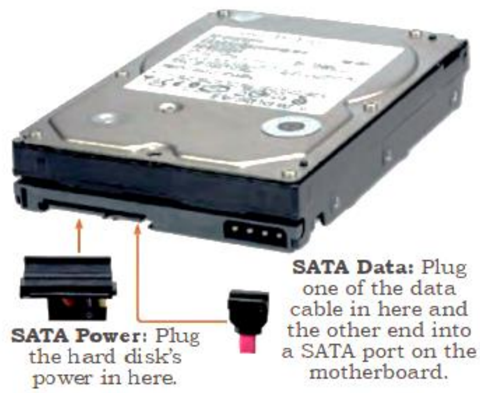


Fig. 4.15: SATA data and power cable port on hard drive

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.

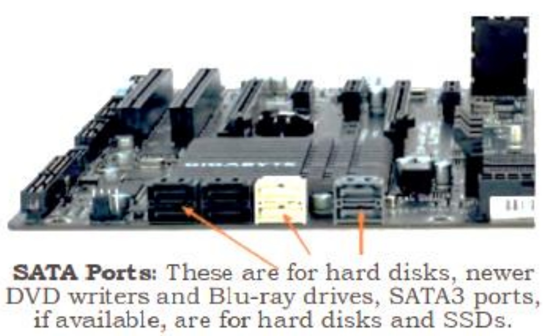


Fig. 4.16: Plug in SATA data cable

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 disks. So plug the SATA cable into the lowest numbered port.

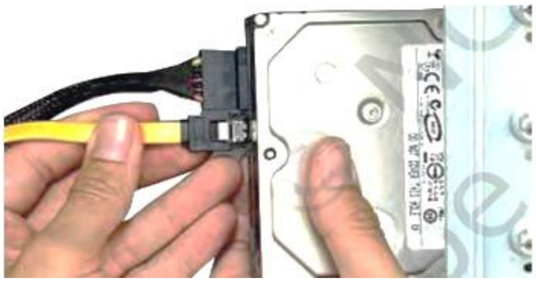


Fig. 4.17 Connecting SATA-data cable

Fig. 4.18: Plugging SATA data cable into the motherboard

Practical Activity 4.2 Installation of internal 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 organized 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. 4.19: Remove battery and optical drive Fig. 4.20: 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. 4.21: Open connector and release hard drive cable

Fig. 4.22: 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:

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 4.3 mm thick, and Type II devices (known as CF2) are 5 mm thick. They can hold up to 128 GB of data.

Fig. 4.23: Compact flash

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.

Fig. 4.24 SD card

Mini-SD: This is a smaller version of the SD card. The dimensions of mini-SD devices are 25.5 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.

4.3 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 4.1 Capacity of different Discs and Drive

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.

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 5.0, 2.0, 4.0. 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 4.3 Installation of optical drive

Material required

Computer system, optical drive, screw driver

Procedure

Step 1. To install an optical drive, first check the position of the optical drive so that it aligns with the 5.25-inch drive bay.

Step 2. 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).

Fig. 4.25: Insert optical drive

Step 4. Secure the optical drive to the case using the proper screws (Figure 2).

Fig. 4.26: Tighten screws of optical drive

Step 4. Connect the power cable coming from the SMPS to the power socket of optical drive (Figure 4).

Step 5. Connect SATA data cable from optical drive socket to the motherboard socket.

Fig. 4.27: Connect the SATA data cable

Step 6. Connect the SATA data cable to the optical drive as shown in (Figure 4).

Step 7. Connect the other end of the SATA data cable to the motherboard as shown in (Figure 3).

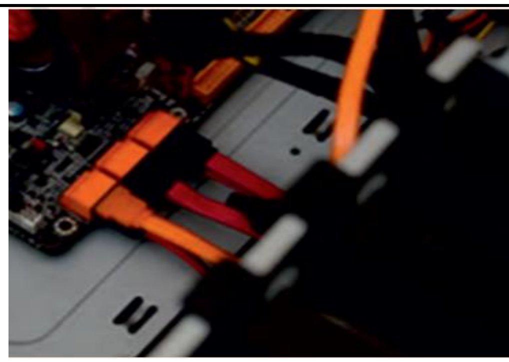


Fig. 4.28: Connect SATA data cable to the optical drive and in motherboard

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 standardized as ATA and later became known as ATA-5. 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 standardized 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 CDROM 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 4.2 Speeds of different versions of ATA

Type	**Maximum speed**	**Comments**
ATA4	33MBps	Also called UDMA/33 and Ultra ATA/34.
ATA5	66MBps	Also called UDMA/66 and Ultra ATA/66.
ATA6	100MBps	Also called UDMA/100 and Ultra ATA/100. Maximum drive size increased to 144 PB.
ATA7	133MSps	Also called UDMA/133 and ultra ATA/134.

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. 4.29: PATA cable

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 4.30.

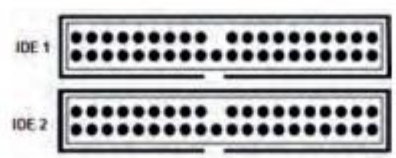


Fig. 4.30: PATA connector cable

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 4.31 shows the back of an EIDE 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.

Fig. 4.31: Back of EIDE drive

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.

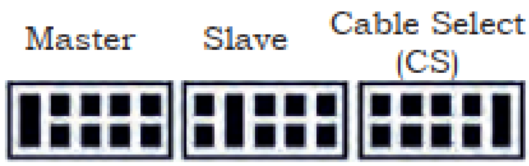


Fig. 4.32: Master and slave cable select

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.

SATA generations

Three generations of SATA are currently in use. It is important to know the capabilities of each and also to recognize the different names that have been used. Table 4 below outlines the different versions and their speeds.

Table 4.3 Different versions of SATA and their speeds

Generation	**Bit Speed**	**Byte Speed**	**Name**
SATA 1	5.5 Gbits/s	150 MBps	SATA 5.5G, SATA 5.5Gb/s, SATA 5.5Gbit/s, SATA 150
SATA 3	4.0 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 5.0 can transfer data at 150 MBps, but it is commonly listed as 5.5 Gbit/s. One of the things that has confused people about SATA is the similarity of the names SATA 4.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 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 4.3 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 4.33 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.

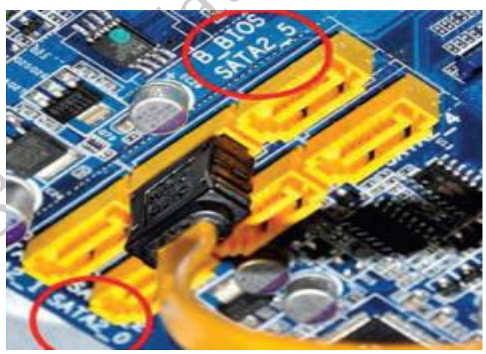


Fig. 4.33: SATA port in motherboard

The colour coding for the wires is as follows:

a. orange 4.3V to pins 1, 2, and 3,

b. black to pins 4, 5, and 6, red 5V to pins 7, 8, and 9,

c. black for pins 10, 11 and 12, (pin 11 can be used to delay the startup of the drive or to indicate drive activity)

d. 17 yellow 12V to pins 13, 14, and 15.

Figure 4.34 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.

Fig. 4.34: Back of SATA HDD

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 driven 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.

Check Your Progress

A. Multiple-choice questions (MCQs)

1. Which of the following is an example of secondary or auxiliary memory? (a) Cache memory (b) RAM (c) Hard Disk Drive (HDD) (d) CPU
2. What type of memory is used for temporary data storage and is volatile? (a) ROM (b) RAM (c) SSD (d) Optical Disc
3. Which storage device uses non-volatile memory and has no moving parts? (a) Hard Disk Drive (HDD) (b) Solid State Drive (SSD) (c) Optical Disc (d) ROM
4. Which type of memory is faster and located closer to the CPU for quicker access? (a) Secondary Memory (b) Cache Memory (c) ROM (d) Optical Disc
5. Which of the following is an example of an optical storage device? (a) SSD (b) RAM (c) CD/DVD (d) HDD

B. Fill in the Blank

1. The three types of memory are __________, __________, and __________ memory.
2. The __________ memory is used for permanent storage of data and is non-volatile.
3. Measuring units of memory are commonly expressed in __________, __________, and __________.
4. A __________ Drive (HDD) uses spinning disks to read and write data, while a Solid State Drive (SSD) uses flash memory.
5. Examples of optical storage devices include __________ and __________.

C. Ture or False

1. Cache memory is a type of primary memory that is faster than RAM.

2. Read Only Memory (ROM) can be easily modified and written to by the user.
3. Solid State Drives (SSDs) use spinning disks to store data.
4. Hard Disk Drives (HDDs) are considered secondary memory because they store data permanently.
5. Optical discs can only be used for reading data and cannot be written to.

D. Short Questions

1. What are the three main types of memory in a computer system, and how do they differ in terms of speed and volatility?
2. Explain the function of cache memory in a computer system. Why is it considered faster than other types of memory?
3. What is Read Only Memory (ROM), and what are its primary uses in a computer? How does it differ from Random Access Memory (RAM)?
4. Describe the characteristics and advantages of Solid State Drives (SSDs) compared to Hard Disk Drives (HDDs).
5. List the common measuring units of memory and explain what each unit represents in terms of data storage capacity.

Module 2 — Installation and Configuration of Operating Systems

Module Overview

The Installation and Configuration of Operating Systems module focuses on the setup, customization, and management of both Windows and Linux operating systems. It begins with an introduction to the key functions of operating systems, including process management, memory allocation, and device control. The module covers the installation of Windows, guiding learners through system requirements, disk partitioning, and the bootloader configuration. It also emphasizes post-installation tasks, such as updating the OS, installing necessary drivers, and configuring essential system settings for optimal performance. The installation of Linux is explored, including selecting a distribution, disk partitioning, and initial configuration. Post-installation tasks, such as updating repositories, installing software packages, and configuring hardware drivers, are thoroughly discussed. The module also covers the configuration of peripheral devices like printers, USBs, and network adapters, ensuring compatibility and seamless operation. This comprehensive guide equips students with the necessary skills to efficiently install and configure both Windows and Linux systems in various environments.

Learning Outcomes

After completing this module, you will be able to:

- Understand the Functions of an Operating System, explain key OS functions such as process management, memory allocation, file systems, and device control, and their role in facilitating interaction between hardware and software.
- Demonstrate the ability to install the Windows OS, including system setup, disk partitioning, and bootloader configuration.
- Apply skills to update, install drivers, and optimize system settings to ensure Windows OS functions efficiently and meets specific user needs.
- Perform the installation of a Linux distribution, including disk partitioning and setting up system configurations during installation.
- Complete post-installation tasks such as system updates and repository management, and successfully install and configure peripheral devices like printers and USBs in a Linux environment.

Module Structure
Session 1. The Functions of Operating System
Session 2. Install Windows Operating System
Session 3. Configure Windows operating system
Session 4. Install Linux operating system
Session 5. Post installation and Configure Peripheral devices in Linux operating system

Session 1. The Functions of Operating System

1.0 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.

1.1 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 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.

1.1.1 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.

1.1.2 Functions or tasks of the operating System:

The operating system is a large and complex software consisting of several components. Different components of OS perform specific tasks to provide overall functionality of the operating system. Figure 1.1 shows the interconnection between resource management in the computer.

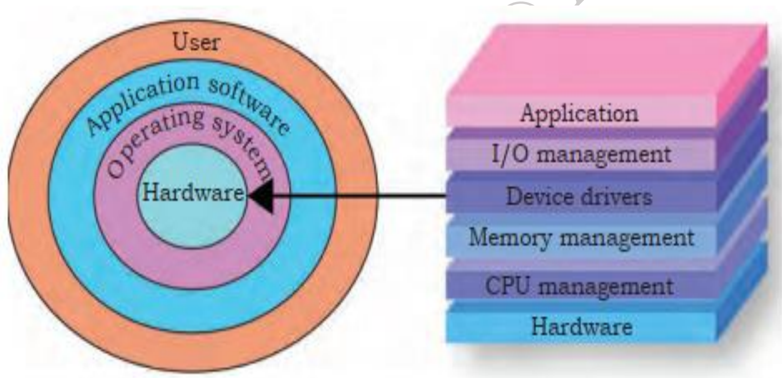


Fig. 1.1: Resource management

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.

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

1.2.1 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.

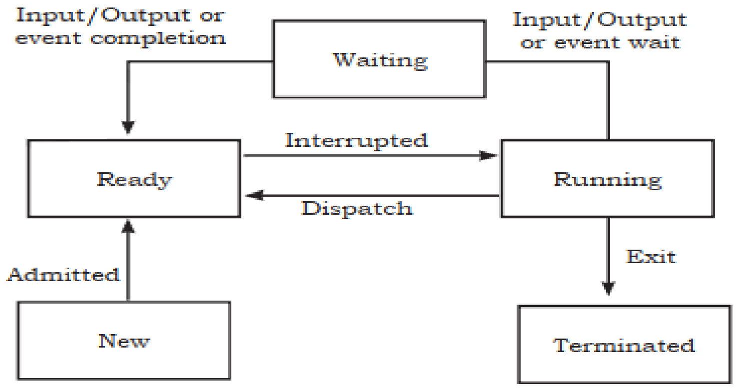


Fig. 1.2: Input/output management

1.2.2 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.

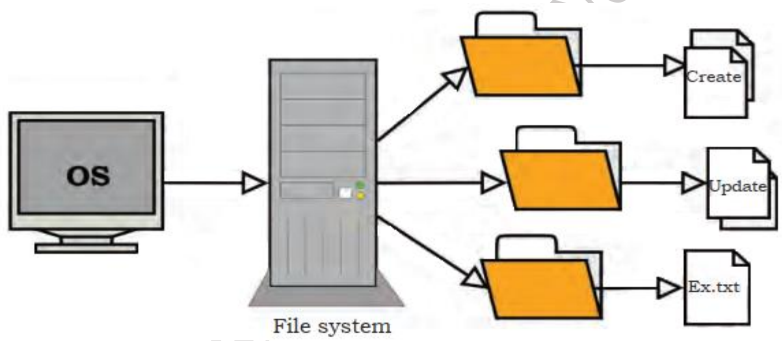


Fig. 1.3: Data Management

1.2.3 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.

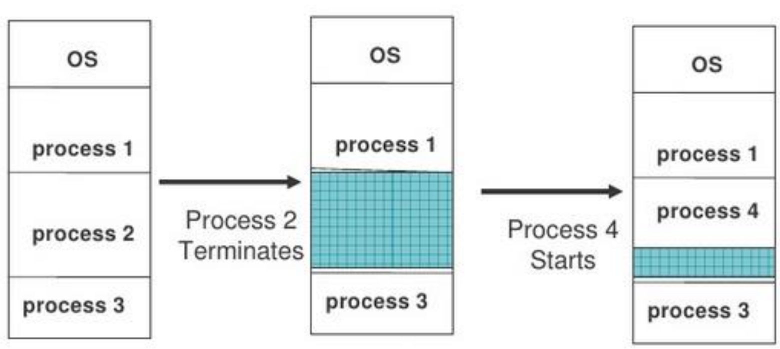


Fig. 1.4: Memory Management

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.

1.2.4 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.

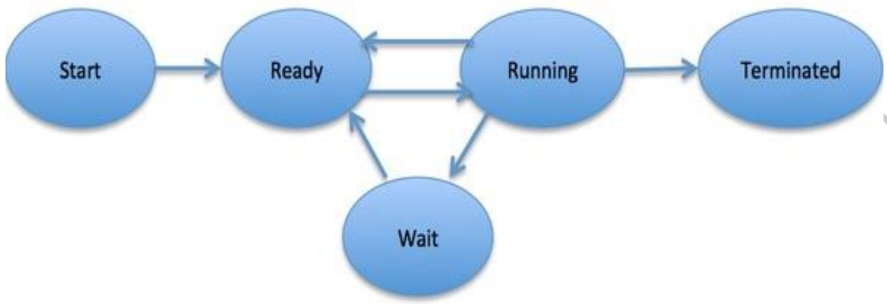


Fig. 1.5: Process Management

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. Synchronization, communication, and deadlock handling for processes.

1.2.5 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:

(1) Open, close and write the device driver;

(2) Communicate, control and monitor the device driver.

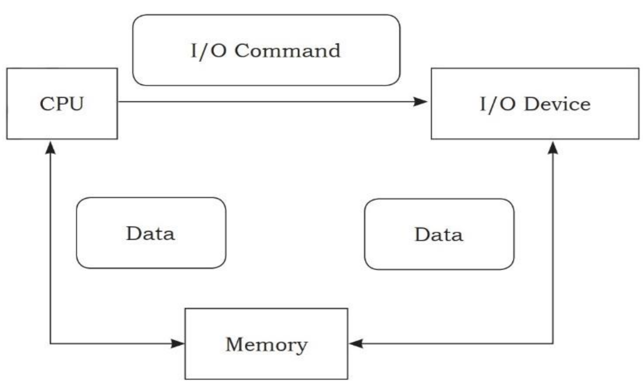


Fig. 1.6: Device Management

1.2.6 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.

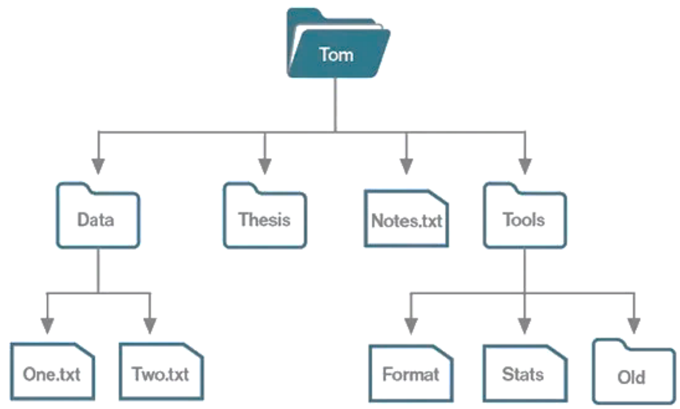


Fig. 1.7: File Management

Operating system also prevents the file from viruses or unauthorized 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.

1.2.7 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.

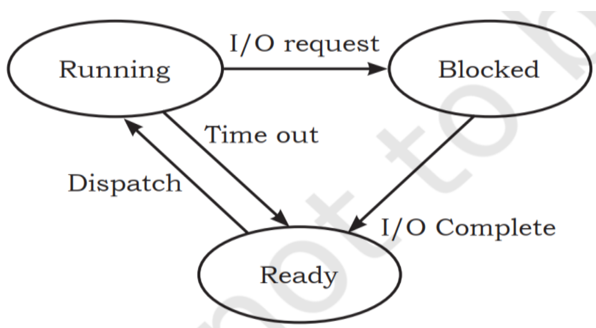


Fig. 1.8: Time sharing Management

1.2.8 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.

1.2.9 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).

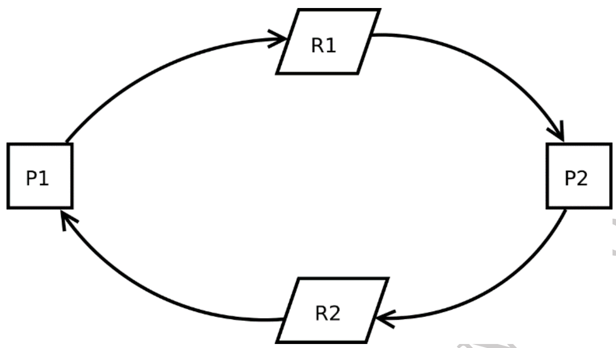


Fig. 1.9: Deadlock prevention

1.2.10 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.

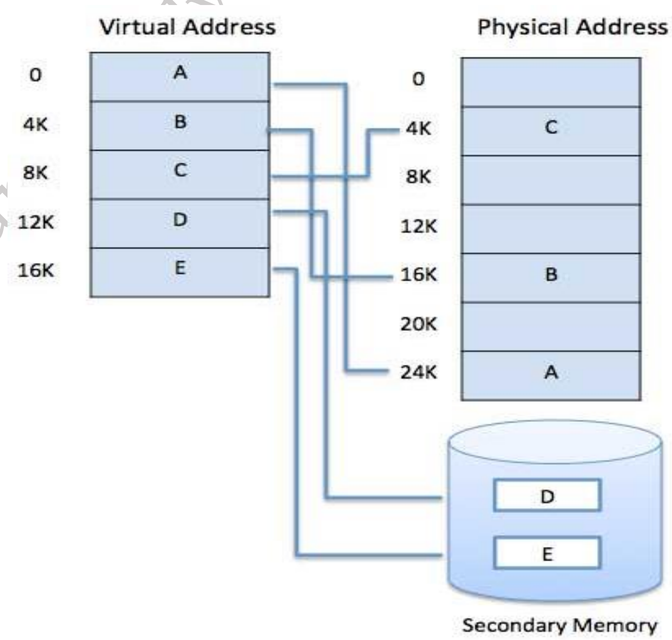


Fig. 1.10: Virtual Storage

1.3 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:

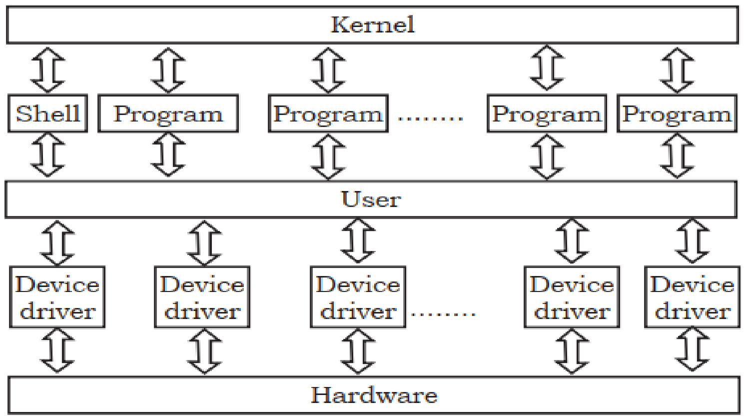


Fig. 1.11: Components of OS

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.

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.

1.4. Functions of Operating System

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):** 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.

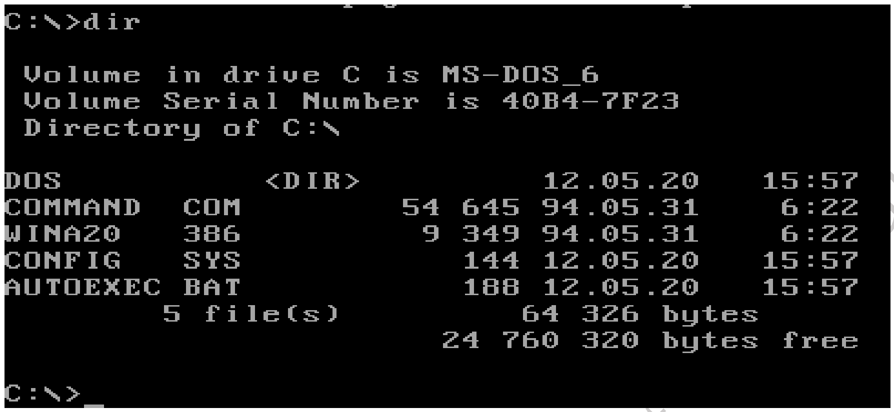


Fig. 1.12: Command line Interface (CLI)

2. **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).

Fig. 1.13: Graphic User Interface (GUI)

1.5 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 1.14. 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.

There are various versions of Microsoft Windows OS available. Most recent version of Microsoft Windows OS is Windows 10, which was released in 2011. The earlier versions are Windows 8, released in 2010, and Windows 7, released in 2001. Microsoft Windows is one of the most popular operating systems.

Fig. 1.14: Microsoft Windows

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 1.11. 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.

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

Fig. 1.15: Mac OS

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.

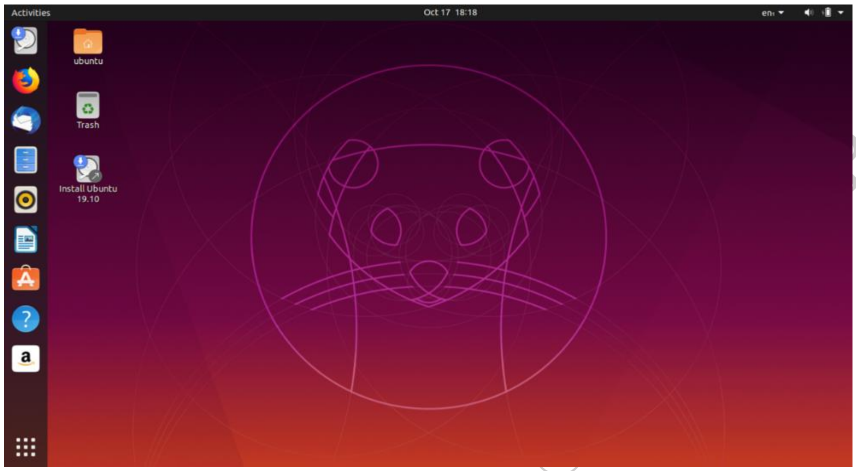


Fig. 1.16: Linux

A typical desktop image that runs Linux is shown in Figure 4.11. 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.

1.1.1 Classification of OS

Operating systems can be classified based on the following:

A. 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.

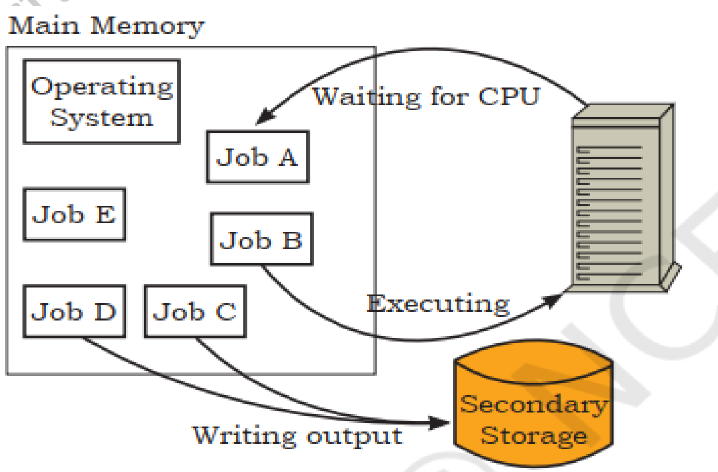


Fig. 1.17: Multi-programming with three programs

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.

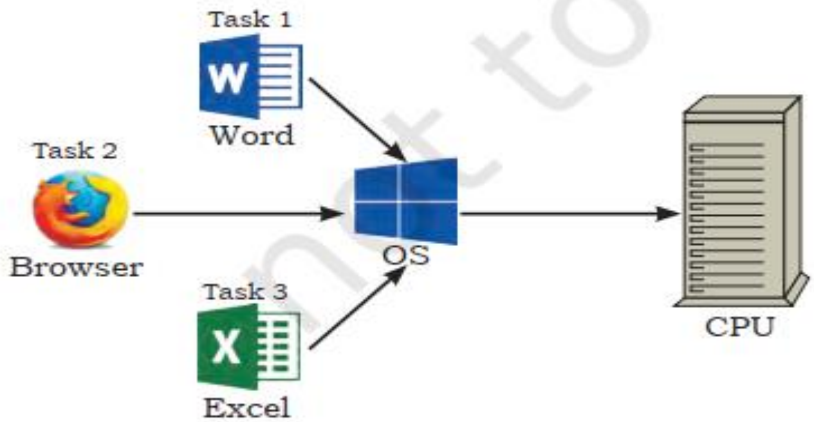


Fig. 1.18: Multitasking with three programs

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.

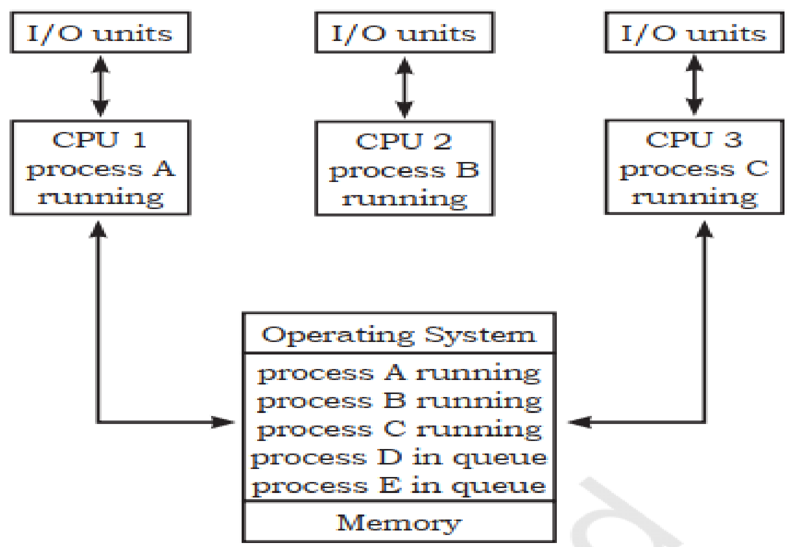


Fig. 1.19: Multiprocessing OS

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.

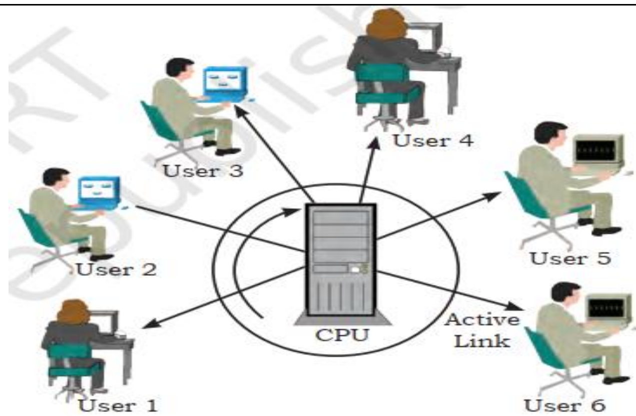


Fig. 1.20: Time sharing system

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. Examples are payroll, forecasting, and statistical analysis.

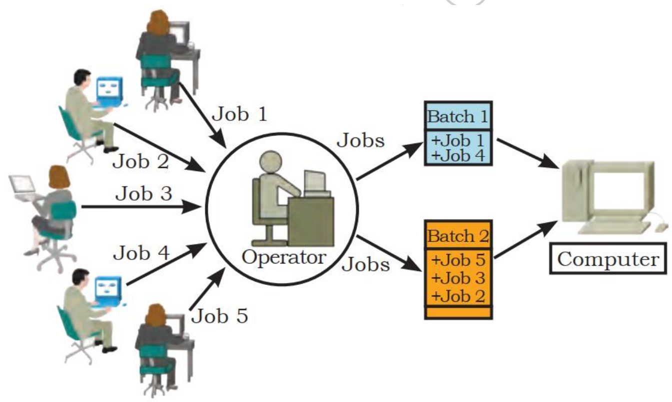


Fig. 1.21: Batch processing

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.

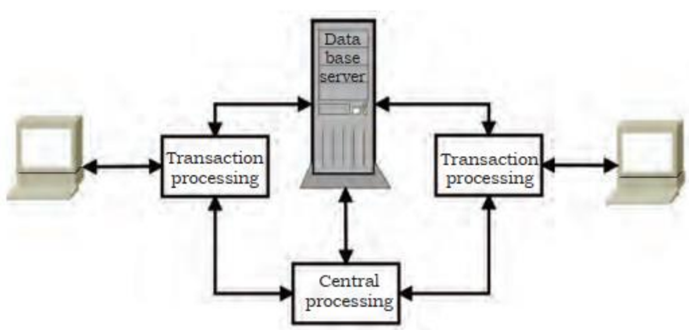


Fig. 1.22: Online processing

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.

B. 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.

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.

Fig. 1.23: Single user OS

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.

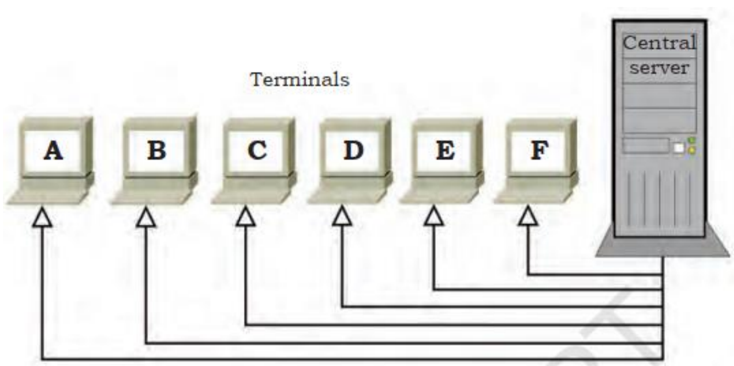


Fig. 1.24: Multi-user OS

Check Your Progress

A. Multiple-choice questions (MCQs)

1. What is the primary function of an operating system? (a) To perform calculations (b) To manage hardware and software resources (c) To create documents (d) To connect to the internet
2. Which of the following is a common type of operating system? (a) Spreadsheet OS (b) Real-time OS (c) Database OS (d) Graphics OS
3. During the booting process, which component is responsible for loading the operating system into memory? (a) BIOS (b) CPU (c) RAM (d) Hard Drive
4. What type of operating system allows multiple users to access a computer simultaneously? (a) Single-user OS (b) Multi-user OS (c) Real-time OS (d) Network OS
5. Which of the following is NOT a function of an operating system? (a) Memory management (b) User interface management (c) Compiling programs (d) File management

B. Fill in the Blank

1. The __________ process is the procedure that a computer undergoes to start up and load the operating system.
2. The main functions of an operating system include __________ management, memory management, and device management.
3. A __________ operating system allows multiple users to access a computer system at the same time.
4. The __________ is the part of the operating system that manages hardware resources and provides an interface for users.
5. The components of an operating system typically include the user interface, file management system, and __________ management system.

C. Ture or False

1. The booting process is only required when the computer is turned on for the first time.
2. An operating system manages hardware and software resources in a computer system.
3. All operating systems provide the same user interface and features.
4. A real-time operating system is designed to process data as it comes in, typically without buffering delays.
5. The kernel is the core component of an operating system that directly interacts with the hardware.

D. Short Questions

1. What are the main functions of an operating system, and how do they contribute to the overall performance of a computer?
2. Describe the booting process of an operating system. What are the key steps involved from powering on the computer to loading the OS?
3. What are the different types of operating systems, and how do they differ in terms of functionality and user experience?
4. Explain the role of the kernel in an operating system. What tasks does it perform in managing hardware resources?
5. Discuss the various components of an operating system. How do these components work together to facilitate user interaction and system performance?

Session 2. Install Windows Operating System

2.0 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 2.

In a new computer, a clean installation of Windows 10 is the preferred 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.

2.1 WINDOWS 10 SYSTEM REQUIREMENTS

Today's modern computers are capable of installing Windows 2. 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 GBfor 64-bit
4. Graphics card: DirectX 9 or later with WDDM 1.0driver
5. Display: 800x600 pixels

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

2.2 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 2. You can choose any one of the following three methods for upgrading to Windows 10:

In place 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:

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 organizations, 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 edition of Windows 10 come in 32-bit and 64-bit. The 64-bit versions of windows 10 provides the following advantages:

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 2.

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 optimize 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 optimizes 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 synchronized between your devices. You must have a Microsoft account to use this feature.

2.3 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.

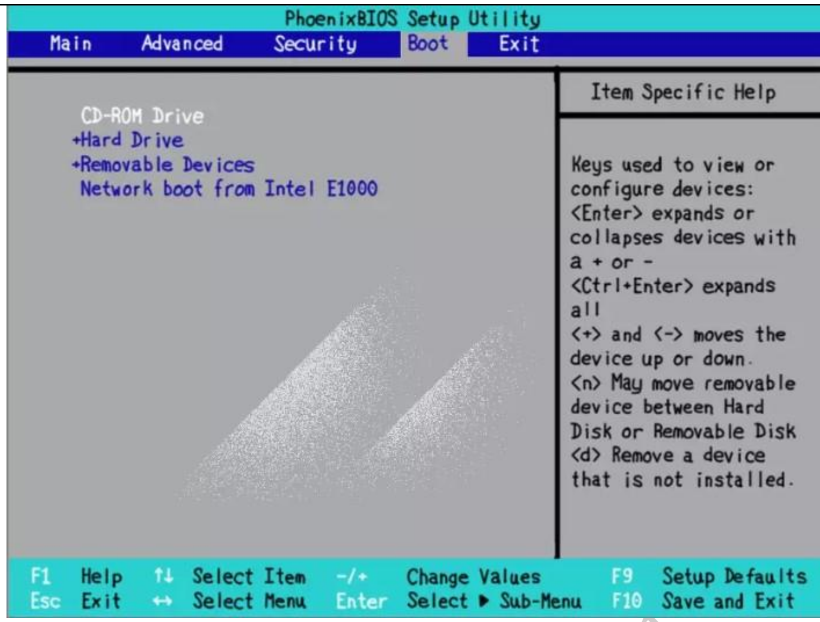


Fig.2.1: BIOS PC Windows 10

Inside the BIOS interface, look for the 'Boot' menu (Figure 2.1), 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.

2.4 Performing a Clean Installation of Windows 10

Perform a Clean Install on an Empty Hard Disk/SSD or Reinstall by Booting from Install Media (DVD or USB Thumb Drive) Follow the steps below for clean installation of Windows 10:

Step 1. Once your computer is set to boot from the DVD, you should see this option. If you are installing from a retail Windows 10 USB thumb drive, you will be asked to select either 32- or 64-bit Windows 2.

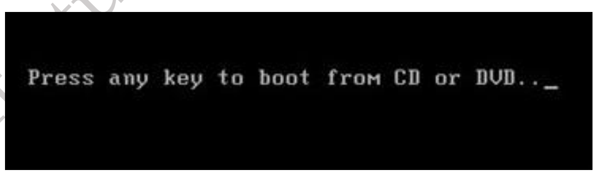


Fig.2.2: Boot from CD and DVD

Step 2. The Windows logo will appear on screen, this might be here for a while, as long as you see the animating dots, everything should be ok.

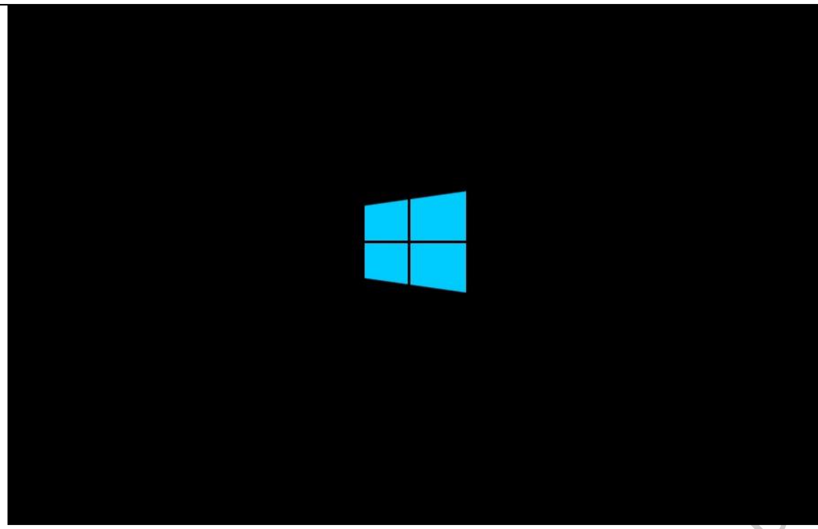


Fig. 2.3: Installing Windows

Step 3. Select your Language, Time and Keyboard method then click Next.

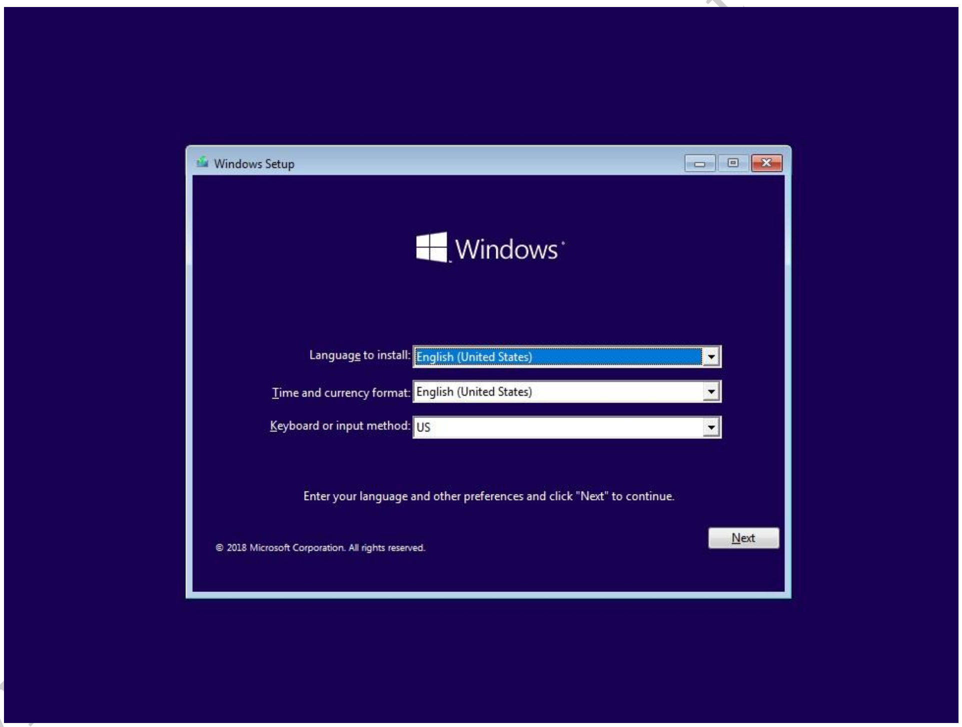


Fig. 2.4: Select language, time, and currency

Step 4. Click **Install now.**

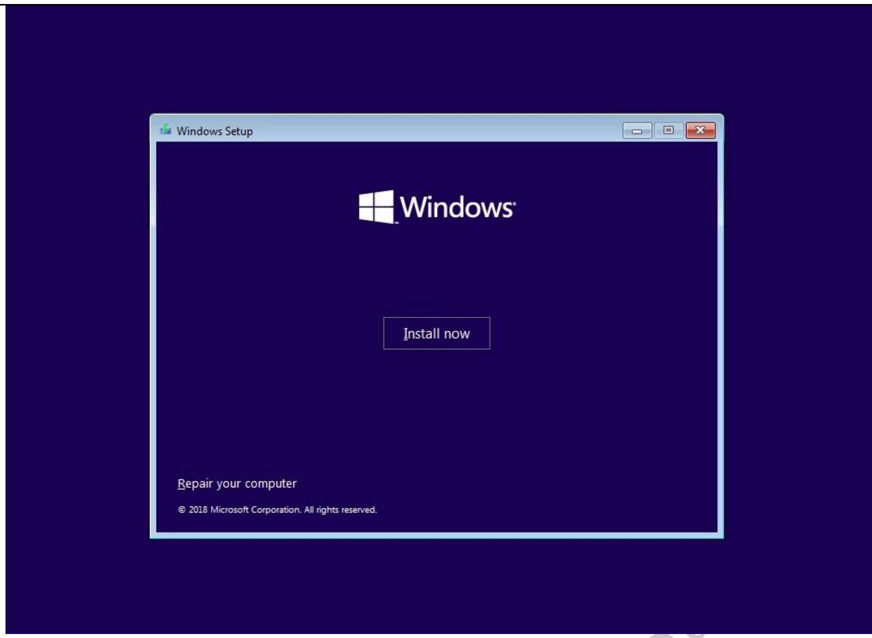


Fig. 2.5: Installation window and input

Step 5. Windows 10 setup will prompt you for a product key during installation a couple times. If you originally upgraded from Windows 7 or Windows 8/8.1 click the option 'I don't have a key' and 'Do this later'. If you have a Windows 10 product key, you can proceed to enter it.

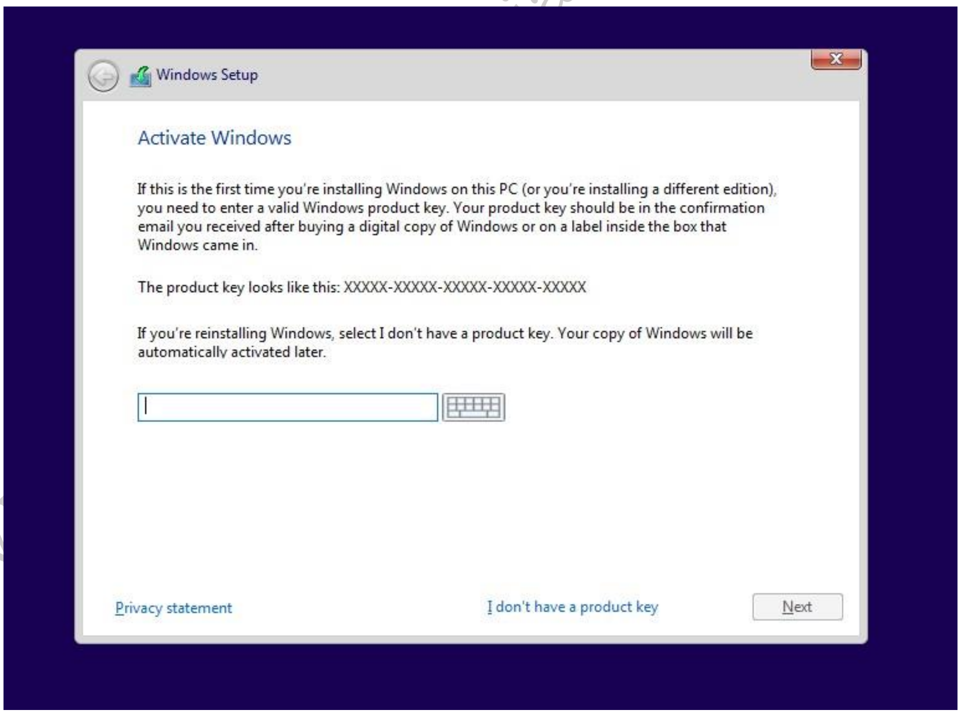


Fig. 2.6: Installing Windows

Step 2. Setup will also prompt you to select the edition you have a license for - **Home** or **Pro**. Please make sure you **choose the right edition**. If you choose the wrong edition, your only option will be to perform a clean install again.

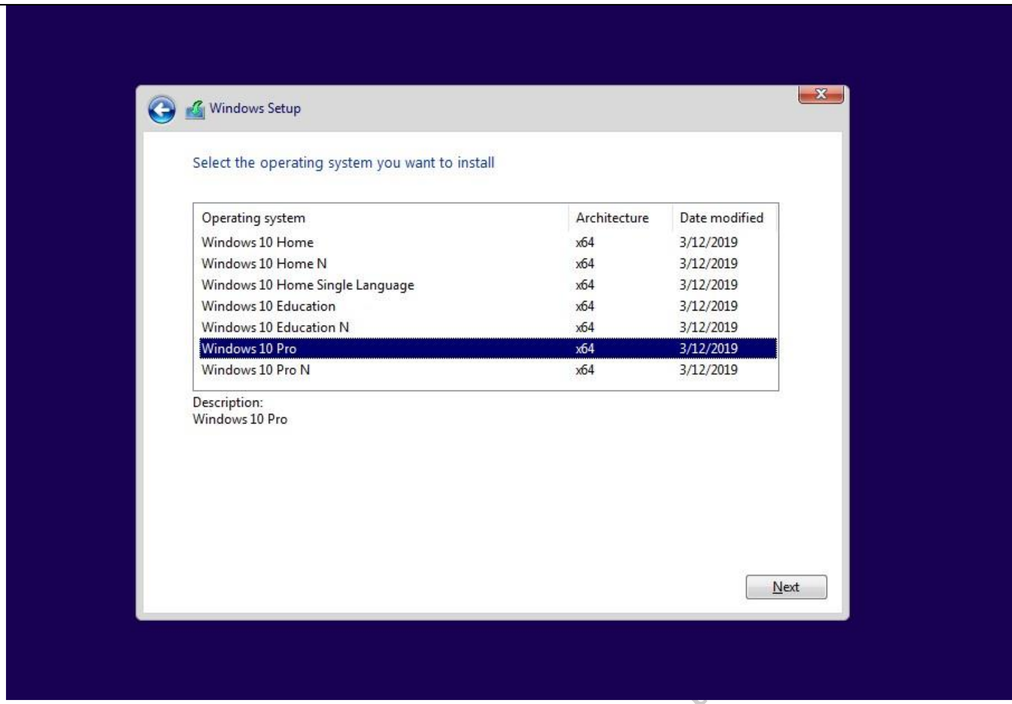


Fig. 2.7: Select Window 10 edition

Step 7. Wait while setup prepares to copy files.

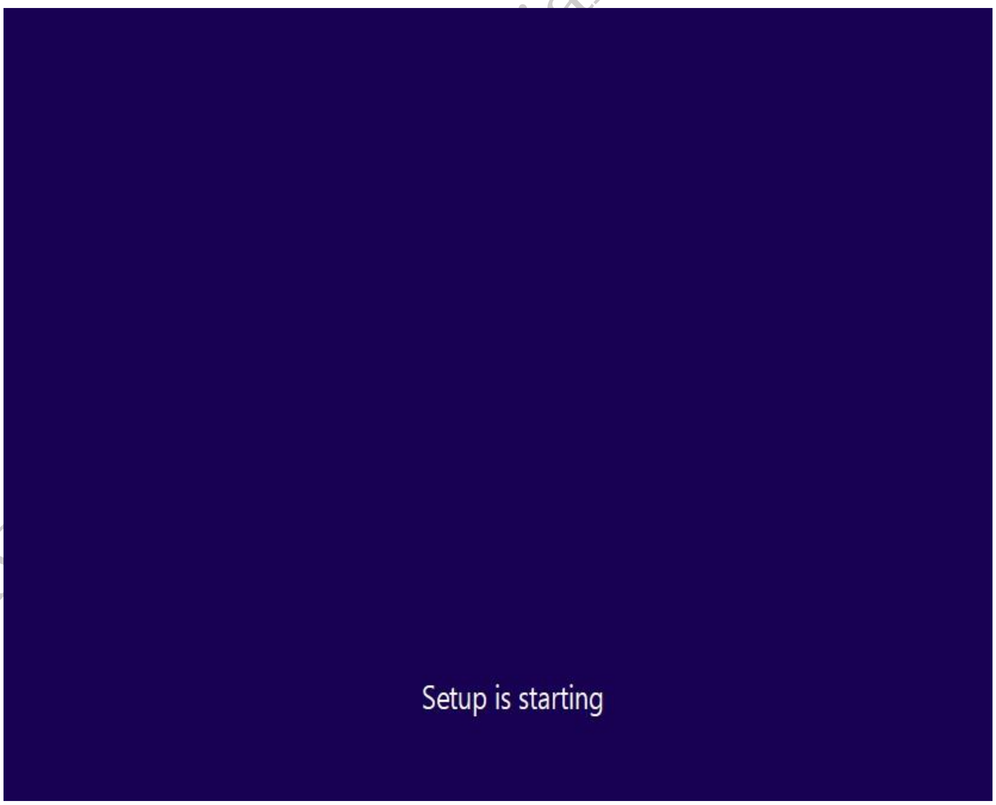


Fig. 2.8: Setup prepare

Step 8. Accept the license terms then click **Next.**

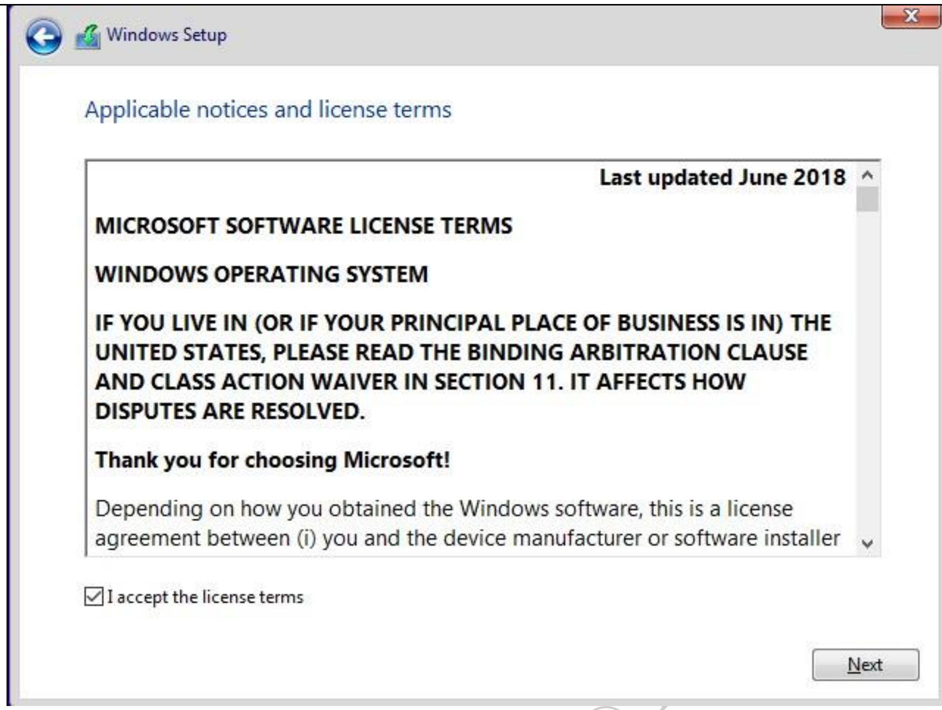


Fig. 2.9 License terms

Step 9. Click Custom: Install Windows only (advanced).

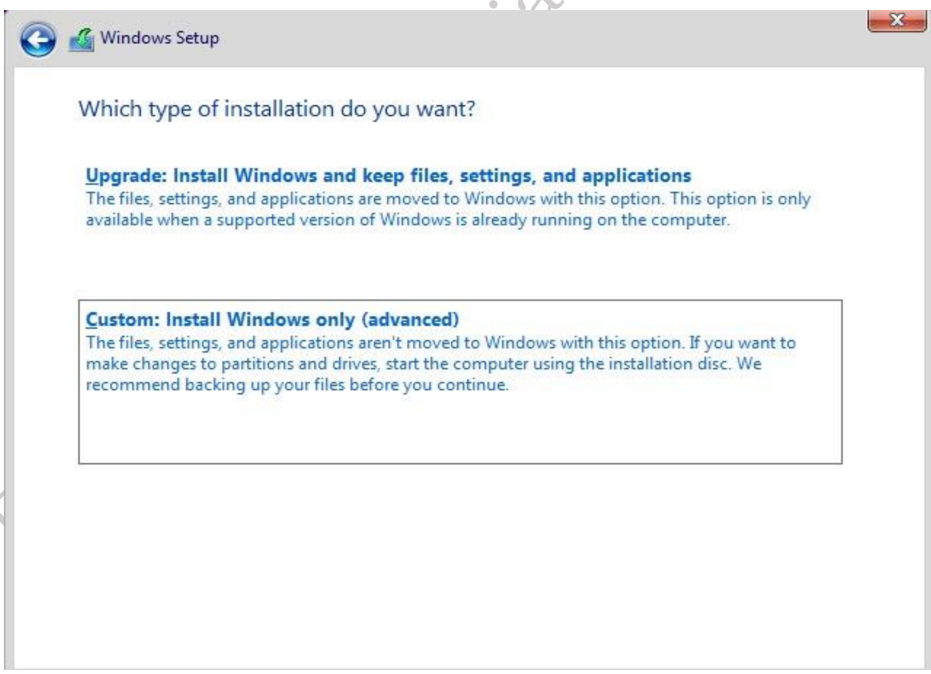


Fig. 2.10 Selecting installation setup window

Step 2. Select the drive then click **New.**

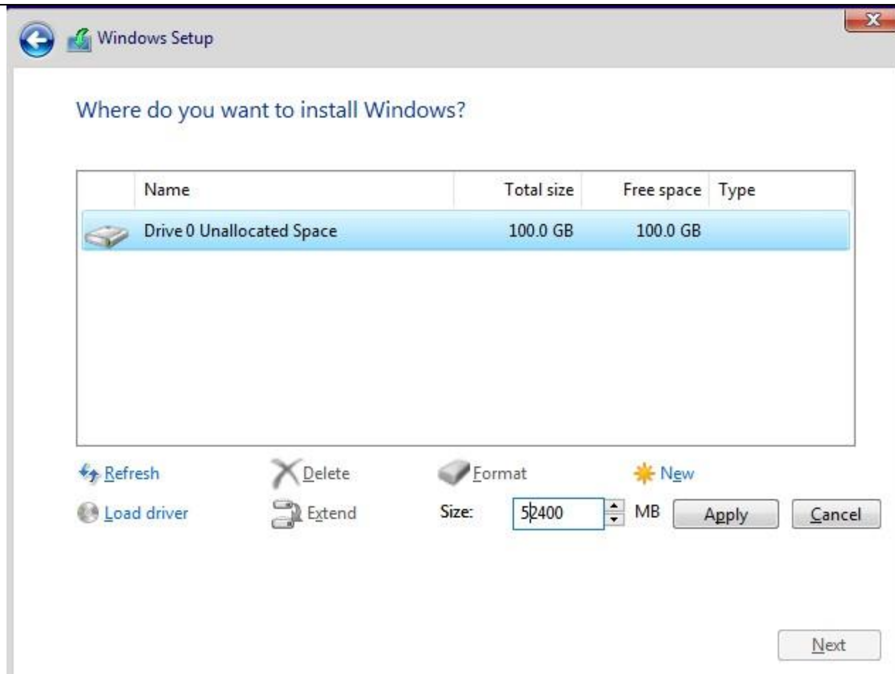


Fig.2.11 Partition window

Step 11. Select the unallocated drive listed, click **New**, click **Apply** then **OK.**

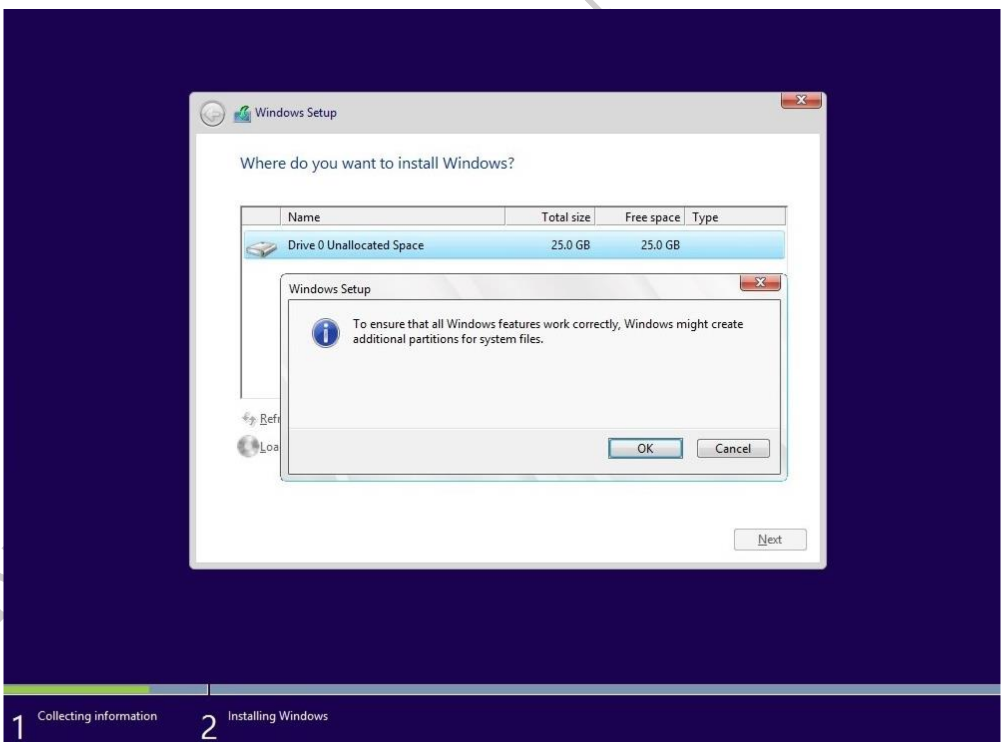


Fig. 2.12 Drive 0 unallocated space

Step 12. This will split the drive into multiple partitions, select the **Primary** partition then click **Next.**

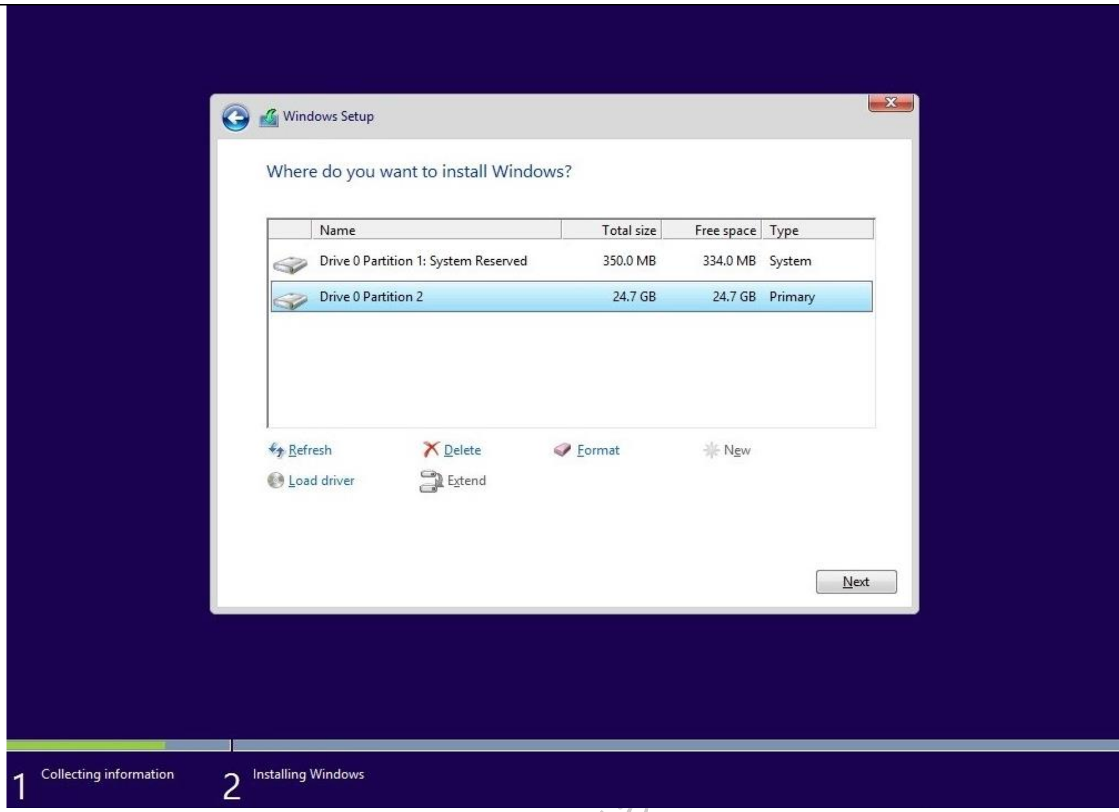


Fig. 2.13 Drive 0 allocated space

Step 13. Wait while Windows installs.

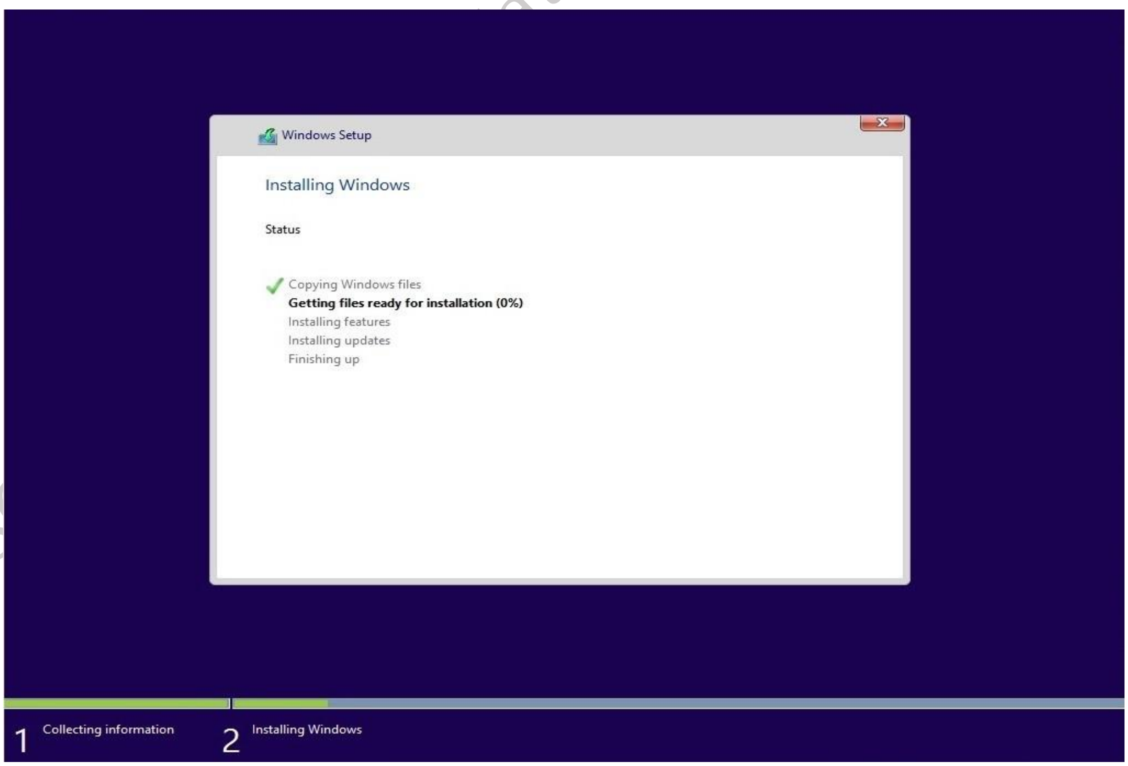


Fig. 2.14 Copy setup files Installing Windows

Step 14. When this phase of setup is complete, Windows will automatically restart then reboot into setup again.

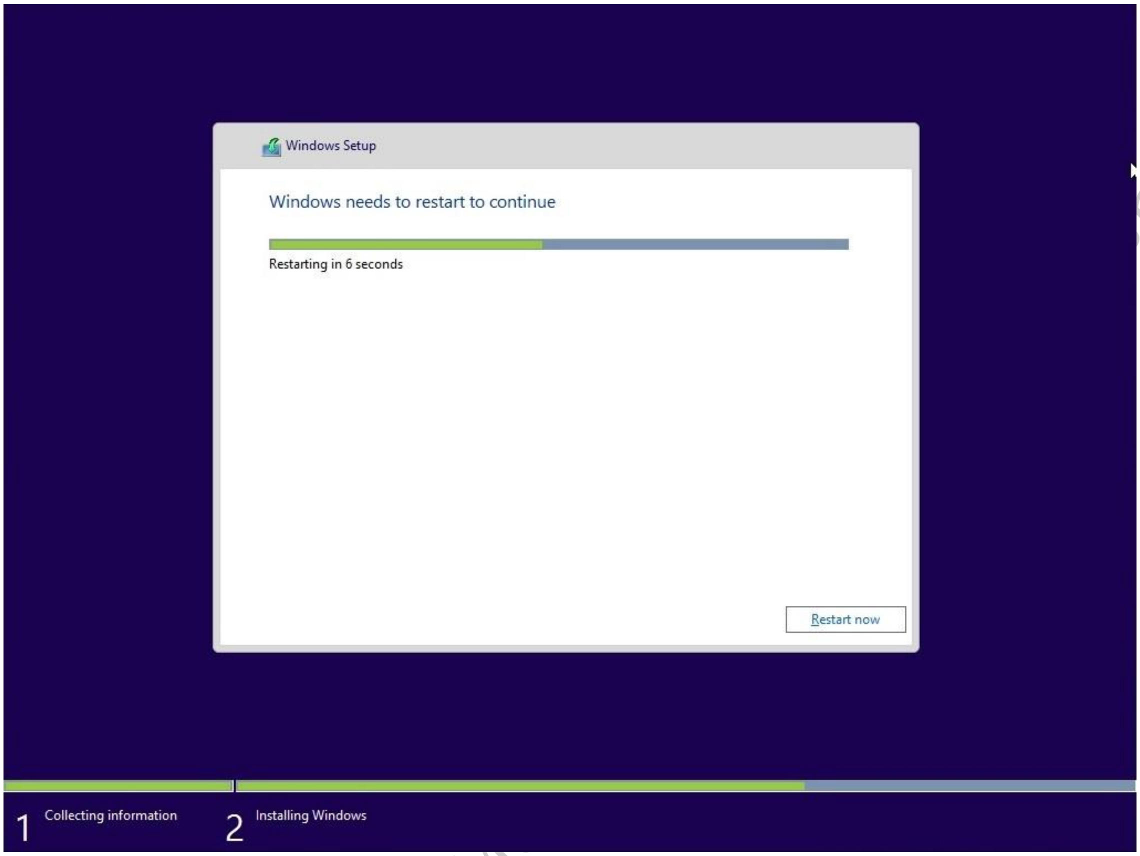


Fig. 2.15 Setup is complete

Step 15. Windows is detecting and installing your hardware. After this is complete, Windows will restart one last time.

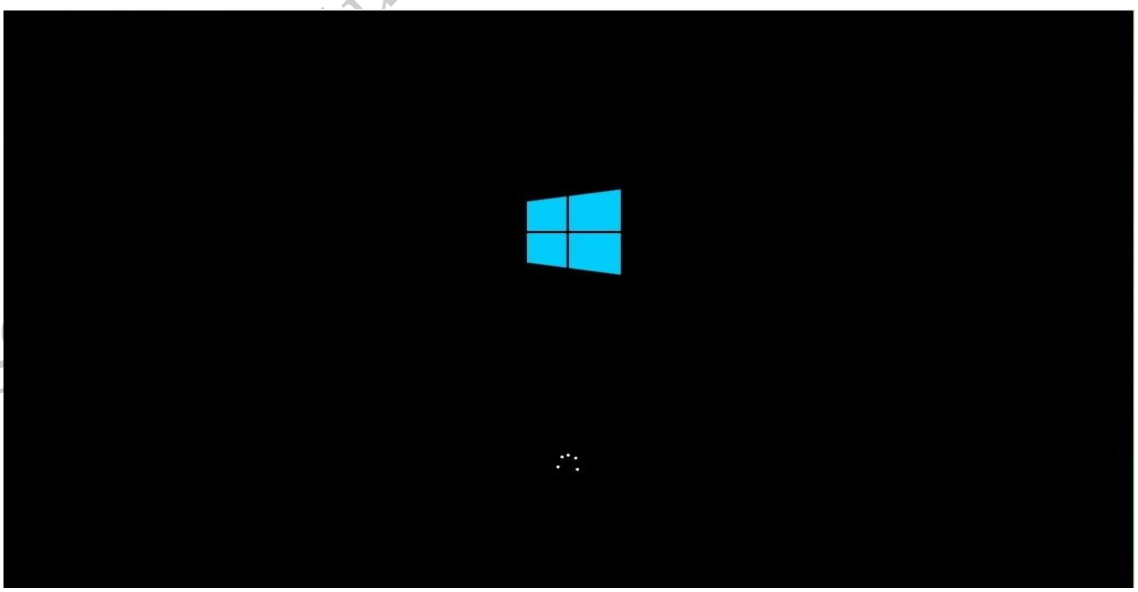


Fig. 2.16 Window setup is completed

Step 12. After complete installation, the initial, window will appear on the computer screen as shown in Fig.

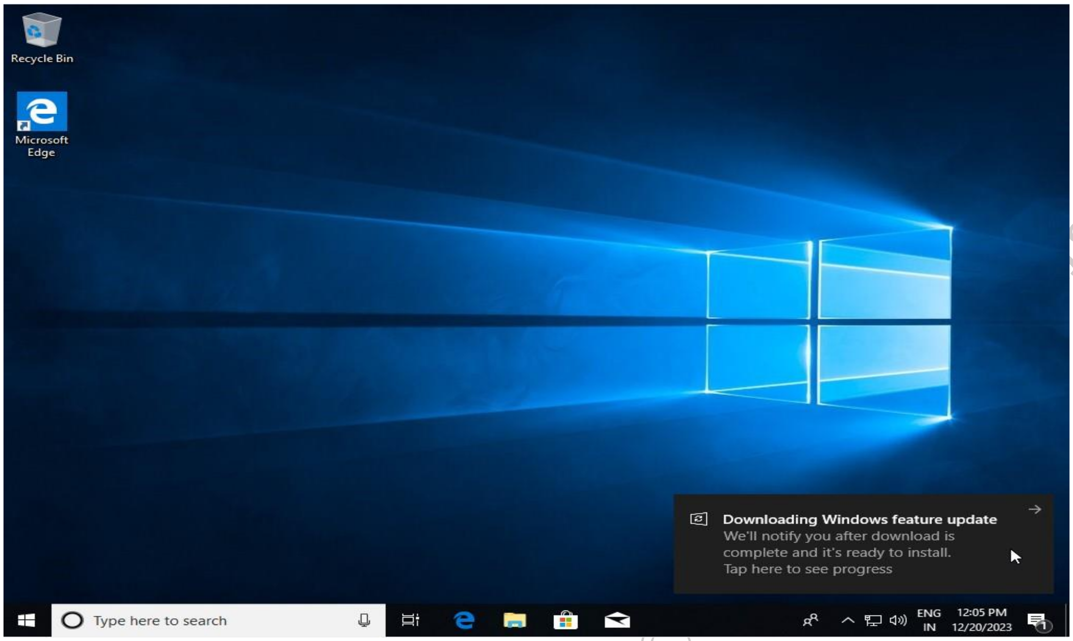


Fig. 2.18 Home window of windows 10

2.4.1 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 2.19.

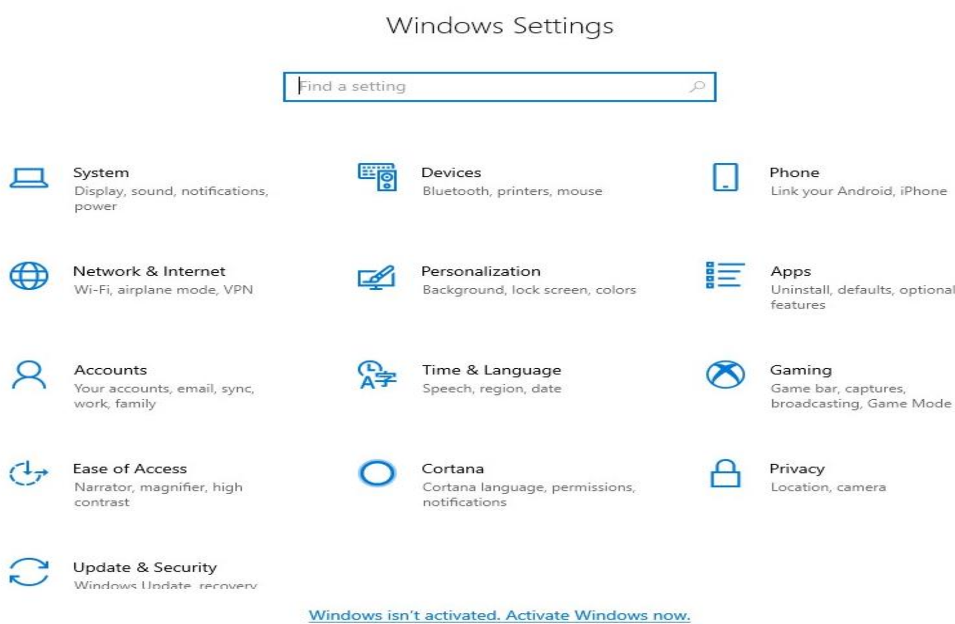


Fig. 2.19: Windows setting

(ii) Click on 'Update & Security' as shown in Figure 2.20.

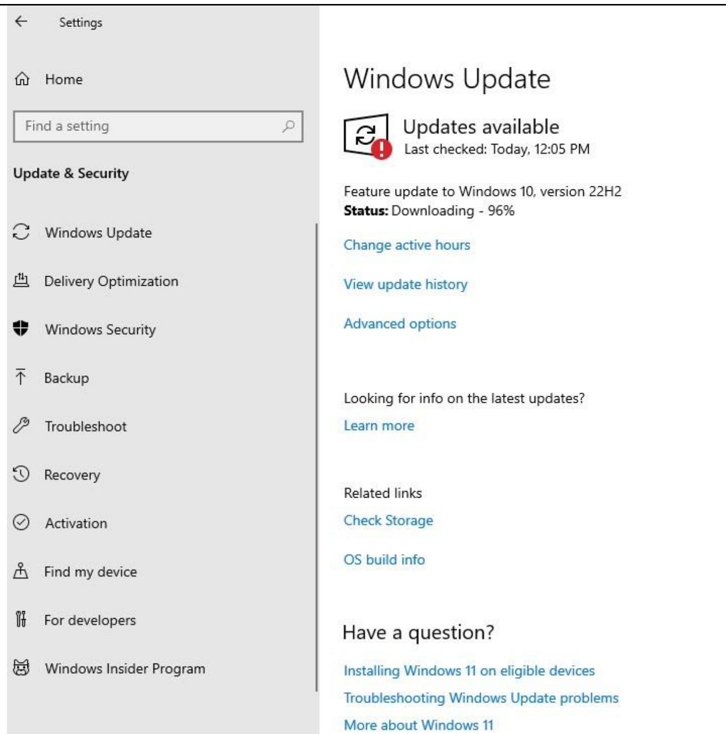


Fig. 2.20: Selecting update and security

(iii) Click on 'Activation' as shown in Figure 2.12.

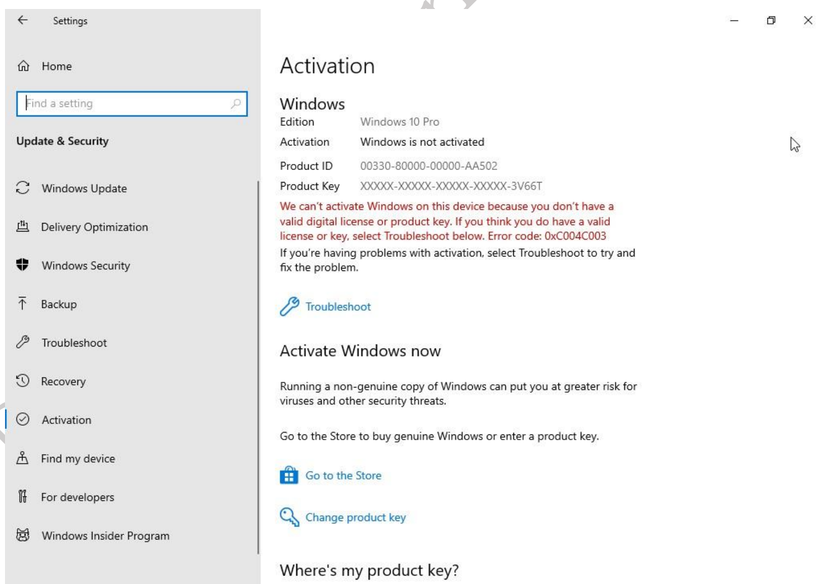


Fig. 2.16: Selecting activation

(iv) Under the 'Activation' head, Windows edition and activation status is displayed as 'Windows is activated with a digital license' as shown in Figure 2.12. 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. 2.17: Selecting activation

(v) To install the latest updates:

(i) Open 'Settings' as shown in Figure 2.14.

(ii) Click on 'Update &' Security' as shown in Figure 2.15.

(iii) Click on 'Windows Update' as shown in Figure 2.18.

Check Your Progress

A. Multiple-choice questions (MCQs)

1. What is the minimum amount of RAM required for a 64-bit version of Windows 10? (a) 1 GB (b) GB (c) 4 GB (d) 8 GB
2. Which of the following storage capacities is required for installing Windows 10? (a) 10 GB (b) 16 GB (c) 32 GB (d) d) 64 GB
3. What is the correct boot order for installing Windows 10 from a USB drive? (a) USB drive, Hard Disk, Optical Drive (b) Hard Disk, USB drive, Optical Drive (c) Optical Drive, USB drive, Hard Disk (d) USB drive, Optical Drive, Hard Disk
4. Which step is necessary before performing a clean installation of Windows 10? (a) Creating a new user account (b) Installing updates (c) Backing up data (c) Activating Windows
5. What tool is commonly used to create a bootable USB drive for installing Windows 10? (a) Task Manager (b) Disk Cleanup (c) Media Creation Tool (d) Device Manager

B. Fill in the Blank

1. The minimum required storage space for installing Windows 10 is __________.
2. For a 64-bit version of Windows 10, the minimum required RAM is __________.

3. To install Windows 10 from a USB drive, you need to set the boot order to prioritize __________ first.
4. The tool used to create a bootable USB drive for Windows 10 installation is the __________.

C. Ture or False

1. The minimum required storage space for installing Windows 10 is 16 GB for a 64-bit version.
2. Configuring the boot order is necessary when installing Windows 10 from a USB drive.
3. You can skip backing up your data when performing a clean installation of Windows 10.
4. The Media Creation Tool is used to create a bootable USB drive for installing Windows 10.
5. A clean installation of Windows 10 does not erase the data on the computer.

D. Short Questions

1. What is the minimum RAM requirement for installing a 64-bit version of Window 10?
2. Why is configuring the correct boot order important when installing Windows 10 from a USB drive?
3. What steps should be taken before performing a clean installation of Windows 10 to prevent data loss?
4. Which tool is used to create a bootable USB drive for installing Windows 10?
5. What is the minimum required storage space for a 64-bit version of Windows 10?

Session 3. Configure Windows operating system

Windows Desktop

Window desktop can be defined as the main screen that appears after turning on the computer and logging into Windows. When any file or folder is opened, it appears on the desktop. We can also put files and folders on the desktop and arrange them as per the requirement.

Task Manager

Task manager is a utility program that is included with the Windows operating system (OS). Its primary purpose is to allow users to monitor and manage the processes and applications running on their computer. There are several ways to launch task manager on a Windows computer. One way is to right-click on the taskbar and select task manager from the context menu. Another way is to press the Ctrl + Shift + Esc keys on your keyboard. You can also press Ctrl + Alt + Del and then select task manager from the options that appear.

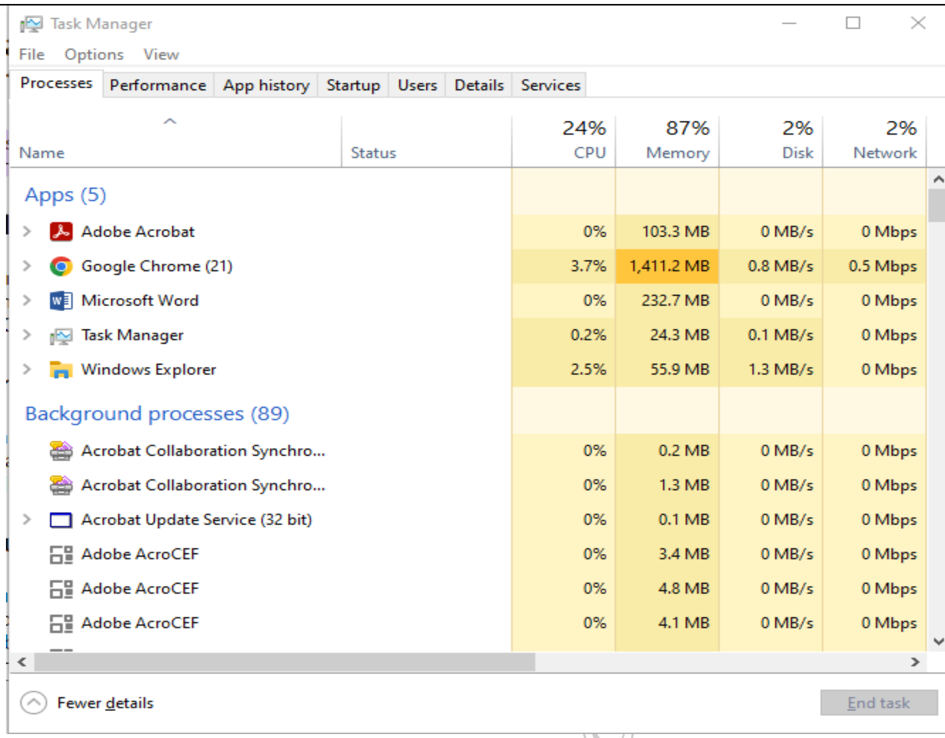


Fig. 3.1 Task Manager

The performance tab in Windows task manager provides real-time data on the usage of system resources such as CPU, memory, and disk. It displays graphs that show the utilization of these resources over time. Users can also view more detailed information about each resource by clicking on the corresponding section of the graph.

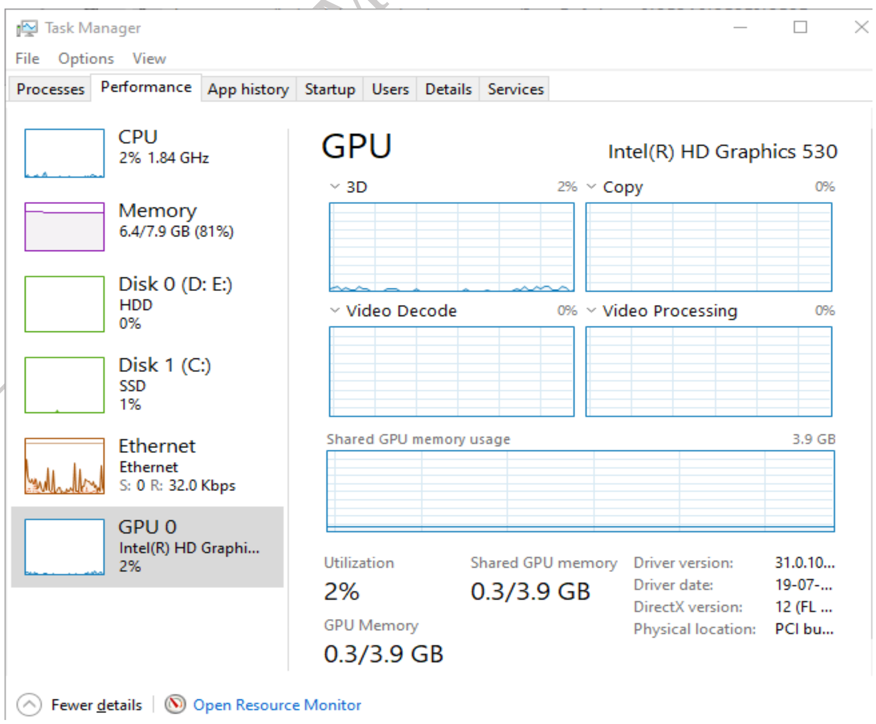


Fig. 3.2 Performance tab of Windows Task Manager

There are several reasons why you might need to terminate a task or process using task manager. For example, if an application is frozen or unresponsive, ending its process can allow you to regain control of your system. Similarly, if a process is using too many system resources and causing performance issues, ending the process can free up those resources for other applications.

File Explorer

File Explorer is a file browser that helps you access, view and manage all the files stored on your computer. It's an important part of Windows, but it can also be used on almost any other operating system as well. Like many of the finer things in life, File Explorer has gotten better with age. To check it out in Windows 10, select the taskbar or the Start menu, or press the Windows logo key + E on your keyboard.

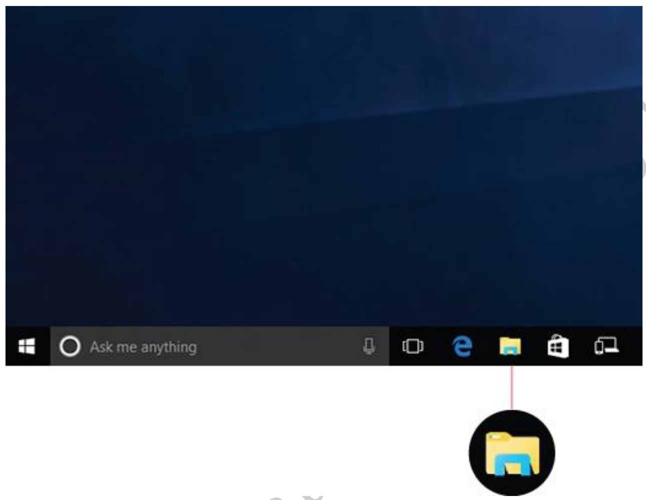


Fig. 3.3 Icon of File Explorer

There are following some noteworthy changes for Windows 10:

- OneDrive is now part of File Explorer. For a quick primer on how it works, check out OneDrive on your PC.
- When File Explorer opens, you'll land in Quick access. Your frequently used folders and recently used files are listed there, so you won't have to dig through a series of folders to find them. Pin your favorite folders to Quick access to keep them close at hand. For more info, see Pin, remove, and customize in Quick access.

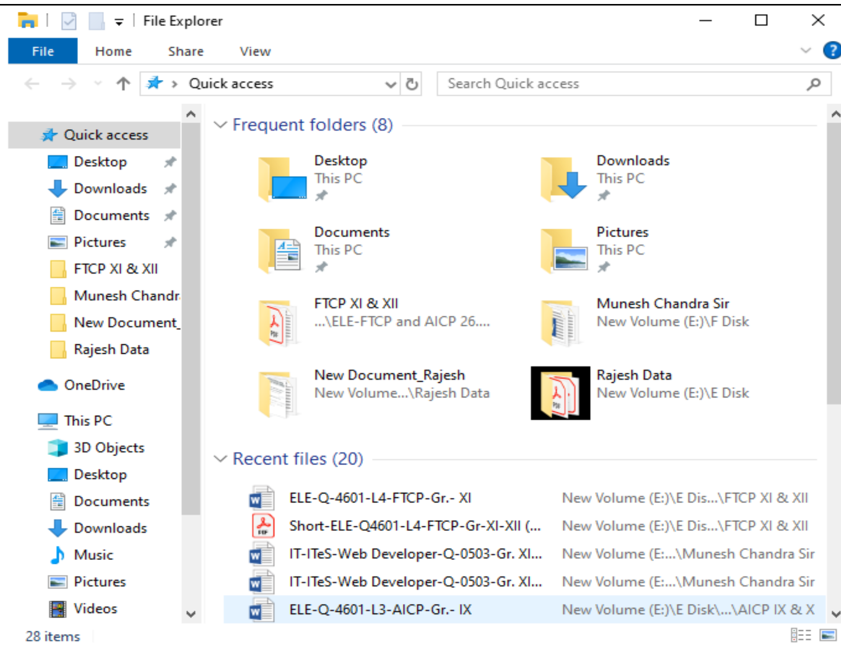


Fig. 3.4 Access of File Explorer

- Now, you can use apps to share files and photos right from File Explorer. Select the files you want to share, go to the Share tab, select the Share button, and then choose an app. For more info on sharing options, see Share files in File Explorer.

If you're coming from Windows 7, here are a couple more differences:

- My Computer is now called This PC, and it won't show up on your desktop by default. To find out how to add This PC to your desktop or the Start menu, see My Computer is now This PC.
- Libraries won't show up in File Explorer unless you want them to. To add them to the left pane, select the View tab > Navigation pane > Show libraries.

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 3.1 Configure Windows 10 for language support

Step 1. Open 'Settings'> 'Time and Language'> 'Region & Language'.

Step 2. Under 'Languages' select 'Add a Language'.

Step 3. Select the language you want to use from the list, as shown in Figure 1.

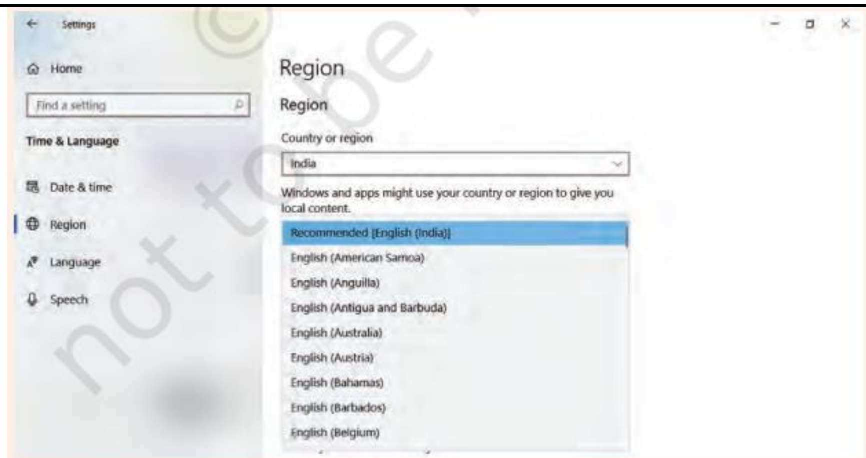
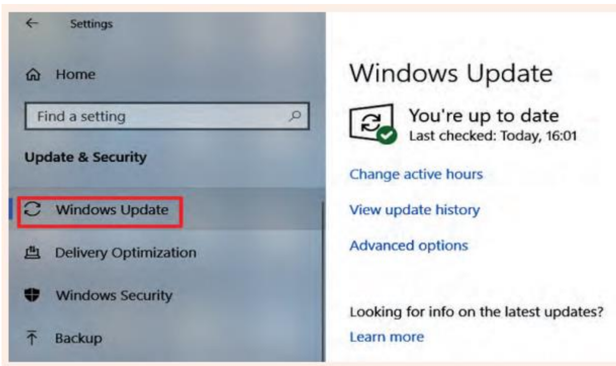


Fig. 3.5 Time and language window

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

Step 5. Click the 'Check for updates' button as shown in Figure 3.7



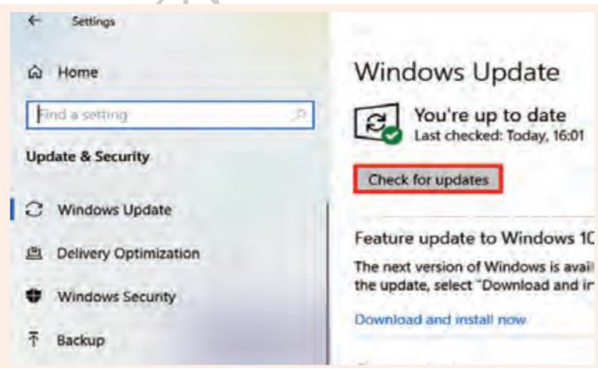


Fig. 3.6 Selecting 'Windows update' **Fig. 3.7 Check for updates**

Device driver

Step 6. To confirm that all the device drivers have been installed correctly, invoke the 'Device Manager' through the Windows key as shown in Figure 3.8.

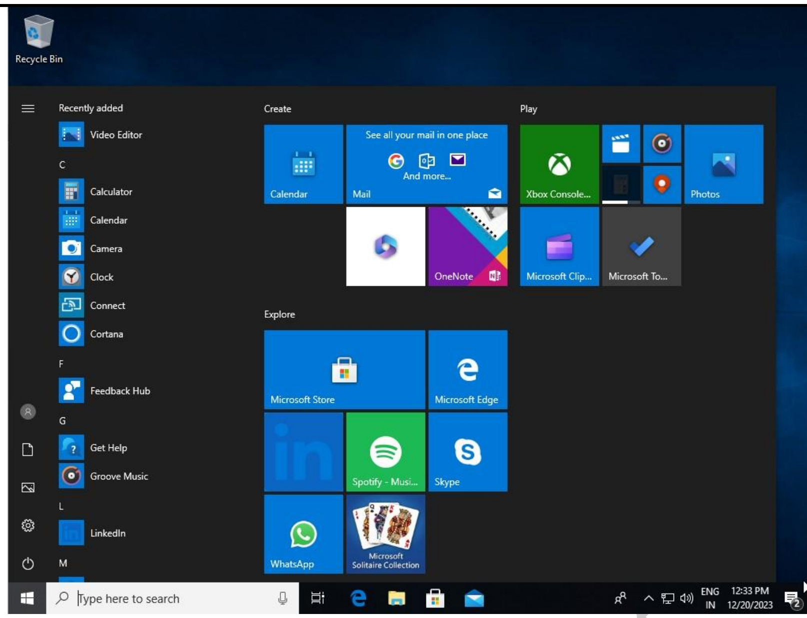


Fig. 3.8 Invoke device manager through the Windows key

Step 3. Search for 'Device Manager' as shown in Figure 3.9. The device manager window will open as shown in Figure 3.10.

Step 8. 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.

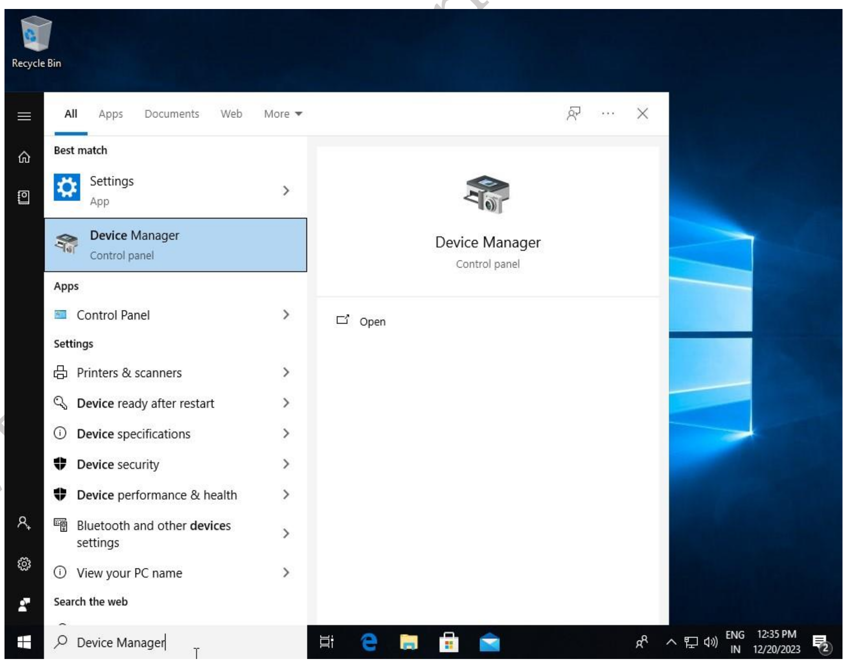


Fig. 3.11 Search device manage

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.

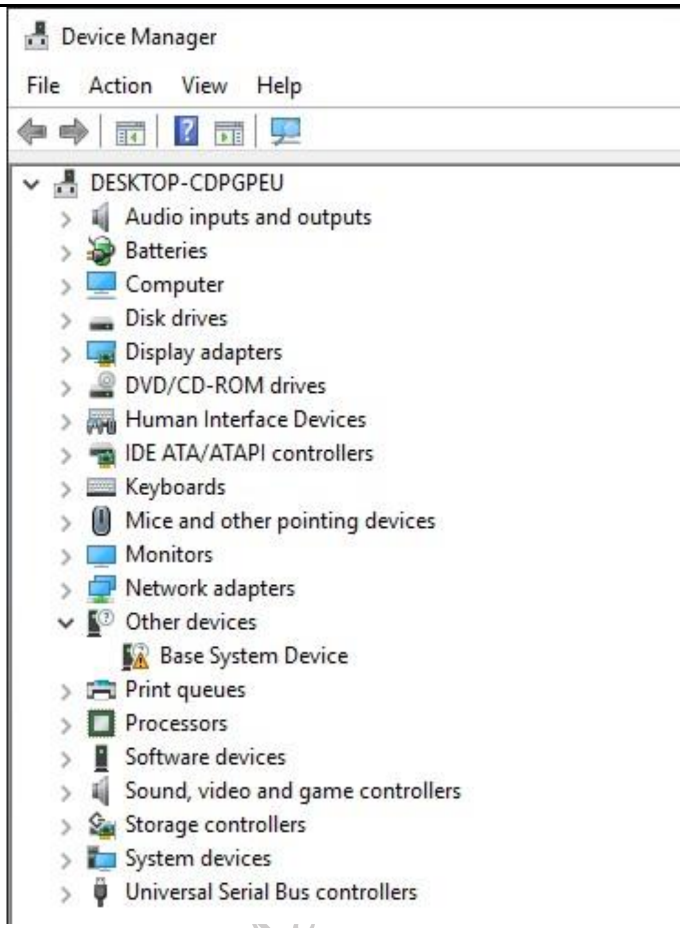


Fig. 3.12 Device manager window

Practical Activity 3.2 Turning off automatic installation of device driver

Step 1. Open 'Control Panel', click on 'Devices and Printers'.

Step 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 3.13.

Step 3. 'Device installation settings' dialog box will appear as shown in Figure 3.14. By default, the 'Yes' option is selected. Choose the option 'No' and then click on the 'Save Changes' button.

Fig. 3.15 Disabling the automatic device driver software installation

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

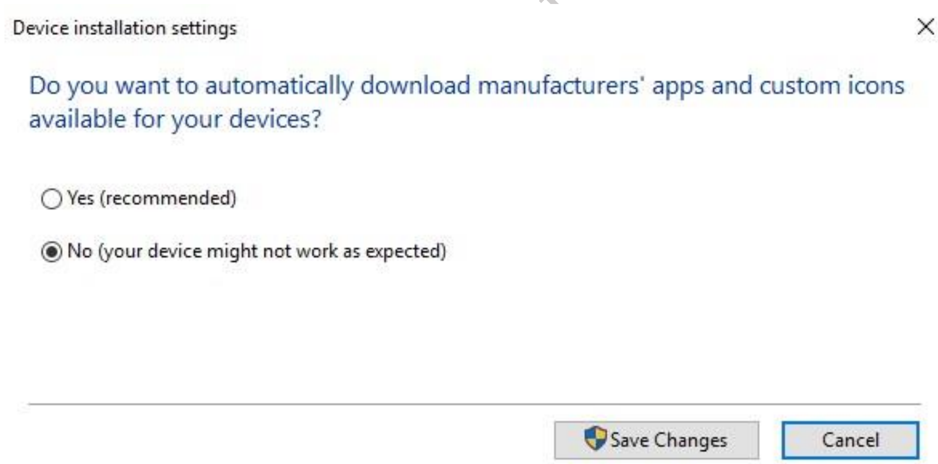


Fig. 3.16 Device installation setting dialog box

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.

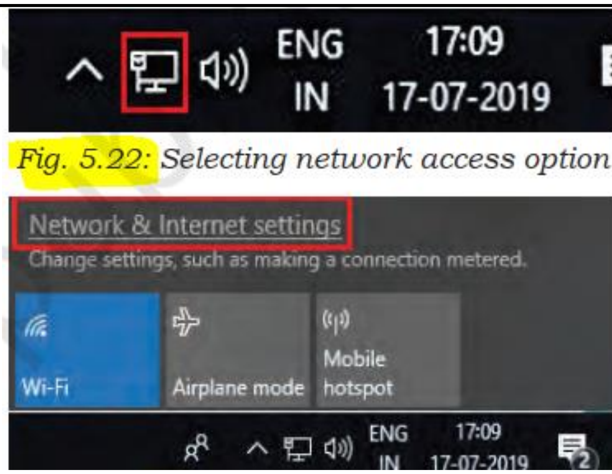
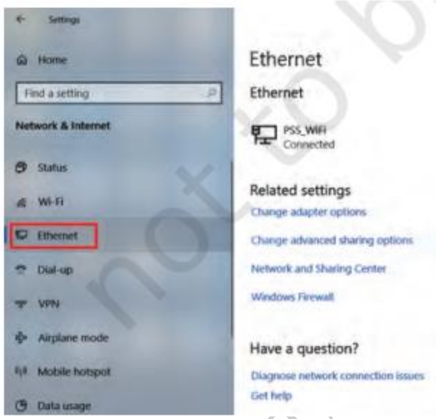


Fig. 3.17 Open 'Network & Internet setting'

Step 5. Right click the network icon in the taskbar and select 'Open Network & Internet settings' as shown in Figure 3.18.



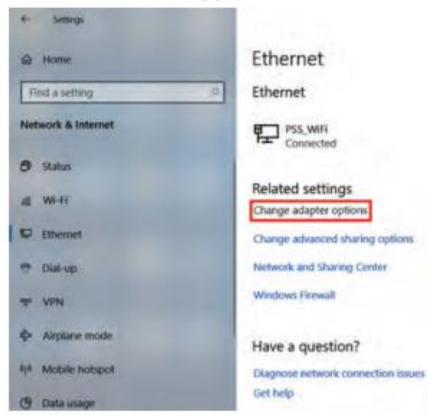


Fig. 3.18 Open ethernet setting Fig. 3.19 Change adapter options

Step 6. In the 'Open Network & Internet Setting' window, click on 'Ethernet' as shown in Figure 3.20, to see the settings of your connection. You can change the related settings as shown in Figure 3.21.

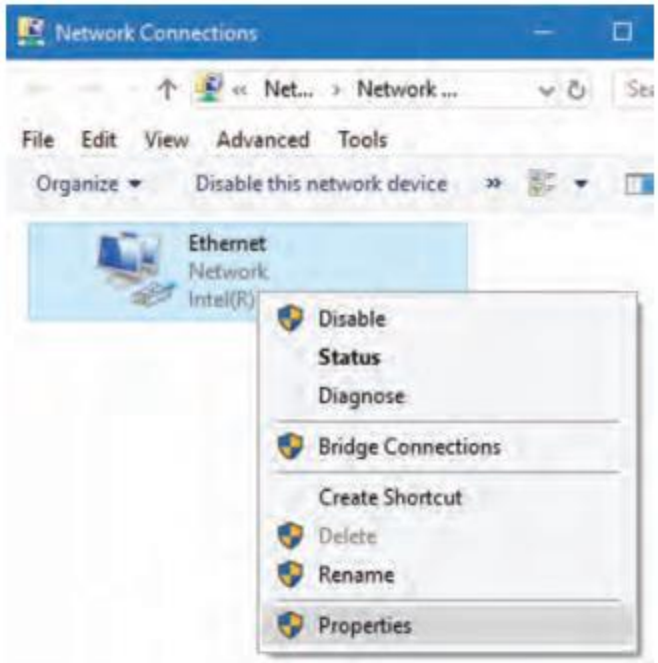


Fig. 3.21: Ethernet properties

Step 3. Right click your active network adapter and choose 'Properties', as shown in Figure 3.22.

Step 8. Under 'This connection is using the following items', double click on 'Internet Protocol Version 4 (TCP/ IPv4)', as shown in Figure 3.23 to change the current IP address and the DNS server.

Step 9. Select 'Use the following IP address' as shown in Figure 3.24, 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.

Step 3. Enter the valid IP address, subnet mask, and default getaway as shown in Figure 3.25.

Fig. 3. 23 Selecting IPv4 **Fig. 3.24 IPv4 properties** **Fig. 3.25 Giving IP**

address

Step 11. You can see the network connection details by clicking on the 'Details' as shown in Figure 3.26. The connection details will be displayed as shown in Figure 3.23.

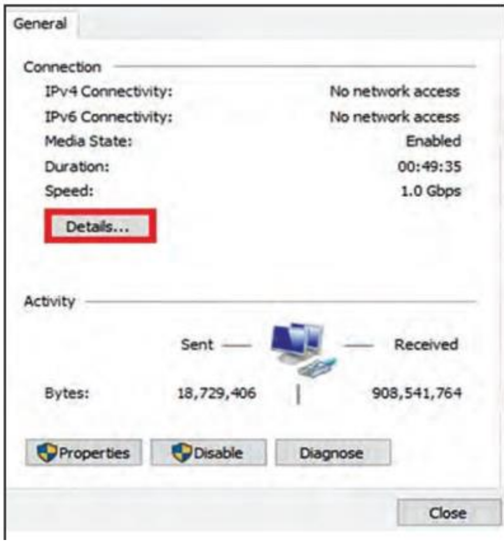


Fig. 3.26 Ethernet status

Fig. 3.27 Network connection details

3.5 Performing a Clean Installation of Windows 11

Performing a clean installation of Windows 11 involves wiping your hard drive completely and installing a fresh copy of the operating system. Here's a step-by-step guide:

Practical Activity 3.3 Clean install of windows 11

Step1. Navigate to the Windows 11 ISO page.

Step 2. Select Windows 11 from the menu under "Download Windows 11 Disk Image (ISO)." If you want to go straight to creating a USB Flash drive, you can download the Windows 11 Installation Media tool from here. See the section below for step-by-step details on how to do that.

Fig. 3.28 download iso image

Step 3. Click Download.

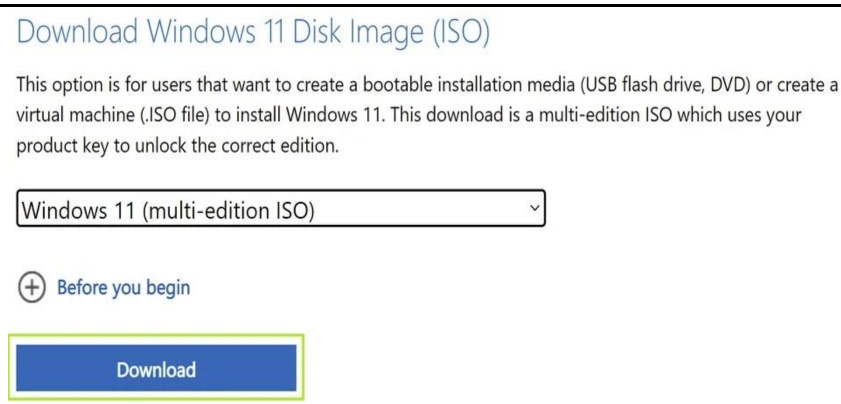


Fig. 3.29 select windows edition

Step 4. Select your language and click confirm.

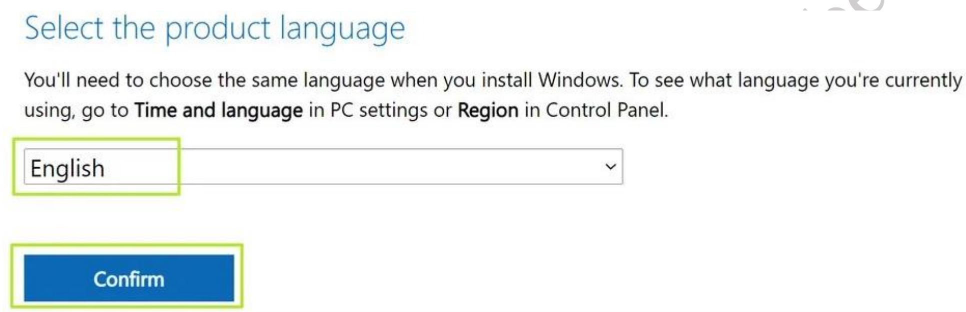


Fig. 3.30 Product language

Step 5. Click the download button that appears.

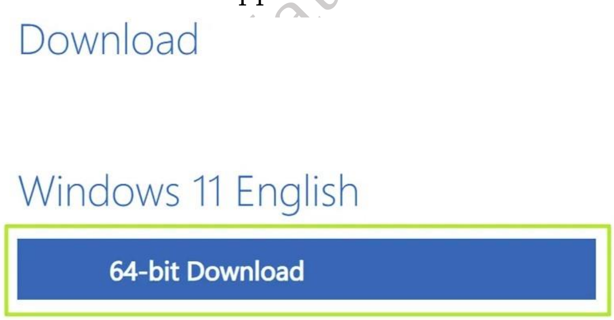


Fig. 3.31: Download window 11 64 bit

The ISO file will now download to your computer.

Create a Windows 11 Install Disk with Media Creation Tool

If you don't want to keep a copy of the latest Windows 11 ISO on your storage drive and just want to have a bootable USB Windows 11 install disk, the easiest way is to use Microsoft's media creation tool. Here's how.

1. Connect a USB Flash drive to your PC. It must be at least 8GB and have no data on it you want to keep. This process will overwrite the whole disk.

2. Navigate to Microsoft's Windows 11 Download page.

3. Click Download Now under Create Windows 11 Installation Media to download the Media Creation Tool.

Fig. 3.32 windows 11 installation media

4. Launch the Media Creation Tool.

5. Click Accept when shown the license agreement.

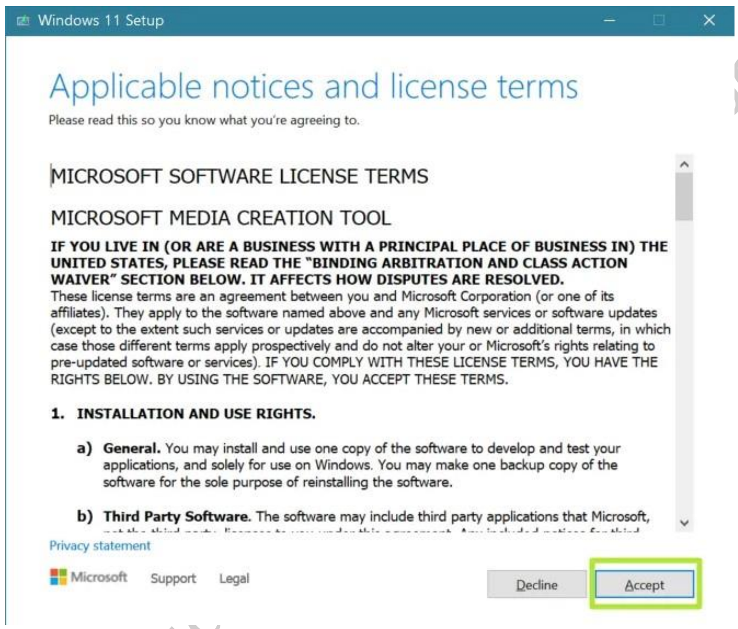


Fig. 3.33 window 11 setup accept license terms

6. Select your language and Edition and click Next. The default choices will probably be correct.

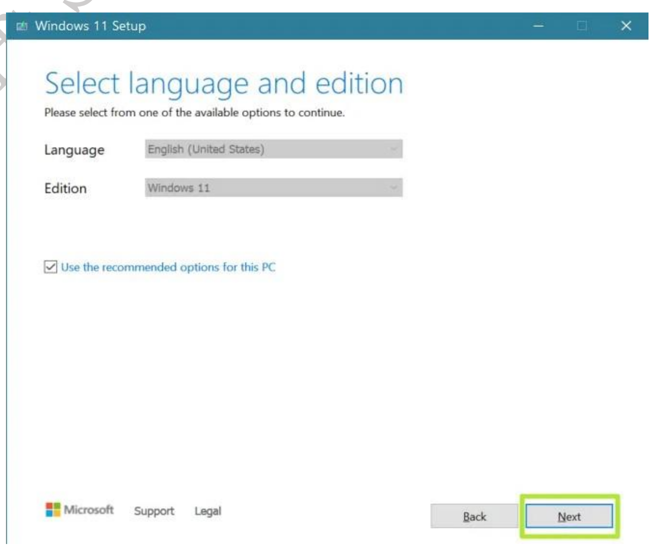


Fig. 3.34 Select language and edition

7. Select USB flash drive and click Next. You can also select ISO file here and create an ISO file instead if you don't have a drive ready.

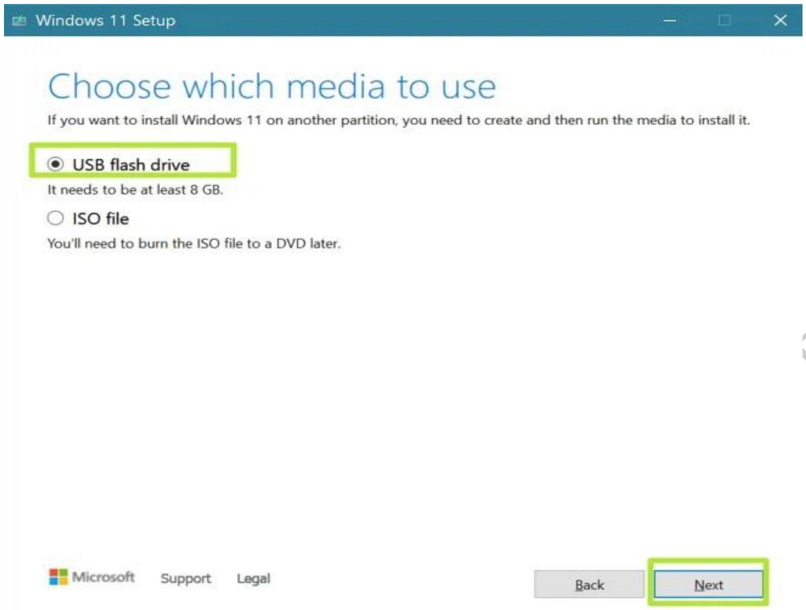


Fig. 3.35 choose a media

8. Select your USB Flash drive (if there's more than one choice) and click Next.

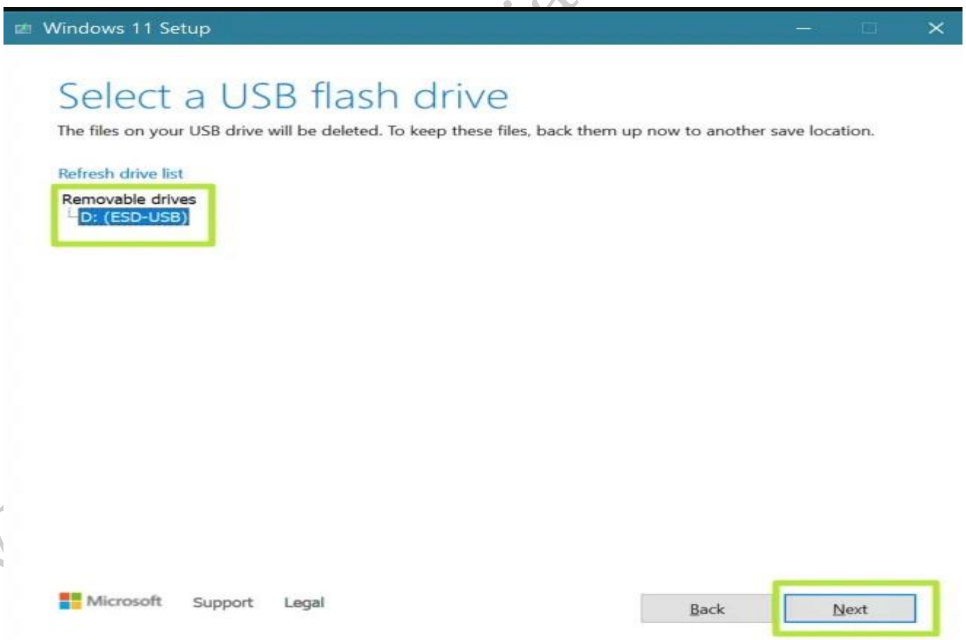


Fig. 3.36 Select USB flash drive

9. You will now have to wait several minutes while your computer downloads Windows 11.

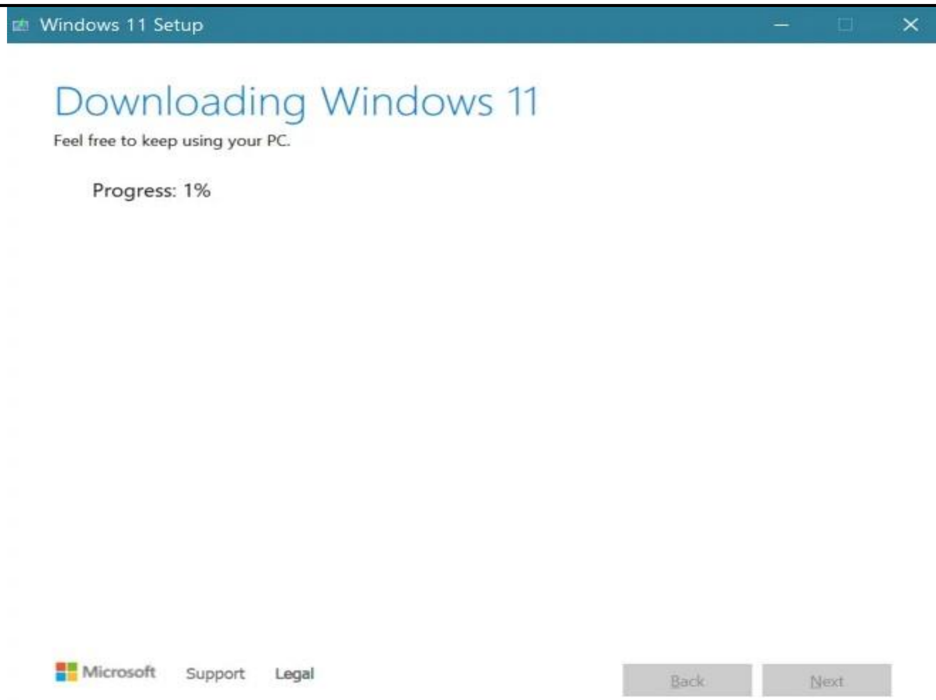


Fig. 3.37 window 11 downloading process

10. Click Finish when it says your USB Flash drive is ready.

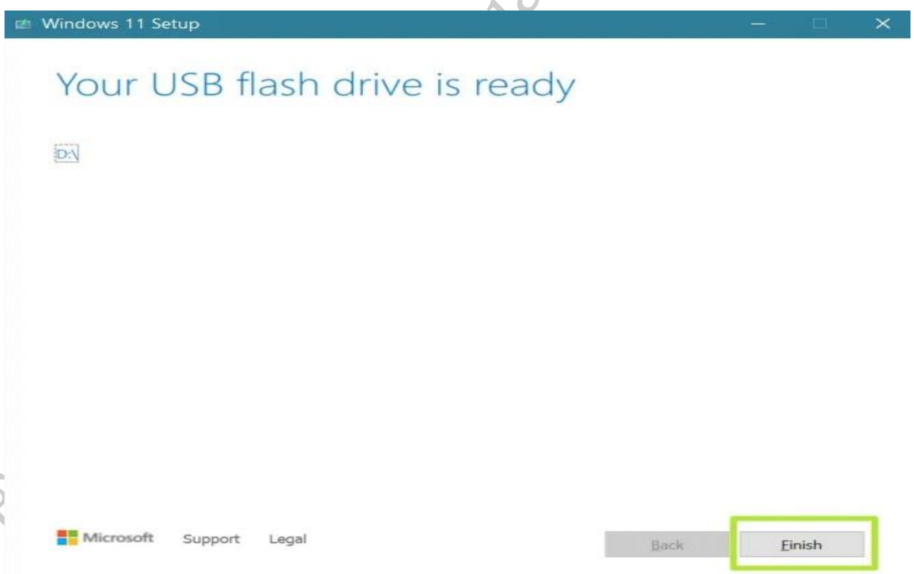


Fig. 3.38 USB flash drive ready

Making a Bootable Windows 11 Install Disk

Unless you're just installing Windows 11 onto a virtual machine, you will need to create a bootable Windows 11 install disk from the data in your Windows 11 ISO file. For that, you'll need an empty USB Flash drive that's at least 8GB. To write or "burn" your ISO file to a USB Flash drive, it's best to use Rufus, a free, third-party utility that will take care of arranges the partitions properly and making the disk bootable. You can also use Rufus to bypass Windows 11's TPM and Secure boot requirements if you choose.

1. Connect your USB Flash drive. Please note that you will be erasing all the data on it.
2. Download and launch Rufus (it does not install).
3. Select your USB drive if it's not already selected by default.

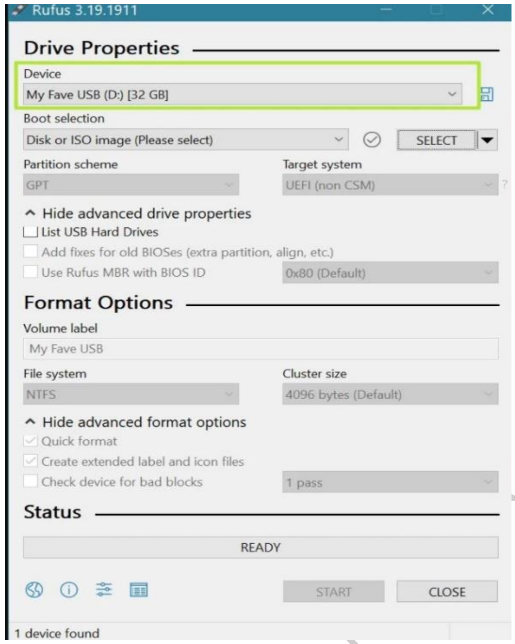


Fig. 3.39 Rufus bootable drive

4. Click Select and choose the ISO file from your storage drive.

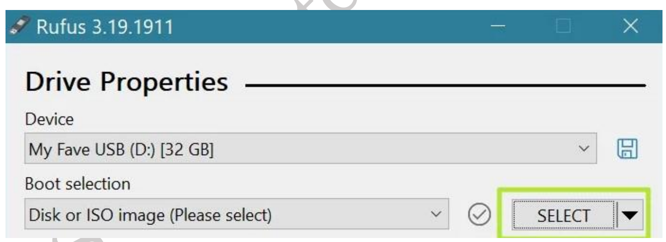


Fig. 3.40 Select the ISO image

5. Click Start at the bottom of the window.

Fig. 3.41 Ready to boot the pen drive

6. Create a second partition and format it as NTFS. It should take all the remaining disk space.

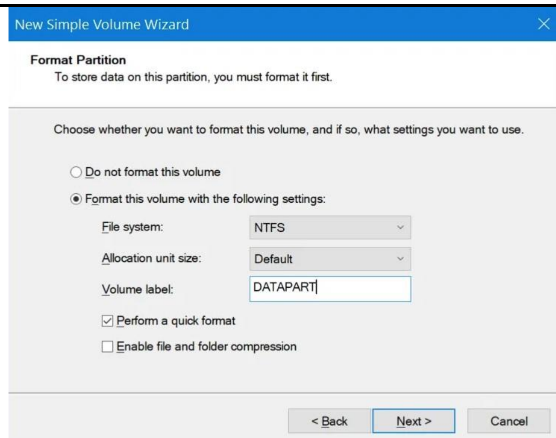


Fig. 3.42 New simple volume wizard

3. Check remove requirement for TPM, 4GB and data collection if you want. These are optional, but recommended and you must click Ok.

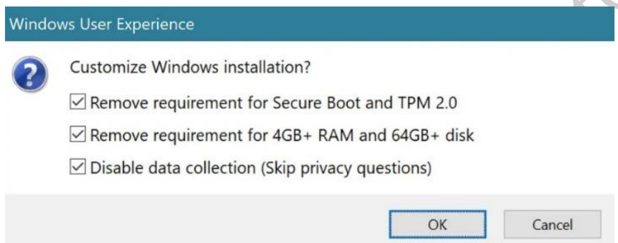


Fig. 3.43 window user experience

8. Click Ok if warned that the process will destroy all data on your USB Flash drive.

Fig. 3.44 warning message to continue this operation

Rufus will now take a few minutes to drive to your drive. When it is done, you will have a USB Flash drive that can boot to install windows.

Installing Windows 11 on the Target PC:

1. Boot your target PC off of the USB installation drive. You may need to hit a key or re-arrange the boot order to boot from USB.

2. Select your language (if it's not already selected) and click Next.

Fig. 3.45 Window setup

3. Click Install now.

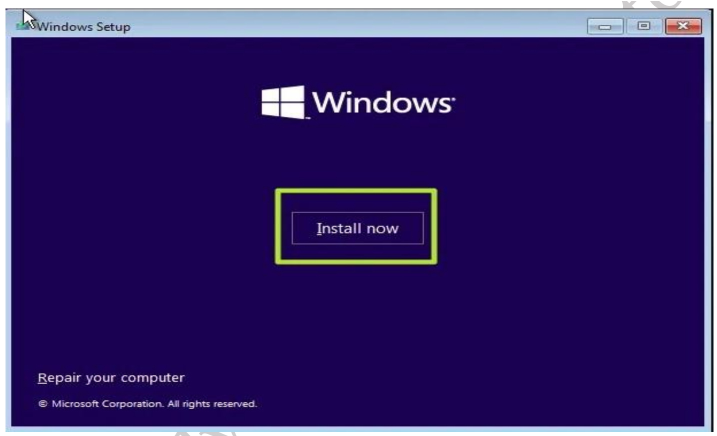


Fig. 3.46 Install now

4. Enter your product key or click "I don't have a product key" if you don't have one. You can always enter it later or use Windows 11 as inactivated.

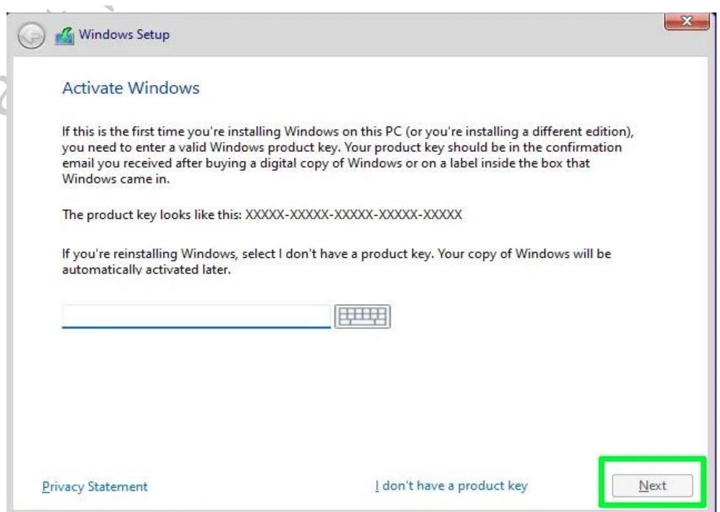


Fig. 3.47 Activation window setup

5. Select the Windows edition if given a choice of editions.

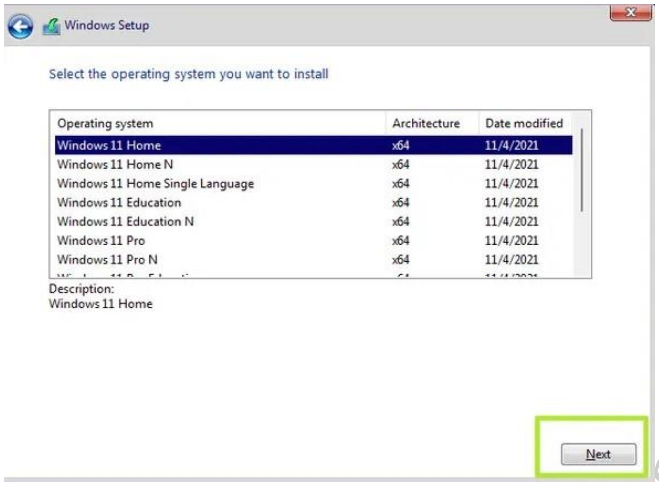


Fig. 3.48 Choose windows edition

6. Accept the license agreement and click Next.

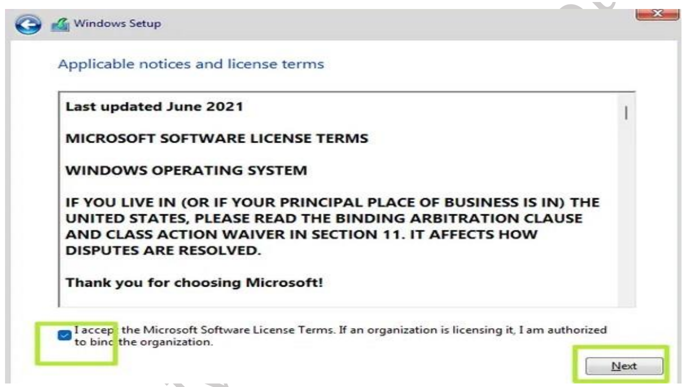


Fig. 3.49 windows accept license

3. Select Custom Install if prompted.

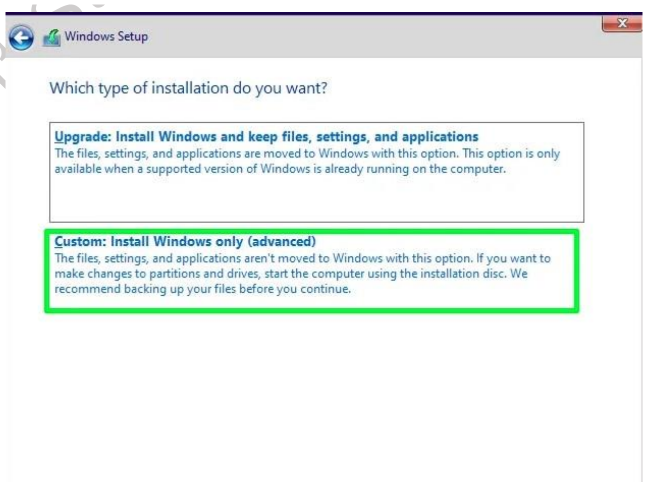


Fig. 3.50 choose type of installation

8. Choose the installation drive and click Next.

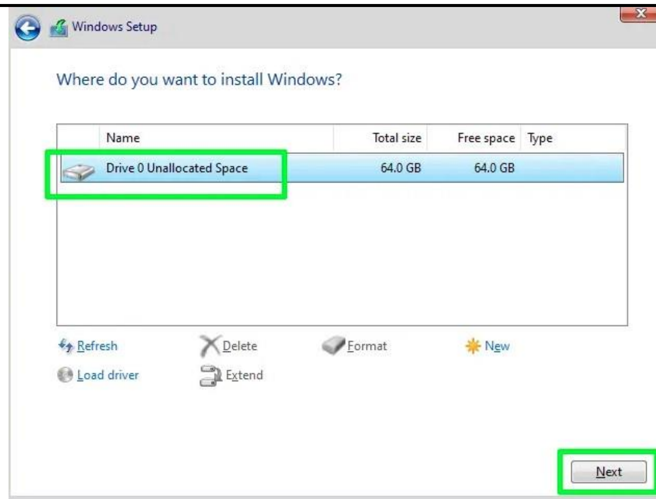


Fig. 3.51 drive unallocated space

9. The installer will copy some files and may reboot at this point.

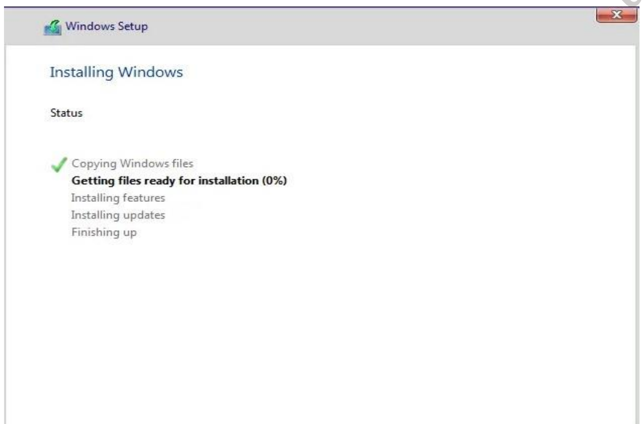


Fig. 3.52 Installing windows copy files

3. Select your country or region (if it's not selected) and **click Yes**. Also, **select your keyboard layout** when prompted.

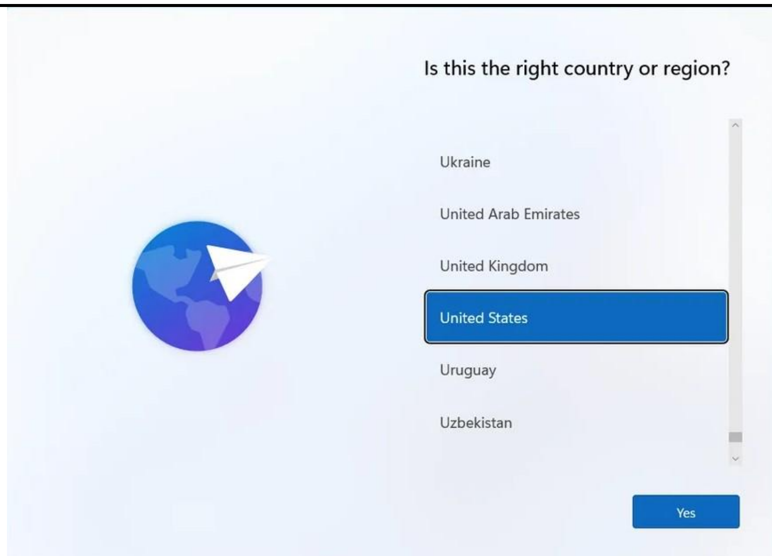


Fig. 3.53 choose the region

11. Name your device and **click Next**.

12. Sign in with your Microsoft account.

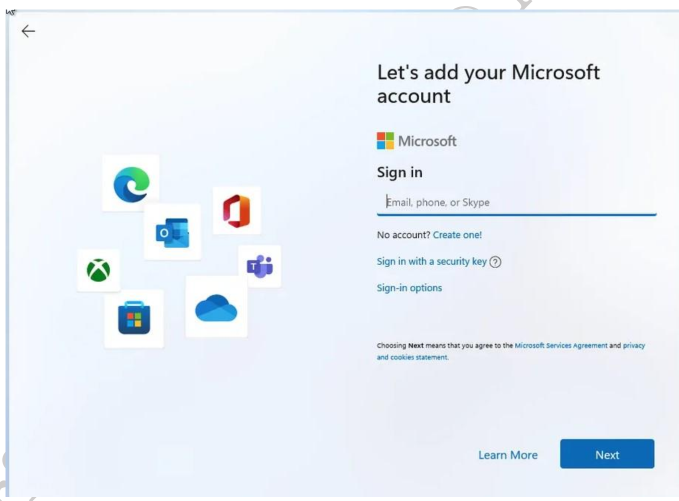


Fig. 3.54 add Microsoft account

13. Create a PIN for quick logins.

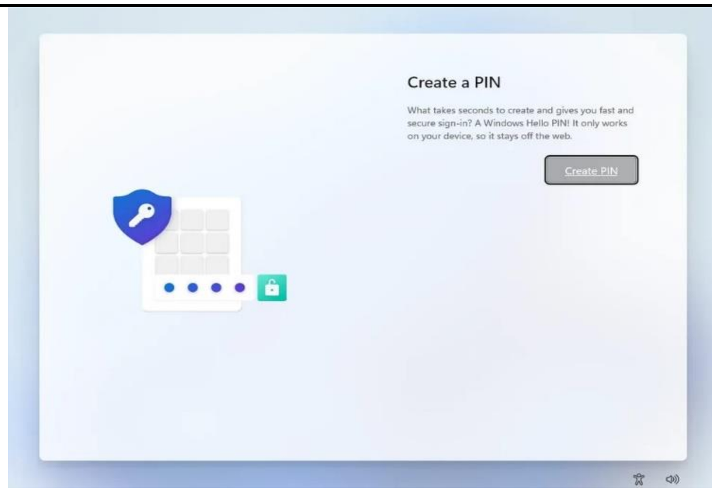


Fig. 3.55 create a pin

14. Click "Set up as new device" (or you can restore a previous config).

15. Click Skip if asked to customize your user experience. This is not necessary.

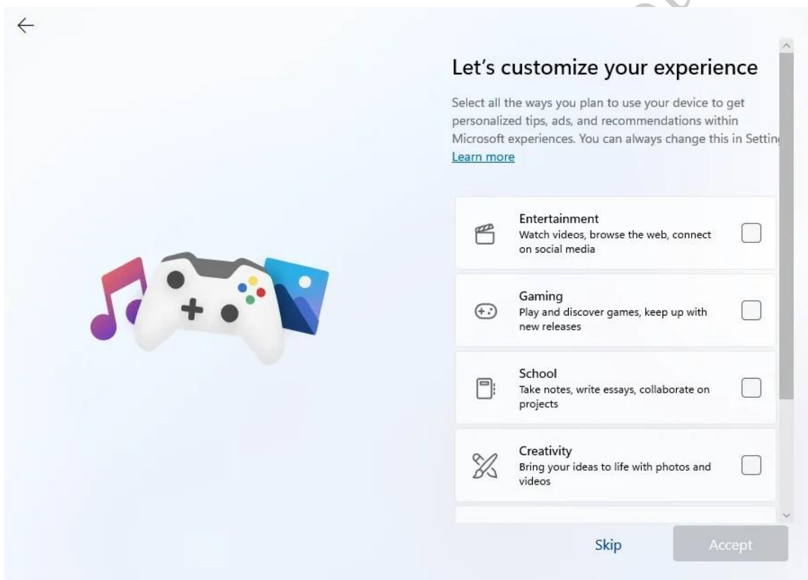


Fig. 3.56 choose the customize

16. Click Next on the Microsoft Account and OneDrive screen.

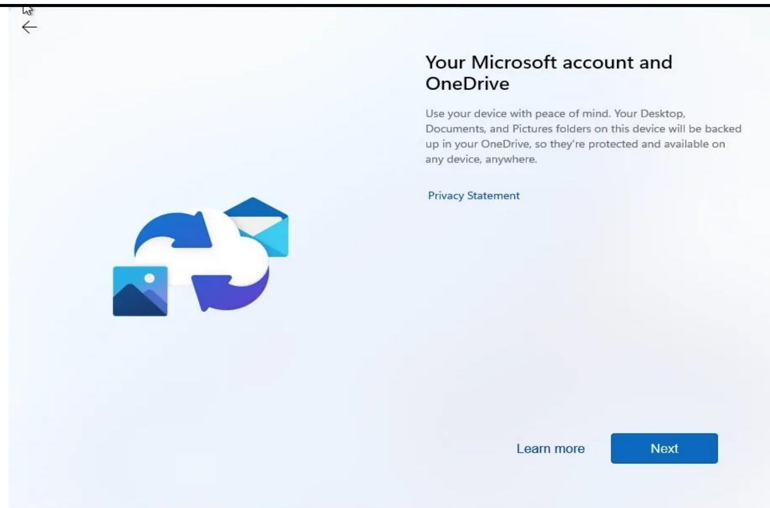


Fig. 3.57 add Microsoft account

13. Windows will now (finally) finalize the installation of Windows 11 using all of the settings you selected up to this point. Windows will ask you to wait will the installation wraps up, which only takes a few minutes on average.

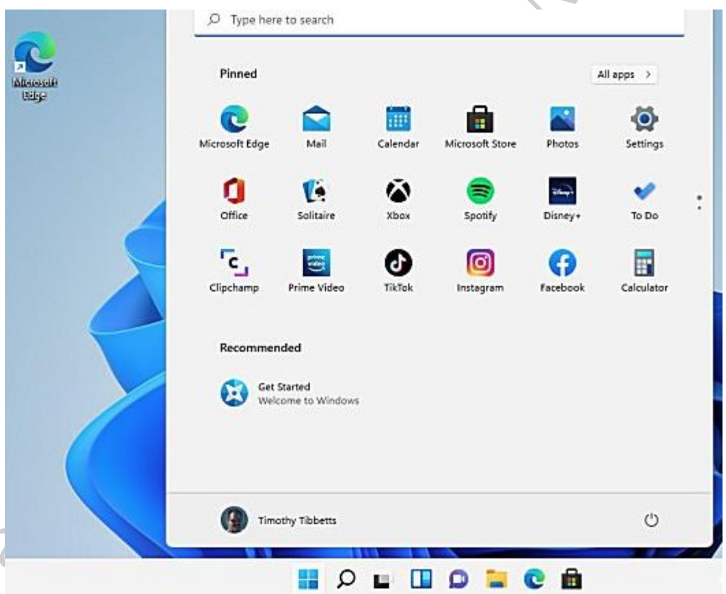


Fig. 3.58 add Microsoft account

3.6 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 11.

Practical Activity 3.4 Installation of printer

Step 1. On your computer or laptop, right-click “Start” and select “Settings.”

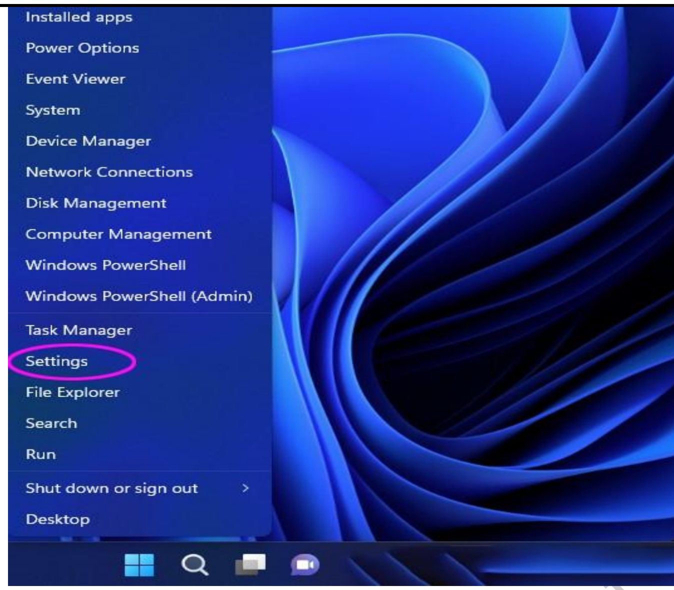


Fig. 3.59 go to setting

Step 2. Go to "Bluetooth & devices," then "Printers & Scanners."

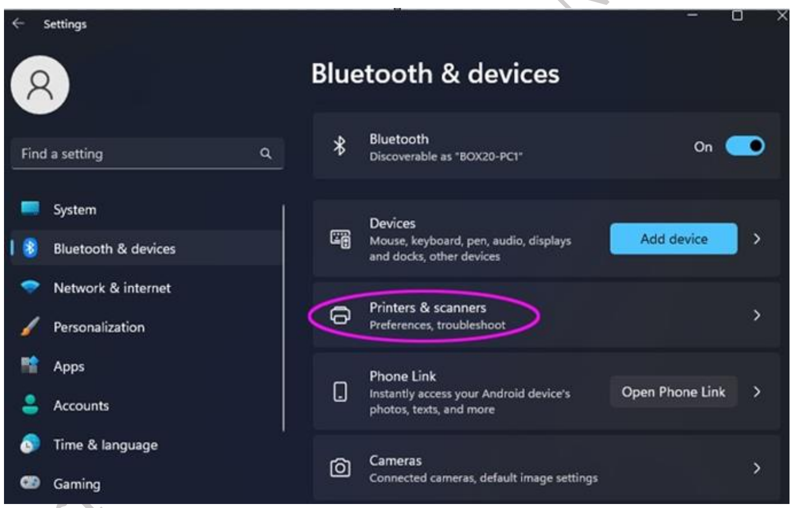


Fig. 3.60 Add printer & scanner

Step 3. Press "Add device" and wait for Windows to find the printer, then choose "Add device" beside the printer you wish to install.

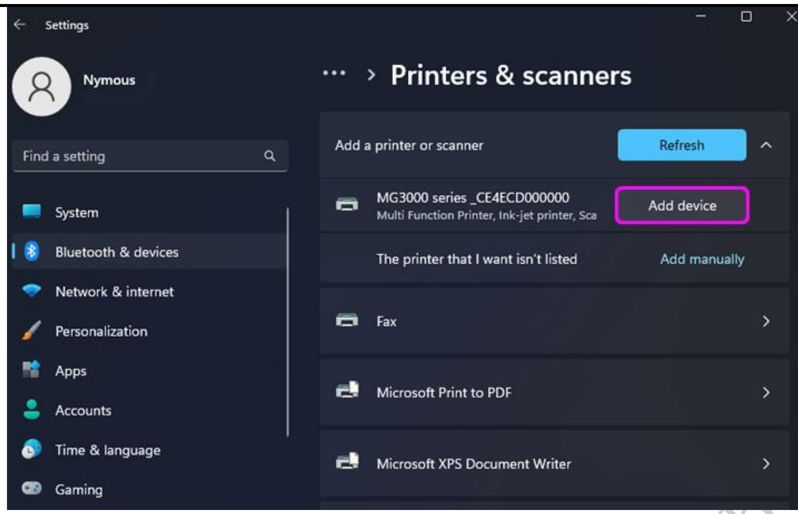


Fig. 3.61 Add devices printer & scanners

Step 4. Now, wait as Windows installs your printer automatically.

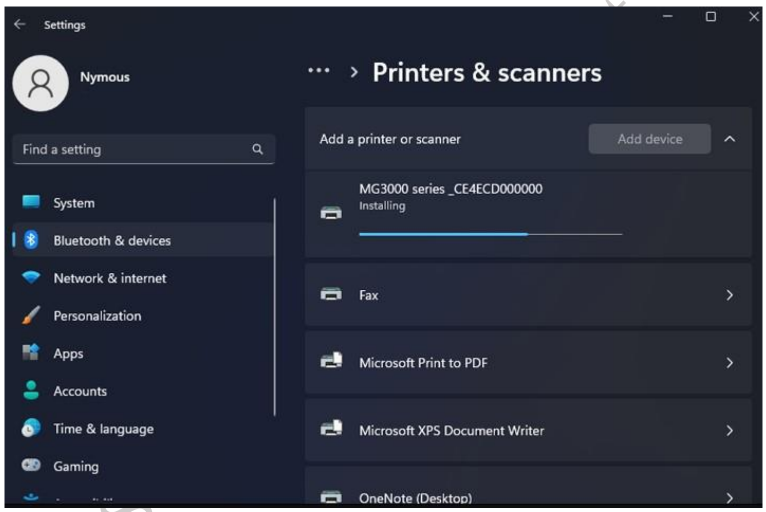


Fig. 3.62 installing process of printer

Once installed, the printer will display with any other peripherals you have installed.

Manually Add a Printer to Windows 11

Follow these steps if your computer has not recognized your printer:

Step 1. Launch "Settings."

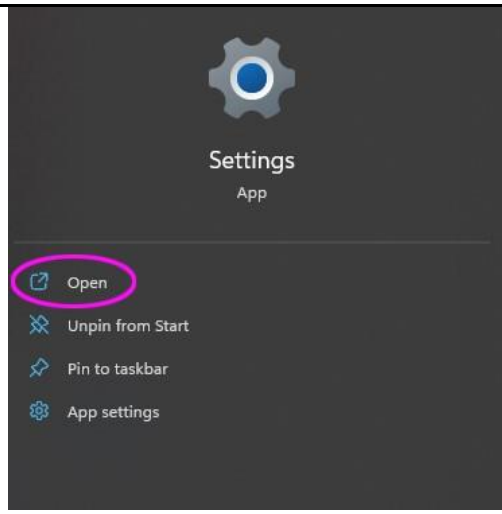


Fig. 3.63 go to the setting

Step 2. Click “Bluetooth & devices,” “Printers & scanners,” then “Add device.”

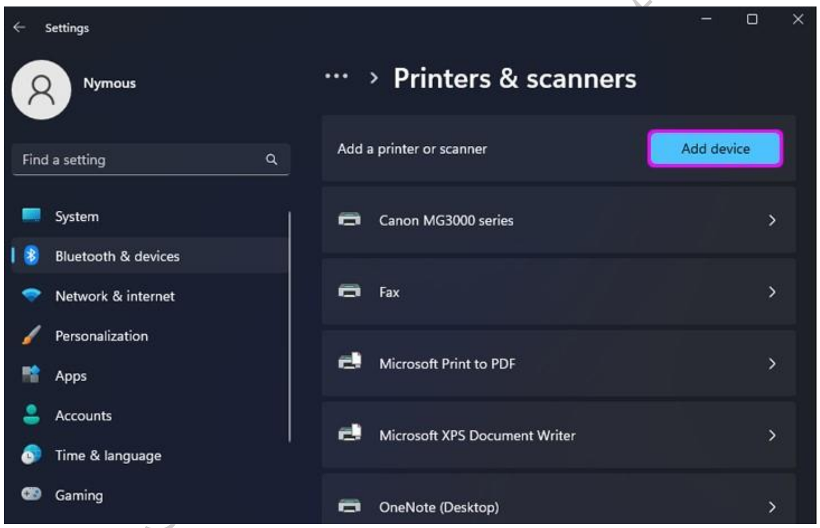


Fig. 3.64 add devices

Step 3. Wait while Windows tries to find your printer automatically. Once “Add manually” displays, press it.

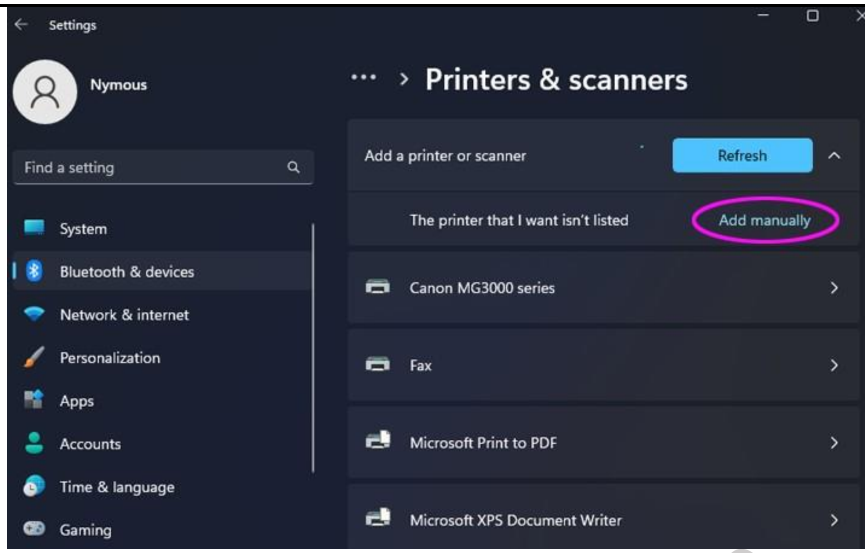


Fig. 3.65 Add manually device is not listed here

Step 4. Here you'll have several options, depending on how you want to connect to your printer. These options will work for network-attached and wireless printers. If the printer is connected directly to your PC, select "Add a local printer or network printer with manual settings," then hit "Next."

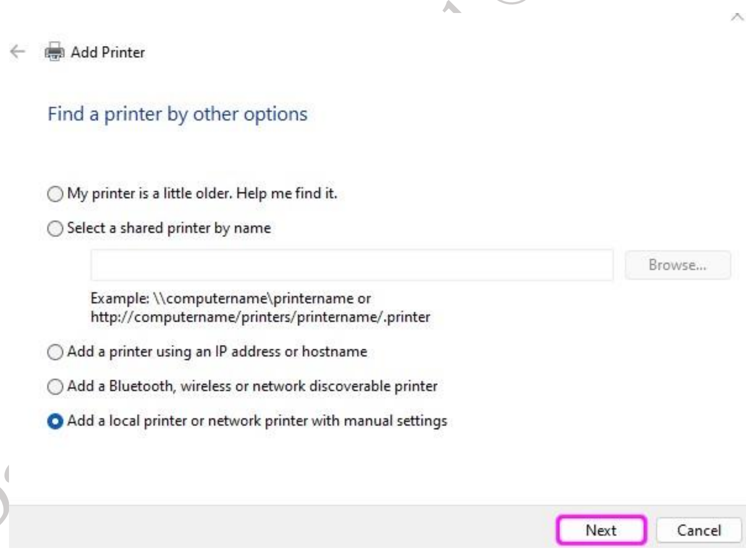


Fig. 3.66 add printer local network

Step 5. Select the port your printer is connected to, then choose "Next." Choose "USB" if it is connected that way.

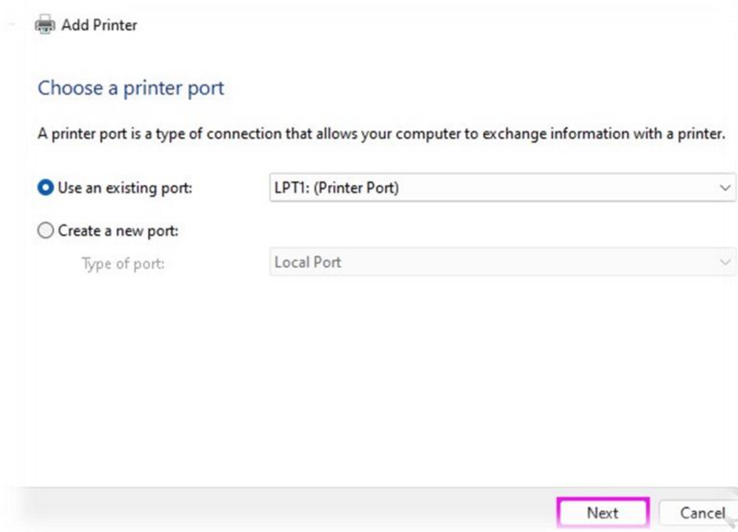


Fig. 3.67 choose an exciting port

Step 6. Now you'll see choices for installing the printer driver. If your printer came with a driver disc, choose "Have Disk" to find it. Otherwise, select "Windows Update."

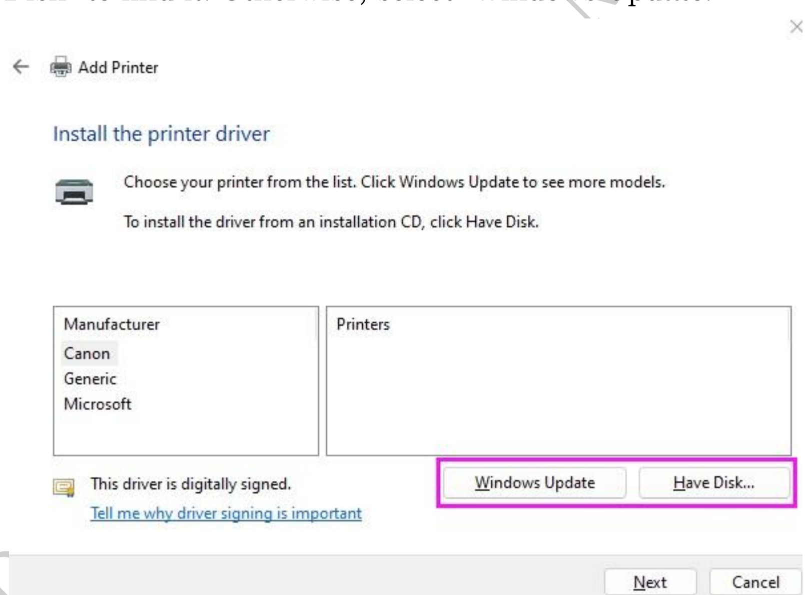


Fig. 3.68 install printer driver

Step 3. Windows will now offer some options. A message will pop up advising that it may take a few minutes while the printers list is updated.

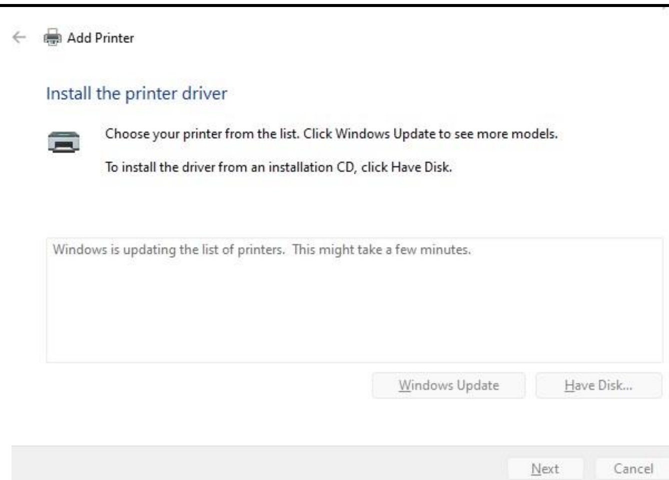


Fig. 3.69 install driver

Step 8. Select your printer's maker from the left column, and the model from the right, then "Next."

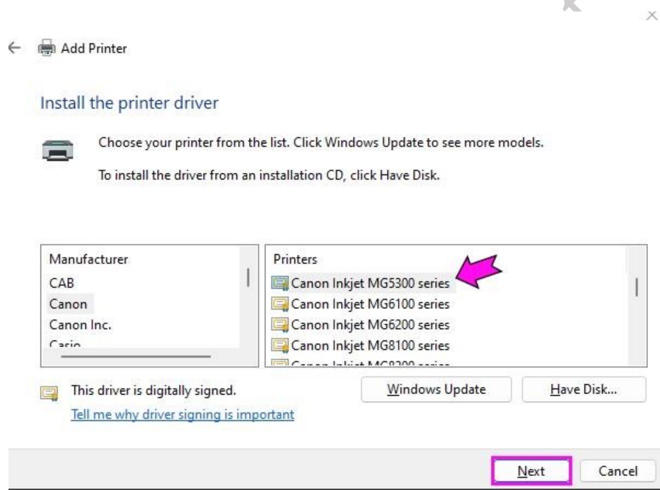


Fig. 3.70 choose a printer series driver

Step 9. Add a printer name, then click "Next."

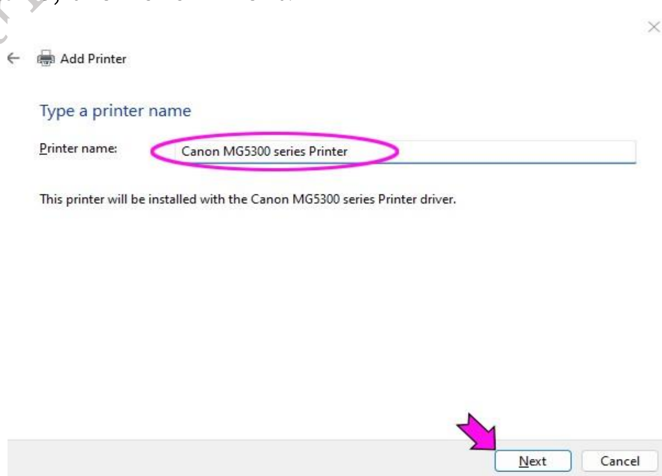


Fig. 3.71 enter a printer name

Step 3. Wait as Windows installs your printer.

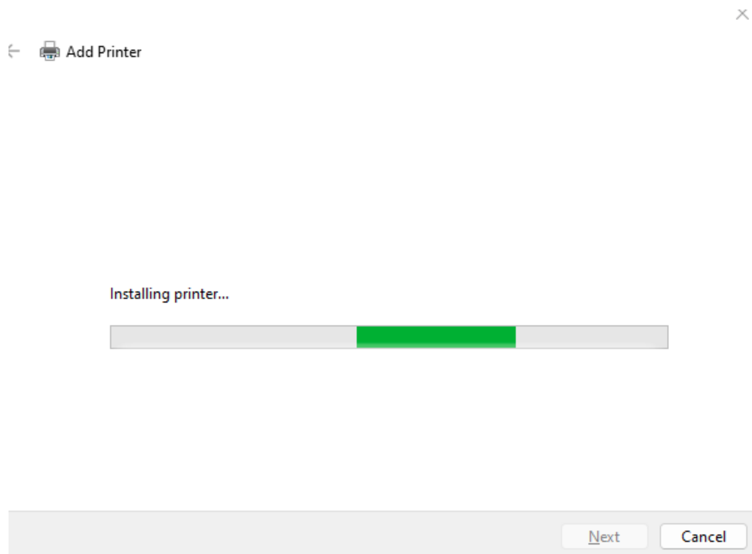


Fig. 3.72 installing process

Step 11. Select "Do not share this printer," then "Next." However, if you want to share, press "Share this printer" and complete the details.

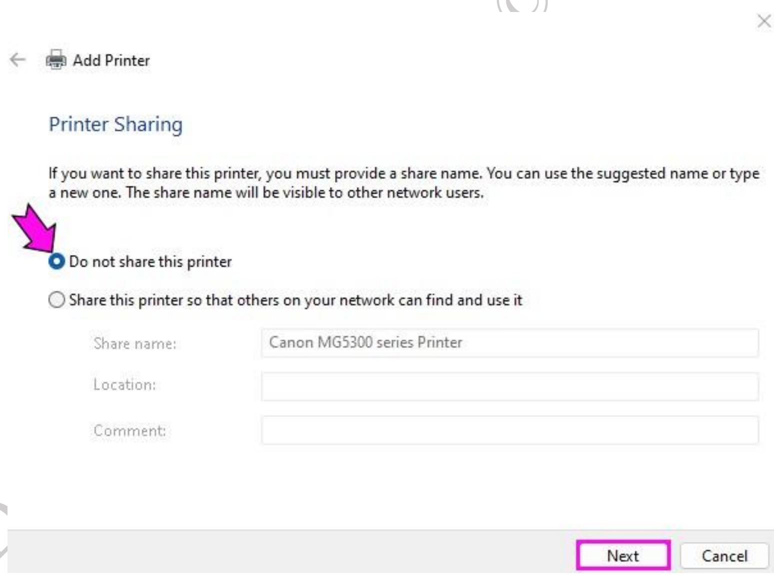


Fig. 3.73 sharing a printer

Step 12. A success page should display. To test the printer, press "Print a test page." Otherwise, hit "Finish."

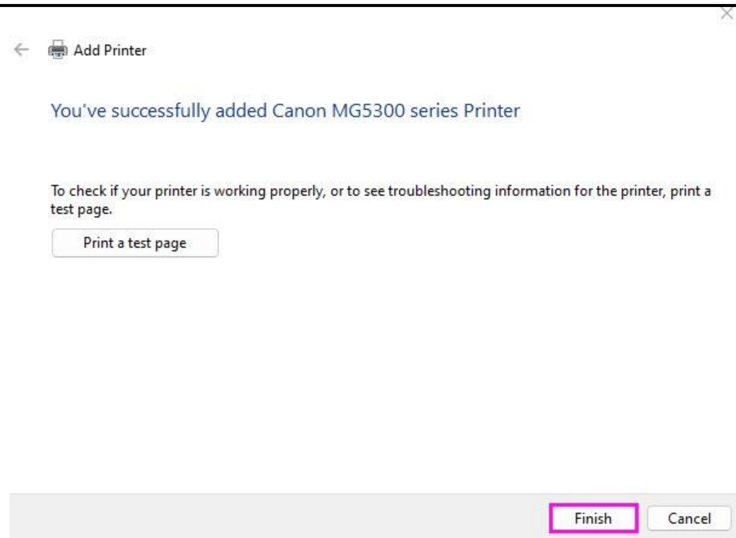


Fig. 3.74 Test a print page

3.7 INSTALLATION OF ANTIVIRUS SOFTWARE

It is essential to install 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 3.32. 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.

Fig. 3.75 Types of Antivirus software

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.

(a) CD/DVD Drive

(b) Internet Explorer 6 or later

(c) Internet connection to receive updates

(d) 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 a antivirus program consider following points—

a. Close all open applications, browsers, programs, and documents for uninterrupted installation.

b. Ensure that you have administrative rights for installing 'Quick Heal antivirus'.

Practical Activity 3.5 Standard installation of Quick Heal Total Security

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

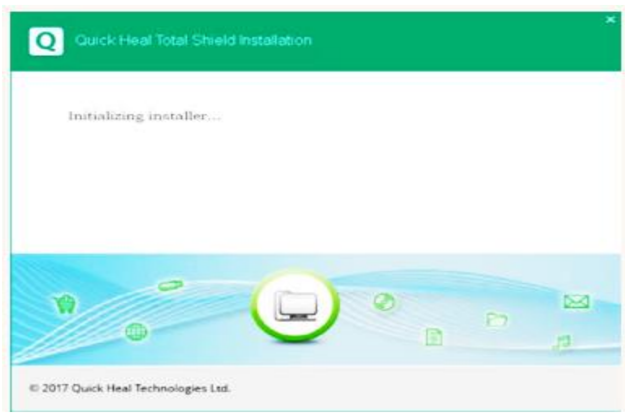


Fig. 3.76 Quick Heal initializing installer

Fig. 3.77 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 'Skip' button to install the current version.

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

Step 4. Click 'Next' to review the Install Location of Quick Heal Total Security as shown in Figure 3.85.

Step 5. Installation process continues

Step 6. Installation successfully completed, now click on 'Register Now' as shown in Figure 3.86.

Step 3. Review the features of Quick Heal Total Security Anti-Virus by clicking 'continue'. This step is optional; you can skip it if you wish.

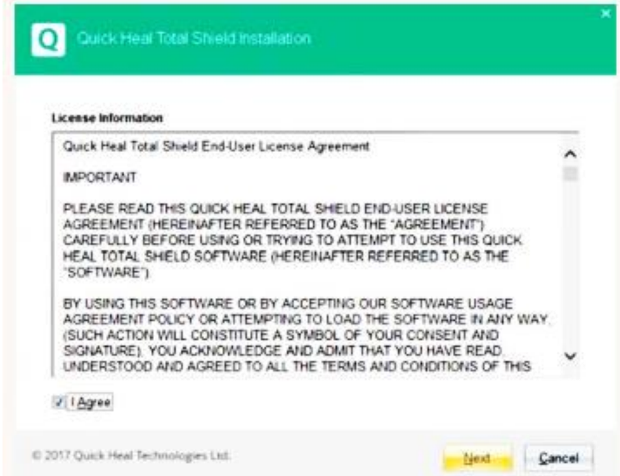


Fig. 3.78 End User License Agreement Window

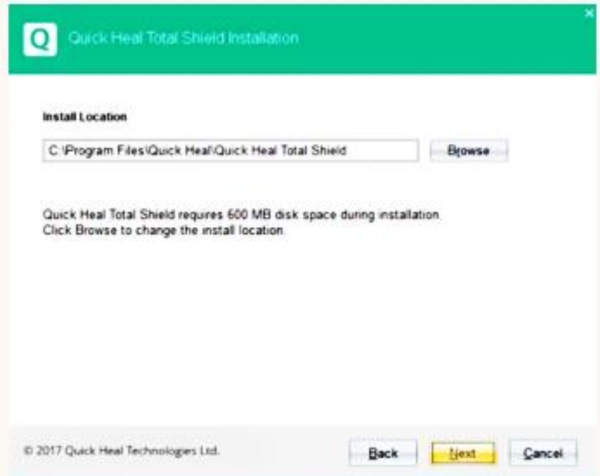


Fig. 3.79 Selecting Install Location window

Fig. 3.80 Installation process progress Window

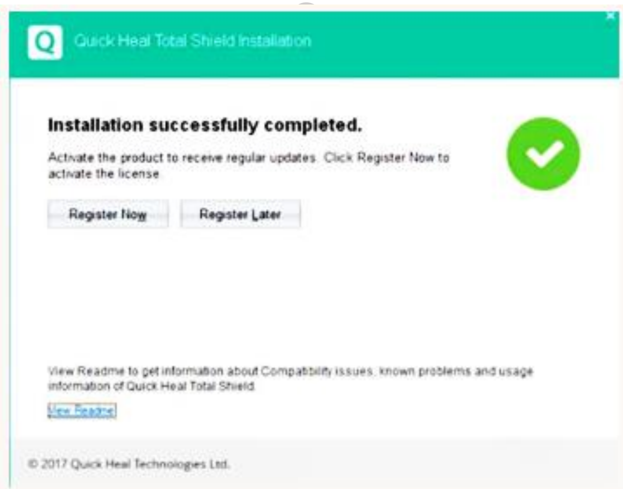


Fig. 3.81 Installation completed Window

Fig. 3.82 Home window of Quick Heal Total Security Anti-Virus

After you have installed and launched Quick Heal Total Security Anti-Virus, 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 ways, and you have to run the most important type, known as full system scan. Scanning will take the time defending 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 working on computer. In such case, it is suggesting to run full system scan and remove any viruses as shown in Figure 3.83 and 3.84.

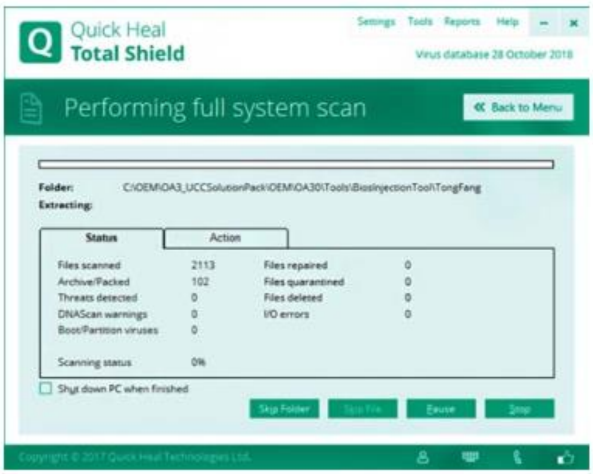


Fig. 3.85 Full System Scan Window

Fig. 3.86 Full System Scan window

Review discovered threats and recommended action

During the scanning process or after completing scanning, the antivirus program will inform 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 professional, don't ignore the problem. You can also contact the support team or customer care of the antivirus software.

MALWARE

The antivirus program may also have 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.

If all fails, then what to do?

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. Re-install the operating system and application programs. After re-installing it, first, install the antivirus software program and update the antivirus immediately. After updating, perform the full scan of system including backup data.

3.8 Old version- 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 3.92. Let the disk allow the loading of the setup file as shown in Figure 3.93. Follow the steps below for clean installation of Windows 3.

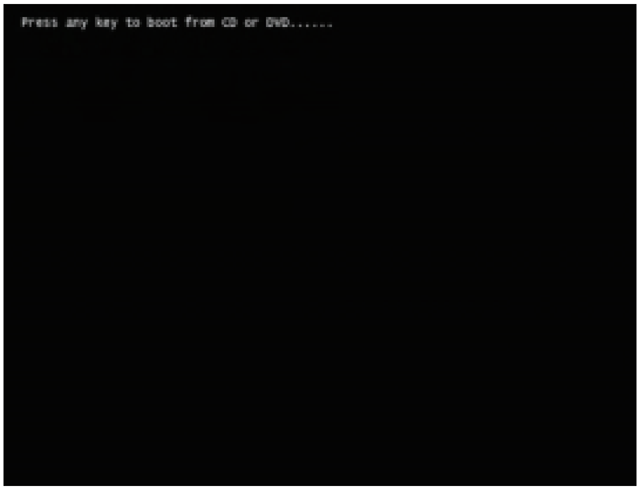


Fig. 3.87 Press any key for booting

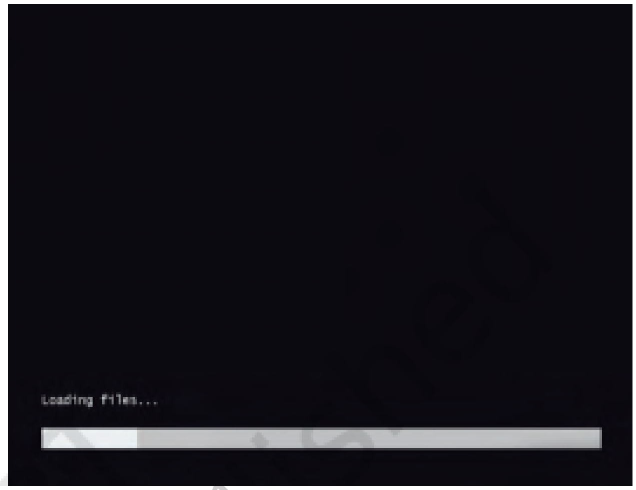


Fig. 3.88 Loading setup file

(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 3.89. Then click on the 'Next' button.

(ii) Click the 'Install now' button as shown in Figure 3.90.

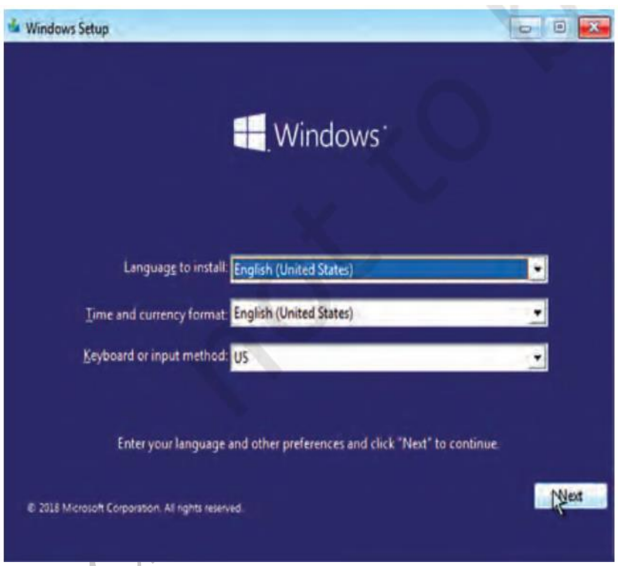


Fig. 3.89 Select language, time, and currency

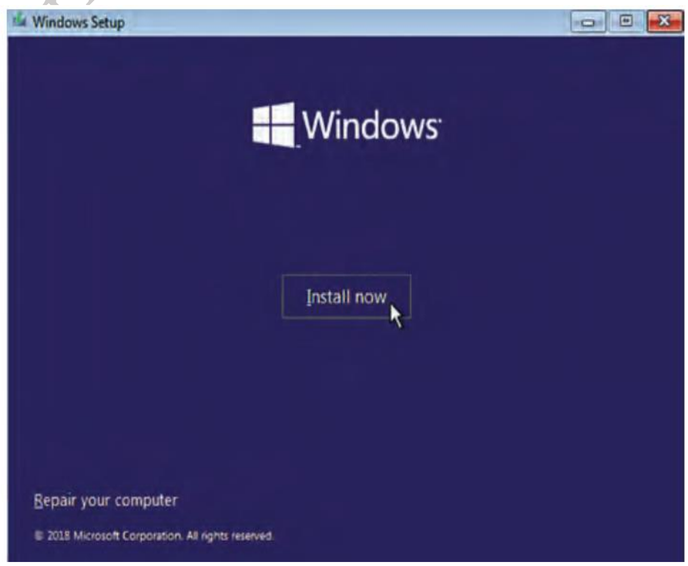


Fig. 3.90 Installation window and input

(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 3.91 below

(iv) A new window as shown in Figure 3.92 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 3.93.

(vi) Click on the 'Custom: Install Windows only (advanced)' option as shown in Figure 3.94.

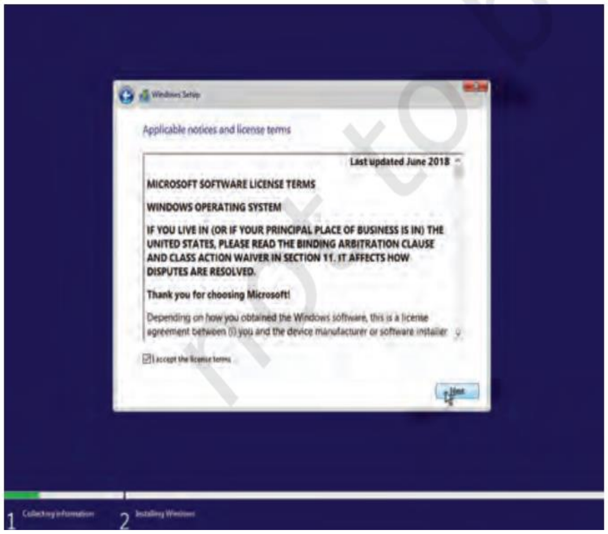


Fig. 3.93 License terms

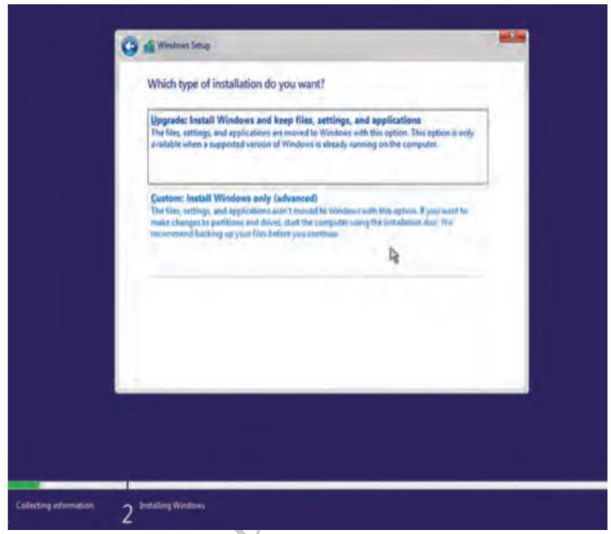


Fig. 3.94 Selecting installation setup window

(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.

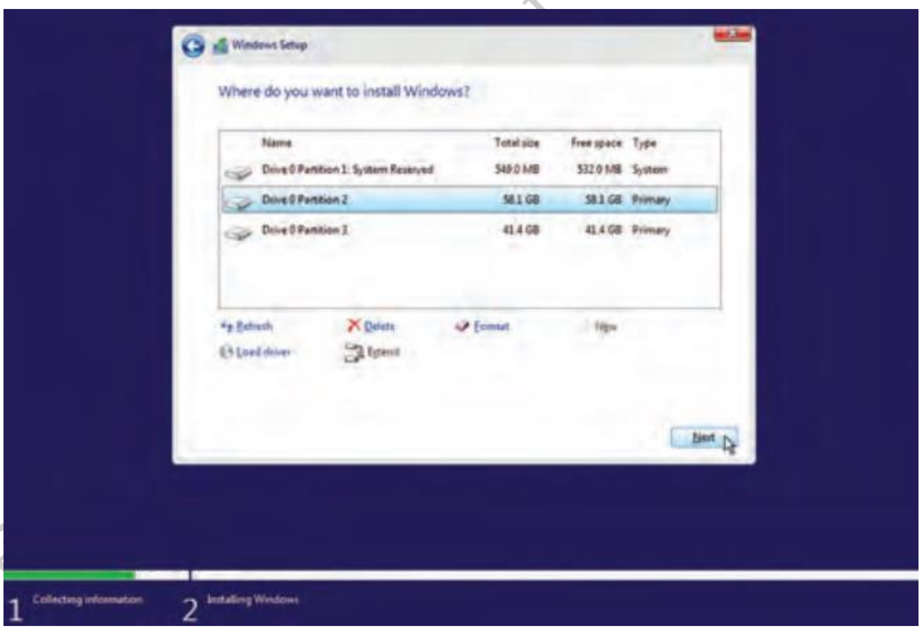


Fig. 3.95 Partition window

(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 3.96.

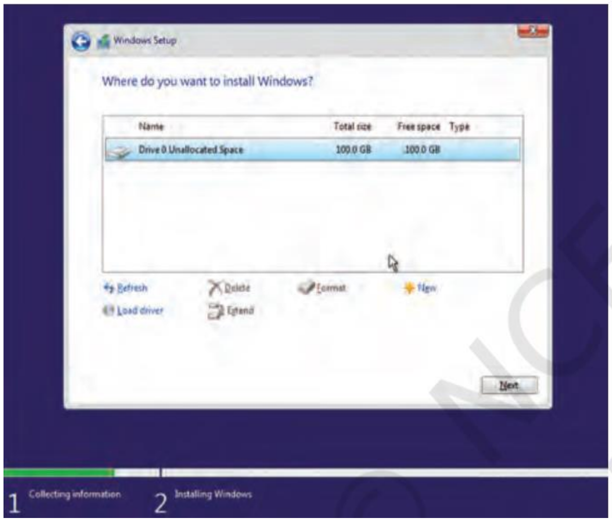


Fig. 3.96 Drive 0 unallocated space

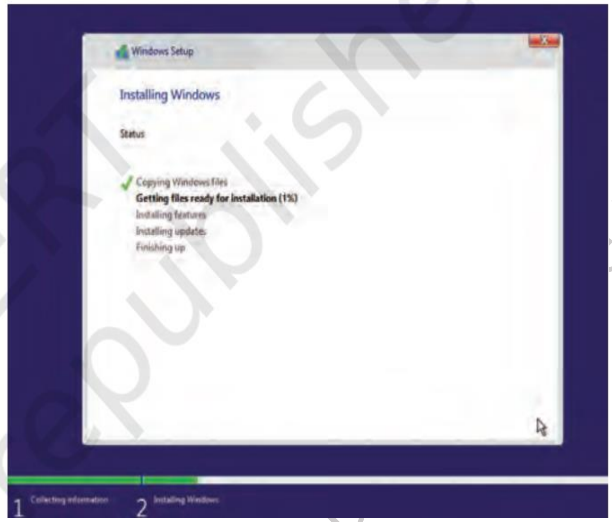


Fig. 3.97 Installing Windows

(x) After completion of these steps, the set-up will proceed to install Windows 10 as shown in Figure 3.93.

(xi) After complete installation, the initial, window will appear on the computer screen as shown in Figure 3.98.

Fig. 3.98 Home window of windows 10

Installing printer (for window 10)

A printer is essentially required for taking print outs from the computer. The following activity illustrates the installation of a printer in Windows 3.

Practical Activity 3.6 Installation of printer

Step 1. Click and run setup.exe file of printer as shown in Figure 3.99. The setup.exe file will extract as shown in Figure 3.100.

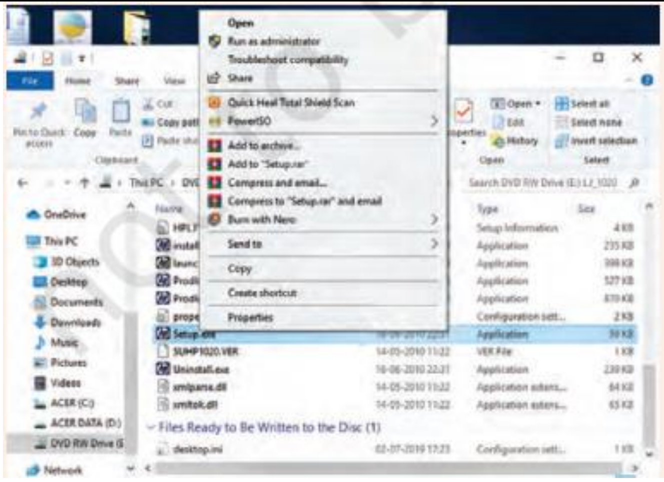


Fig. 3. 99 Run printer .exe setup file

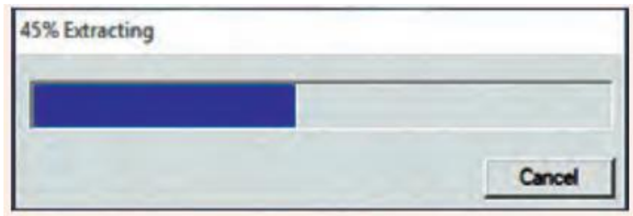
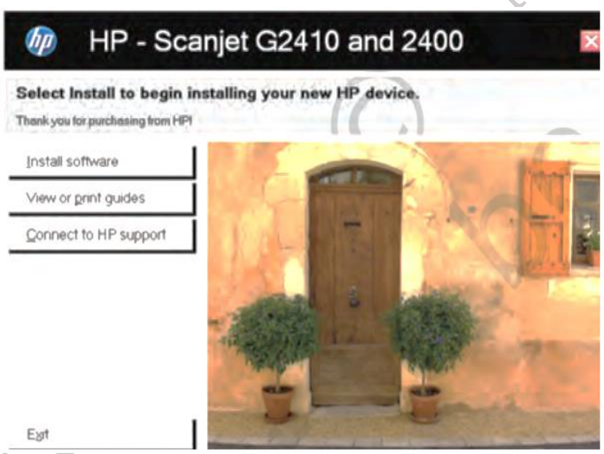


Fig. 3.100 Setup extracting Window

Step 2. Click on install button as shown in Figure 3.101.

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.



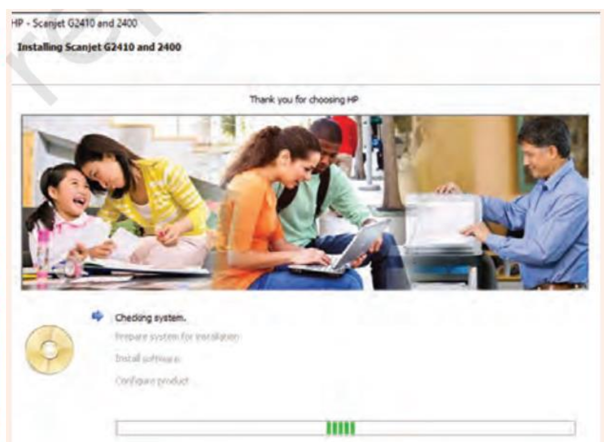


Fig. 3.101 HP driver installation window **Fig. 3.102 Checking system**

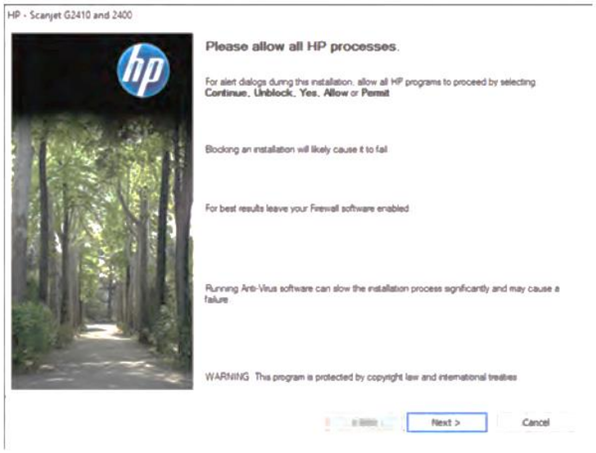


Fig. 3.103 Scanjet permission-allow all installation Agreement

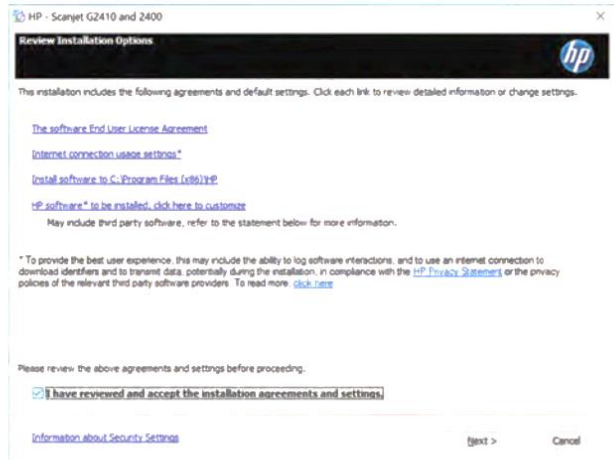


Fig. 3.104 Accepting 'End User license process window

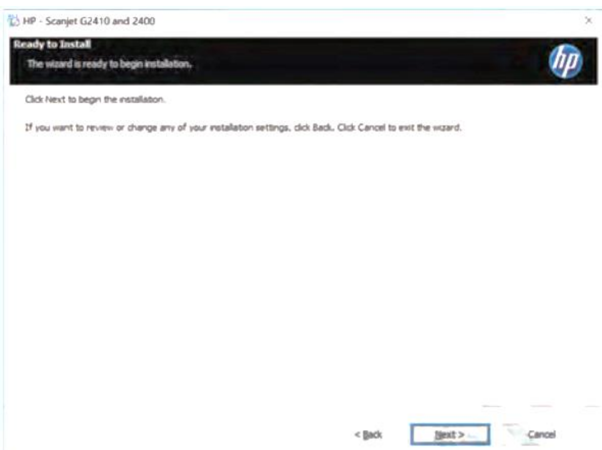


Fig. 3.105 Ready to install

Fig. 3.106 Installing software

Fig. 3. 107 Connect Scanner to PC

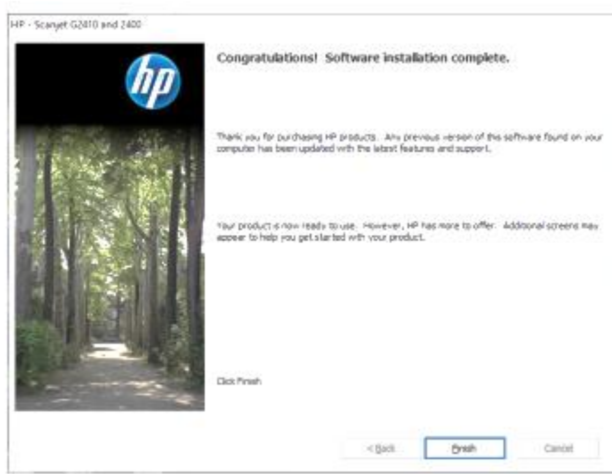


Fig. 3.108 Successful setup installation

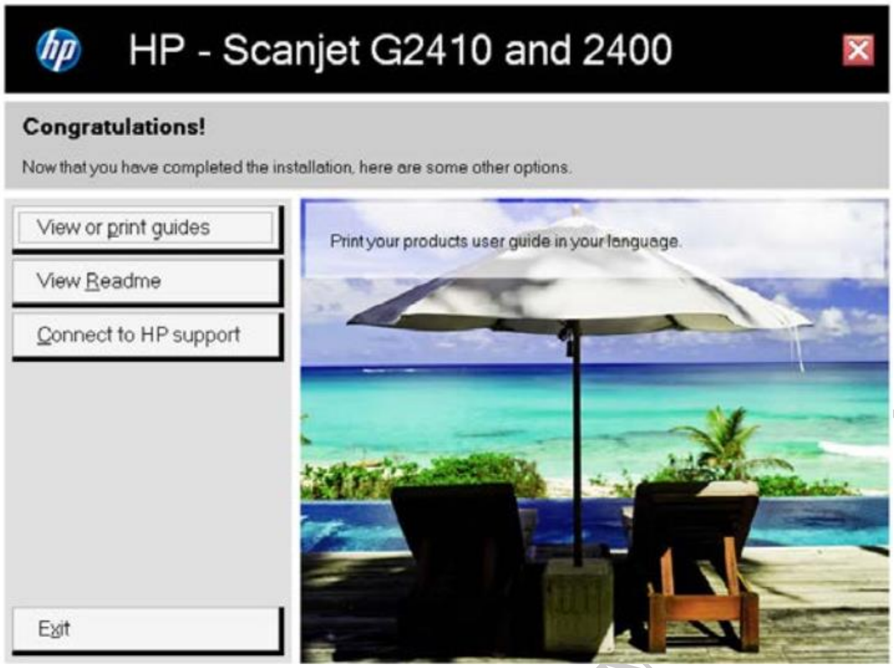


Fig. 3. 109 HP Scanjet Window.jpg

Check Your Progress

A. Multiple-choice questions (MCQs)

1. Which of the following is the shortcut to open Task Manager in Windows? (a) Ctrl + Shift + Del (b) Ctrl + Alt + Del (c) Ctrl + Alt + Shift (d) Alt + F4
2. Which tool in Windows is used to manage files and folders? (a) Control Panel (b) Task Manager (c) File Explorer (d) Device Manager
3. In Windows 10, where can you change the system's region and language settings? (a) Task Manager (b) File Explorer (c) Control Panel (d) Settings
4. What is the first step to perform a clean installation of Windows 11? (a) Install antivirus software (b) Boot from installation media (c) Open Task Manager (d) Run File Explorer
5. Which of the following steps is necessary to install a printer in Windows 10? (a) Open Task Manager (b) Connect the printer and install drivers (c) Open File Explorer (d) Update antivirus software

B. Fill in the Blank

1. The shortcut to open the Task Manager in Windows is ________.
2. ________ is the tool used to navigate files and folders in Windows.
3. To change the system's region and language in Windows 10, go to the ________ section in Settings.
4. The first step in performing a clean installation of Windows 11 is to boot from the ________.

5. To protect your system from malware, it is important to install ________ software.

C. Ture or False

1. The Windows Desktop is the primary user interface in Windows operating systems.
2. File Explorer allows users to browse and manage files and folders on their computer.
3. You can change the region and language settings in Windows 10 only through the Control Panel.
4. Performing a clean installation of Windows 11 will erase all data on the hard drive.
5. Installing a printer in Windows 10 does not require any software or drivers.

D. Short Questions

1. What features does the Windows Desktop provide to users for managing applications and files?
2. How can users customize the view and layout of File Explorer in Windows 10?
3. What are the key steps to change the region and language settings in Windows 10?
4. What precautions should be taken before performing a clean installation of Windows 11?
5. What is the process for installing antivirus software on a Windows computer, and why is it important?

Session 4. Install Linux operating system

Linux, often hailed as the backbone of the open-source software movement, is a powerful and versatile operating system that has become a cornerstone of modern computing. Born out of the curiosity and collaboration of software enthusiasts, Linux has grown into a robust platform used by millions of individuals and organizations worldwide. In this chapter, we will explore the essence of Linux, its history, architecture, uses, and key features that make it a preferred choice for various computing environments.

Linux

Linux is a free and open-source operating system that is widely used in computer systems, servers, and mobile devices to manage all the hardware resources on your desktop. It is a Unix-like system that Linus Torvalds first introduced in 1991, and since then, it has evolved into a versatile operating system used in a wide range of applications.

- One of the most important features of Linux is its open-source nature, which means that anyone can access its source code, modify it, and distribute it freely without any licensing restrictions. This makes Linux an attractive option for developers and businesses who want to customize and optimize their operating systems and source software for specific applications and hardware.
- Linux is highly modular, allowing users to choose which components to install and configure depending on their specific needs. This makes it a highly flexible and customizable elementary OS that can be tailored to meet the requirements of individual users or organizations.

- Another important aspect of Linux is its stability and reliability. Linux is known for its ability to run for extended periods without needing to be rebooted or restarted. It is a critical feature in enterprise applications where downtime can be costly.

A Brief History of Linux

The history of Linux is a fascinating journey that began with the curiosity and ingenuity of a young Finnish computer science student named Linus Torvalds. The Linux operating system has its roots in the Unix operating system, and its development is marked by collaboration, community involvement, and the principles of open-source software.

In the early 1990s, Linus Torvalds, a Finnish computer science student, initiated the development of Linux as a Unix-like operating system kernel. The kernel is the core component of an operating system, managing system resources and facilitating communication between hardware and software.

Initially, Torvald's operating system was only intended for personal use, but he soon released it to the public as a free and open-source project. The first version, known as Linux 0.01, was released in September 1991.

In the early 2000s, Linux became increasingly popular in enterprise applications, where its stability and scalability made it an attractive alternative to proprietary operating systems like Windows and Unix.

Today, Linux is widely used as the largest open-source software project in a variety of applications, including servers, supercomputers, mobile devices, and embedded systems.

Owns of Linux

Linux, as an open-source operating system, is not owned by any individual or corporation in the traditional sense. Instead, it is a collaborative project developed by a global community of contributors. The Linux operating system is released under the GNU General Public License (GPL), which is a free and open-source software license.

Architecture of Linux

The architecture of Linux can be conceptualized in several layers, each playing a crucial role in the functioning of the operating system. There are an overview of the key components:

Hardware Layer: The hardware layer consists of the physical components of a computer, including the central processing unit (CPU), memory (RAM), storage devices (hard drives, SSDs), input/output devices (keyboard, mouse, display), and other peripherals.

Kernel: The kernel is the core of the Linux operating system. It directly interacts with the hardware and manages its resources. Key responsibilities of the kernel include process scheduling, memory management, device drivers, file system management, and system calls. The Linux kernel is modular, allowing the addition or removal of features through loadable kernel modules.

Shell and Command Line Interface (CLI): The Linux shell is a command-line interpreter that acts as an interface between the user and the kernel. It allows users to interact with the operating system by entering commands. Linux supports various shells, with Bash (Bourne Again SHell) being one of the most widely used. The CLI provides powerful tools for file manipulation, process control, and system configuration.

System Libraries: System libraries are collections of functions and routines that provide essential services to applications and the kernel. They act as an intermediary between application software and the kernel version. Common libraries include the GNU C Library (glibc) and other libraries specific to programming languages.

System Calls: System calls are interfaces between user-level applications and the kernel. They allow applications to request services from the kernel, such as file operations, process management, and network communication. Examples of system calls include open (), read (), write (), and fork ().

Applications Layer: The applications layer comprises the user-facing software that runs on top of the operating system. This includes desktop environments (e.g., GNOME, KDE), window managers, graphical applications, and command-line utilities. Linux supports a vast array of applications ranging from office productivity tools and web browsers to development environments and multimedia software.

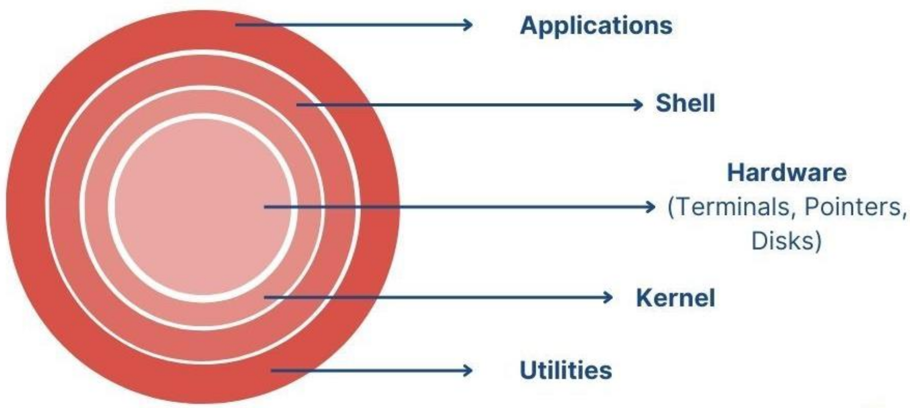


Fig. 4.1: Architecture of Linux

Working of Linux

Linux operates on the principles of a multi-layered architecture, with its core components interacting to manage hardware resources, provide user interfaces, and execute applications.

Step 1: Boot Process

When a computer is powered on, the BIOS (Basic Input/Output System) or UEFI (Unified Extensible Firmware Interface) initiates the boot process. The bootloader (e.g., GRUB) then loads the Linux kernel into memory from the designated boot partition.

Step 2: Kernel Initialization

The Linux kernel initializes the system, including hardware detection, memory setup, and initializing essential subsystems. It mounts the root file system and sets up the initial process, known as the init process.

Step 3: Init System and System Services

The Init system (e.g., systemd) takes control, managing system services and initializing the user space. System services, including essential daemons, are started to ensure the proper functioning of the system.

Step 4: User Space Initialization

The Init process spawn's user space processes, including the shell and other essential hardware components. User space initialization also involves mounting additional file systems and configuring the network.

Step 5: User Login

If a graphical user interface (GUI) is used, the display manager prompts the user for login credentials. And then, the shell prompts the user for login credentials in a command-line interface (CLI).

Step 6: Shell and CLI Interaction

Upon successful login, the user is presented with a shell prompt. After this the user can interact with the shell by entering commands to perform tasks, manage files, run applications, and configure the system.

Step 7: File System Management

Linux uses a hierarchical file system. Users navigate and manipulate files and directories using commands such as ls, cd, cp, and mv. File permissions and ownership are managed to control access and security.

Step 8: Process Management

The kernel manages processes, which are instances of executing programs. The ps, kill, and top commands allow users to view and manage processes. Users can run multiple processes concurrently, and the kernel handles process scheduling.

Step 9: Memory Management

Linux employs virtual memory to manage physical RAM and disk space efficiently. Memory management involves techniques like paging and swapping to ensure optimal use of resources.

Step 10: Networking

Linux has a robust networking stack supporting various protocols. Network configuration is managed through utilities like ifconfig and IP. Applications communicate over the network using protocols such as TCP/IP.

Step 11: Package Management

Package managers (e.g., APT, YUM, Pacman) simplify software installation, removal, and updates. Users can install software from repositories, and package managers handle dependencies and updates.

Step 12: Security

Linux follows a security model based on user permissions and ownership. Regular security updates and patches are released to address vulnerabilities.

Step 13: User Logout and System Shutdown

When a user logs out or the system is shut down, processes are terminated, and the system state is saved. The kernel initiates the shutdown process, unmounts file systems, and halts or reboots the system.

Distribution of Linux

A Linux distribution, often referred to as a distro, is a complete and packaged operating system that includes the Linux kernel, system libraries, utilities, and additional software components. The purpose of a distribution is to provide users with a complete and ready-to-use environment. While the Linux kernel is common across all distributions, the choice of software, package management system, default configurations, and user interfaces can vary widely.

There are a brief overview of some popular Linux distributions and where they are

commonly used:

Ubuntu:

Use Cases: General-purpose desktops, laptops, and servers.

Features: User-friendly, extensive software repositories and long-term support (LTS) versions.

Desktop Environment: The default is GNOME, but other flavors (Kubuntu, Xubuntu) with different desktop environments are available.

Notable Variants: Ubuntu Server, Ubuntu Desktop, Ubuntu LTS.

Debian:

Use Cases: Stable servers and general-purpose desktops.

Features: Emphasizes stability, large software repositories, and commitment to free software.

Desktop Environment: Minimal by default and the users can choose during installation.

Notable Variants: Debian Stable, Debian Testing, Debian Unstable.

Fedora:

Use Cases: Cutting-edge desktops, developers, and servers.

Features: Emphasizes the latest software, innovative technologies, and shorter release cycles.

Desktop Environment: The default is GNOME, but other spins with different desktops are available.

Notable Variants: Fedora Workstation and Fedora Server.

CentOS:

Use Cases: Stable servers, enterprise environments.

Features: Based on the same sources as Red Hat Enterprise Linux (RHEL), focuses on stability and long-term support.

Desktop Environment: Minimal installation and is often used as a server OS.

Notable Variants: CentOS Stream.

Arch Linux:

Use Cases: Enthusiasts and users who want a highly customizable system.

Features: Rolling release model, minimal installation, and a do-it-yourself approach.

Desktop Environment: Users choose during installation and no default desktop.

Notable Variants: Manjaro (based on Arch with an easier installation process).

The openSUSE:

Use Cases: Desktops, servers, and enterprise environments.

Features: YaST configuration tool, focuses on usability and stability.

Desktop Environment: The default is KDE, but GNOME and other options are available.

Notable Variants: openSUSE Leap, openSUSE Tumbleweed.

Slackware:

Use Cases: Enthusiasts and users who prefer simplicity.

Features: Oldest surviving Linux distribution, minimalism, and simplicity.

Desktop Environment: Users choose during installation and no default desktop.

Right for Linux Distribution

- Choosing the right distribution depends on factors such as your level of expertise, the intended use of the system, and personal preferences.
- For beginners, Ubuntu or its derivatives are often recommended due to their user-friendly nature.
- Advanced users and those seeking customization might prefer Arch Linux or a derivative like Manjaro.
- Enterprise environments often opt for CentOS or Debian for their stability and long-term support.

Applications of Linux

Linux finds applications across a broad spectrum of edge computing environments due to its versatility, stability, and open-source nature. Some of the most common applications of the Linux system are as following:

Server Systems:

Web Servers: Linux, especially its distributions like Ubuntu Server, CentOS, and Debian, are widely used for hosting web servers, including popular source solutions like Apache and Nginx.

Database Servers: Linux is a common choice for running database servers, with MySQL and PostgreSQL being popular database management systems.

Enterprise Environments:

File Servers: Linux is employed for file sharing and network-attached storage (NAS) solutions, offering reliability and performance.

Email Servers: Systems like Postfix and Dovecot running on Linux are frequently used for managing email servers.

Cloud Computing:

Many featured cloud service providers, such as Amazon Web Services (AWS) and Google Cloud Platform (GCP), use Linux as the underlying primary operating system for their virtual machines and container instances.

Development and Programming:

Linux is a preferred platform for software development, offering a rich set of development tools, compilers, and libraries.

Popular programming languages like Python, C, C++, Java, and others have robust support on Linux.

Desktop Computing:

General-Purpose Desktops: Linux desktop environments (e.g., GNOME, KDE, Xfce) provide a user-friendly experience for everyday computing tasks.

Educational and Home Use: Lightweight distributions like Ubuntu, Linux Mint, and Fedora are commonly used for educational purposes and home desktops.

Embedded Systems and IoT:

Linux is widely used in embedded systems and Internet of Things (IoT) devices due to its scalability and adaptability.

Distributions like Yocto Project and OpenEmbedded facilitate customizing Linux for specific embedded applications.

Security and Network Appliances:

Linux is often employed in security appliances, such as firewalls and intrusion detection/prevention systems.

Router and gateway devices frequently use Linux-based operating systems.

Scientific and High-Performance Computing:

Linux is a dominant force in scientific research and high-performance computing (HPC) environments.

Supercomputers and clusters often run Linux due to its stability, performance, and support for parallel computing.

Educational Institutions:

Linux is widely used in educational institutions for teaching computer science, artificial intelligence, and programming.

Distributions like Edubuntu are tailored for educational use.

Media and Entertainment:

Linux is used in media production, video editing, and animation.

Software like Blender, GIMP, and Kdenlive run on Linux, providing professional-grade tools.

Install Linux On Your System

You will understood, what is Linux. So, install it on your system and make the most of this amazing OS. There are the steps you must follow to get this done with ease.

Choose a Linux desktop distribution: There are different older, well-known distributions of Linux to choose from, such as Ubuntu, the popular distribution, Fedora-based distribution, Debian-based distributions, and many other newbie-friendly distributions. Each server distribution has its own strengths and weaknesses. Combinations of software can vary between Linux distributions, so choose the one that fits the needs of the community of users.

Download the installation media: Once you have chosen a server-specific distribution, you will need to download the installation media. This is typically an ISO file that you will need to burn a DVD or USB drive. You may also be asked to install third-party software.

Boot from the installation media: Insert the installation media into your computer and restart it. Most computers will automatically boot from the installation media, but you may need to change your boot order in your BIOS settings.

Follow the installation wizard: The installation wizard will guide you through the installation process. You will be asked to choose your programming language, keyboard layout, and time zone. You will also need to partition your hard drive and choose where to install Linux in the user setup.

Install Linux: Once you have made all the necessary choices, the installer will begin the installation process. This may take some time, depending on your computer's speed and the size of the server-only distribution.

Reboot: Once the installation is complete, you will need to reboot your computer. Remove the installation media and boot into your new Linux installation.

Customize your installation: After you have installed Linux, you can customize it to your liking.

You can install additional software, desktop tools, and programming tools, change your desktop environment, and modify your settings.

Fig. 4.2: Install Linux On Your System

Types of Linux installation

The following installation methods are usually available for Linux

- DVD/CD-ROM – If you have a DVD/CD-ROM drive and the Linux CD-ROMs or DVD you can use this method.
- Hard Drive – If you have copied the Linux ISO images to a local hard drive, you can use this method. You need a boot CD-ROM (use the linux askmethod boot option).
- NFS – If you are installing from an NFS server using ISO images or a mirror image of Linux, you can use this method. You need a boot CD-ROM (use the linux askmethod boot option). The distribution tree is shared/exported on an
- NFS server.
- FTP – If you are installing directly from an FTP server, use this method. You need a boot CD-ROM (use the linux askmethod boot option).
- HTTP – If you are installing directly from an HTTP (Web) server, use this method. You need a boot CD-ROM (use the linux askmethod boot option).
- SMB (Server Message Block) This method is relatively new, and not all distributions support it. The installation tree can be shared on a Samba server or shared from a Windows box.
- Live USB Drive or CD – One of the easiest ways to get started with Linux is by creating a live USB or CD drive. After you place Linux on the drive, you can insert your USB stick, CD, or DVD into any computer you come across and restart the computer. The computer will boot from the removable media you provided and you'll be able to use Linux without making any changes to the computer's hard drive. To create a Linux USB drive or CD, download the latest Linux disc image from Linux's website. Use Unetbootin to put Linux on your USB flash drive or burn the downloaded ISO image to a disc. (On Windows 7, you can right-click an ISO file and select Burn disc image to burn the ISO file without installing any other software.) Restart your computer from the removable media you provided and select the Try Linux option.
- Virtual Machine – Like other operating systems, Ubuntu can be run in a virtual machine on your computer. The virtual machine runs Ubuntu in a window on your existing Windows or Mac desktop. You'll be able to try Linux without even restarting your computer, although virtual machines are slower than running the operating system on your computer itself. The

Ubuntu desktop's 3D effects, in particular, won't perform very well in a virtual machine, while they should perform smoothly on most computers.

The installation methods can also be categorizing into 4 major categories

- Clean: installation that does not write to current OS storage media
- Dual-boot: peaceful co-existence with current OS on same storage or VM environment
- Replacement: overwriting of current OS with Linux on platform storage media
- Upgrading/Recovery: enhancing or repairing current Linux OS installation

Installation of Ubuntu Linux

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, 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 very much 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 secured as compared to windows operating system.
- High customization, it means you can set your own flavors of working.
- Many Ubuntu flavors are readily available.
- Online Ubuntu community are available to help you for any problem.
- Minimum hardware required to install Ubuntu.
- Lot of free software in Software Center

Installation Requirements:

Check the following technical requirements before starting the installation:

- Connect your computer system to an uninterrupted power supply.
- Ensure that your computer should have 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 24.04 LTS.
- Make sure to take the data backup before starting the fresh installation.

Boot from Ubuntu bootable disk DVDUSB flash drive

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

- Put the Ubuntu bootable disk in case of DVD into optical/DVD drive and in case of USB flash drive into the USB socket. Make sure the boot device order has set to the disk being used 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 the figure 4.3, will appear on your computer screen.

Fig. 4.3. Installation window of Ubuntu

There are two options shown as "**Try Ubuntu**" and "**Install Ubuntu**". The first option "**Try Ubuntu**" allows you to just use the Ubuntu on trial basis without doing permanent installation, the other option "**Install Ubuntu**" makes you to actual installation.

It will launch the installer automatically as shown in figure 4.4. Before selecting the **Install Ubuntu** option, select the language from the left side pan. By default, the language selected as "English". Ubuntu can also be installed in other listed languages.

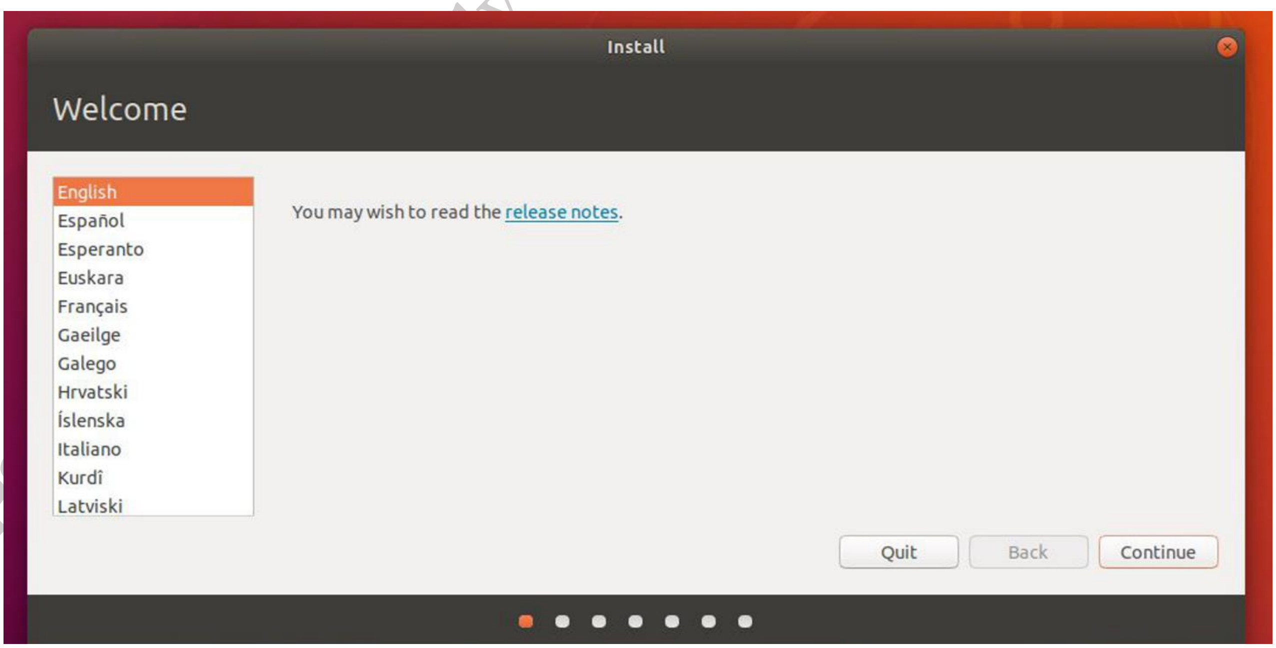


Fig. 4.4. Default language selected as "English"

Prepare to install Ubuntu

Now the installer will recognize your computer configuration, and install the device drivers automatically. If it doesn't guess the default layout of any device correctly, use the **'Detect 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 the figure 4.5.

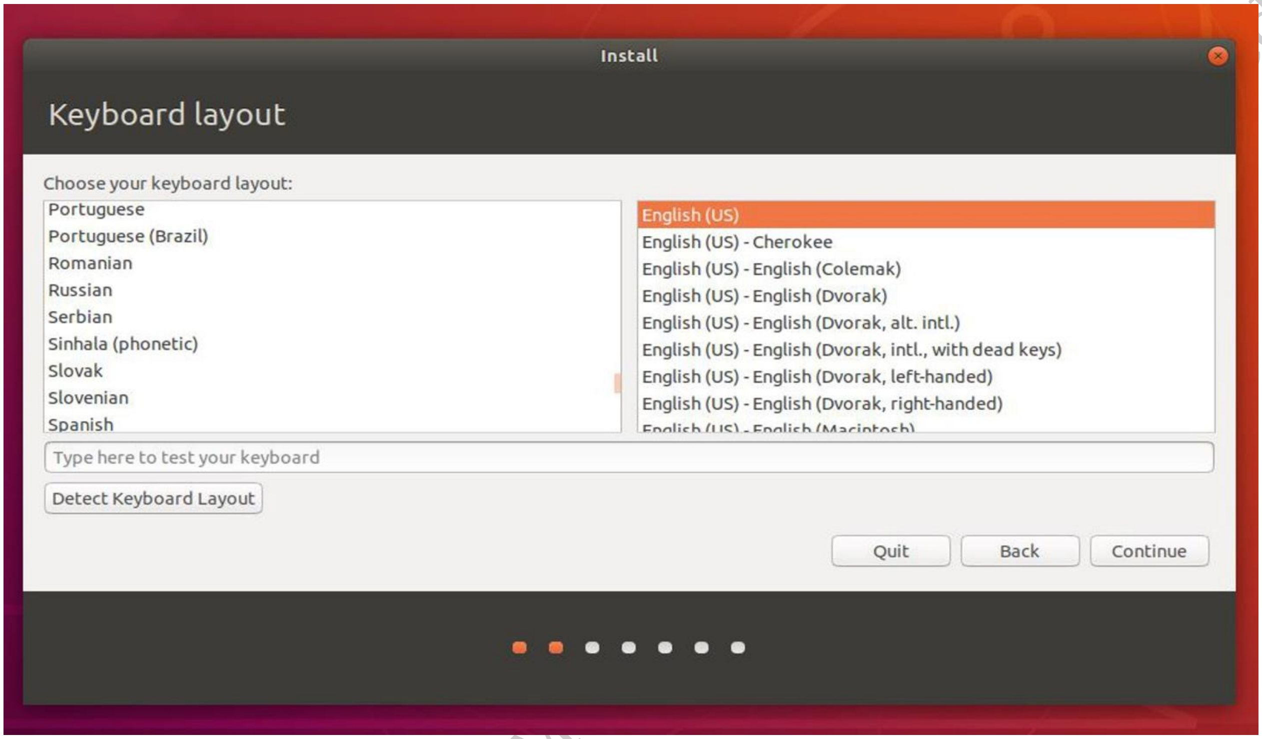


Fig. 4.5: Select 'Detect keyboard layout'

Press **Continue** to apply. The next window will appear as shown in figure 4.6, that will be ask you the type of installation **'Normal installation**' and **'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 this shows the Other options, showing the two checkboxes "Download updates while installing Ubuntu" and "Install third party..." the first options

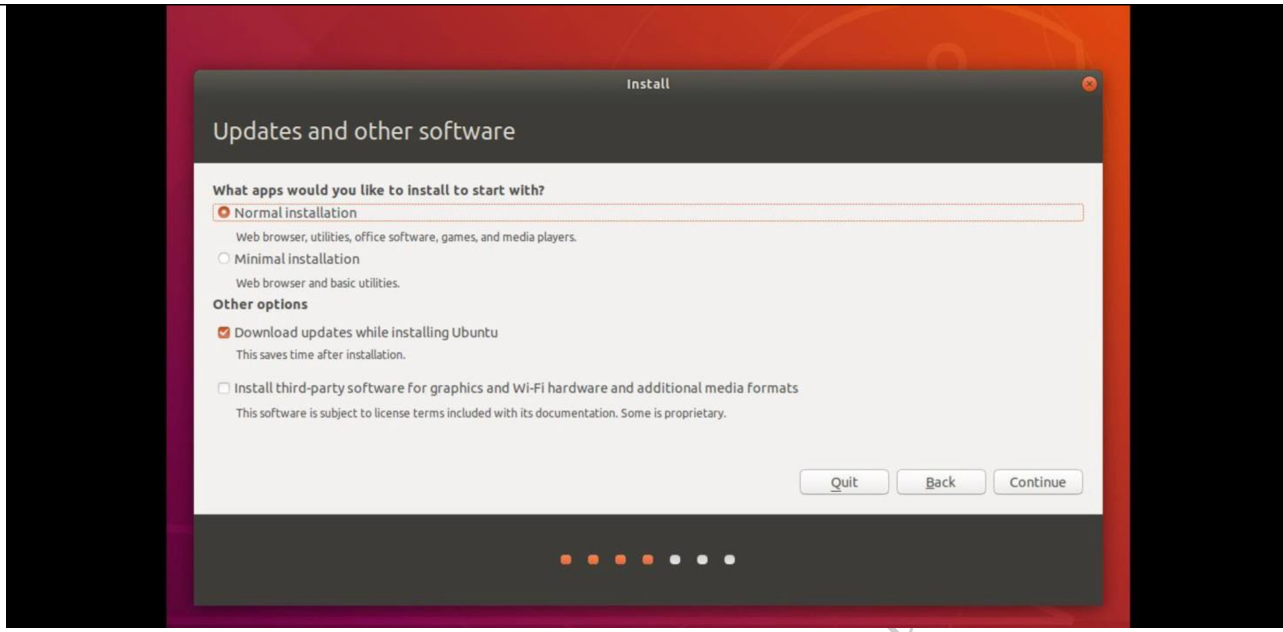


Fig. 4.6 Selecting the Normal installation

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

Select installation type and allocate drive space

The next installation window shown in figure 4.7 will ask you to provide the installation type. If the computer has already installed any other operating system then you can install the Ubuntu alongside the other operating systems so that you can have option to boot the computer with any of the operating system. The **Erase disk and install Ubuntu** 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.

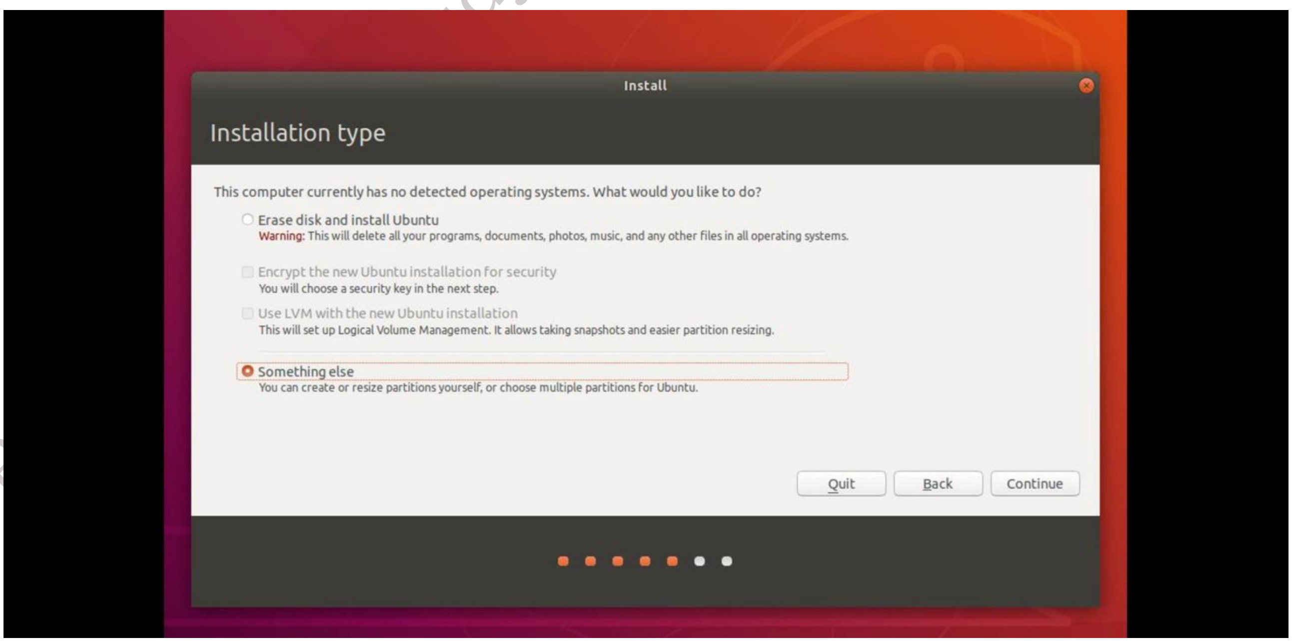


Fig. 4.7 Selecting Something else to create partition

Select the appropriate option and click on continue. The next window as shown in figure 4.8 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.

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

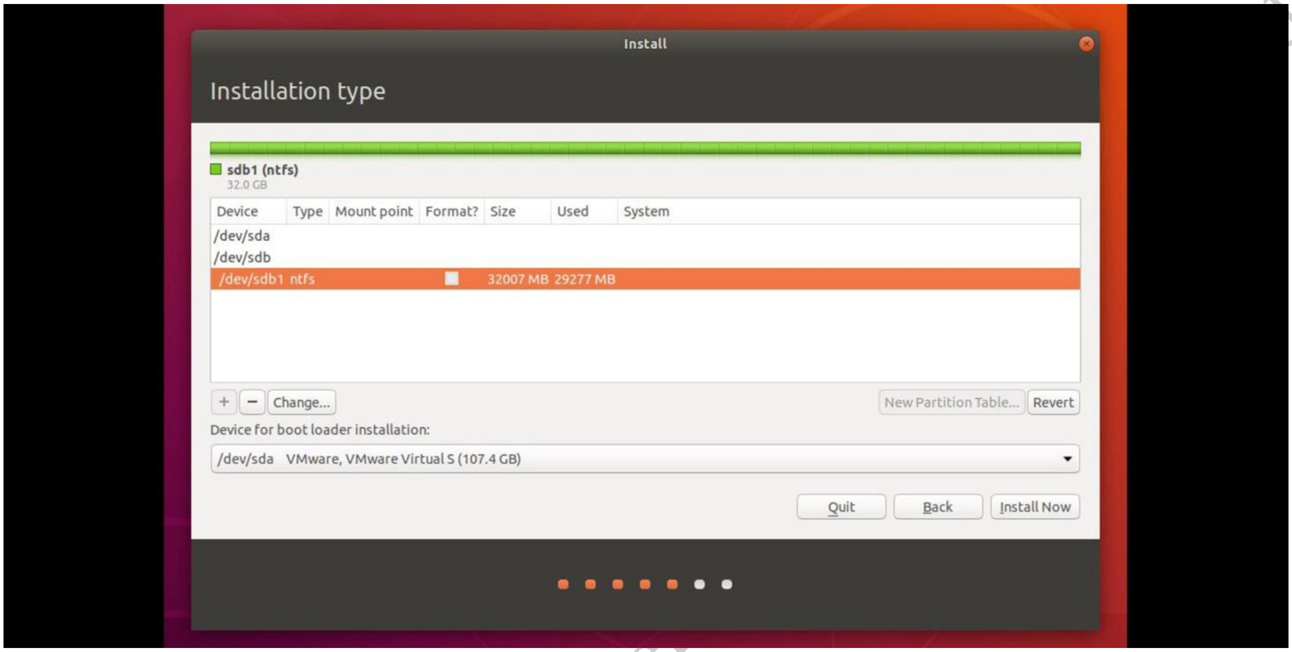


Fig. 4.8 Pre-existing partition of the disk

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 the amount of RAM in your PC. For example, having 1 GB of RAM, create swap area of 2GB (2048 MB) as shown in figure 4.9.

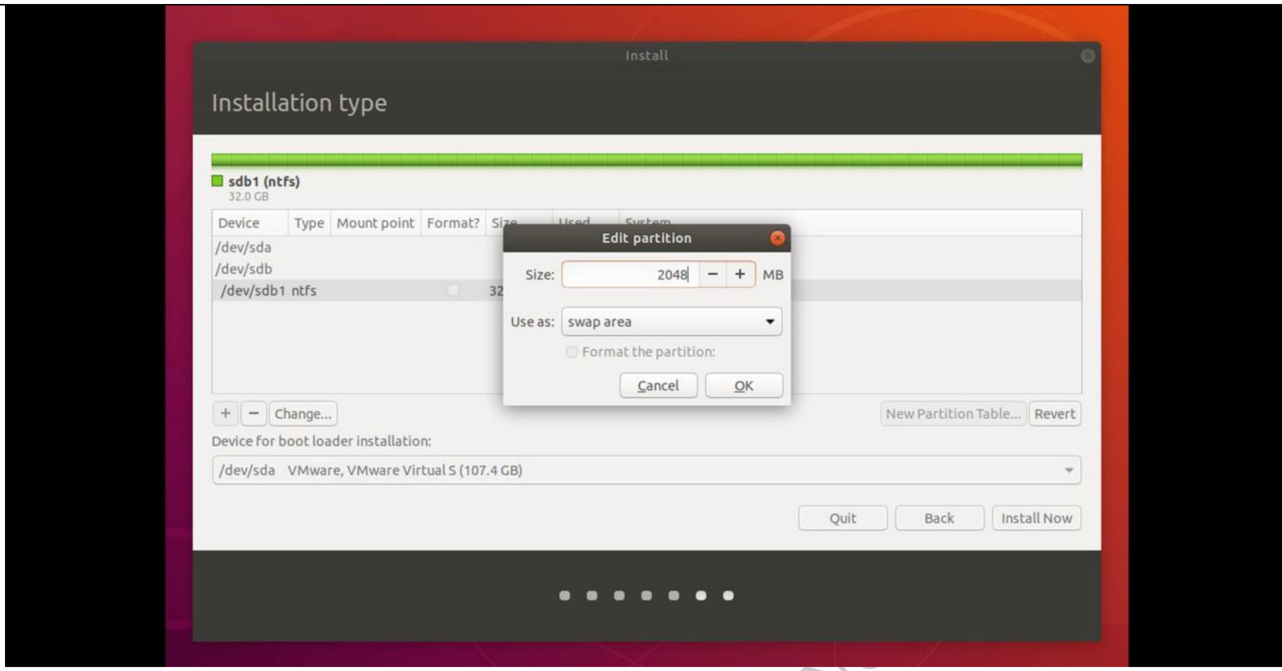


Fig. 4.9 Creating swap partition

When you click on **'OK'**, an alert will be displayed. Then click on **'Continue'** button as shown in figure 4.10, to create the partition name **swap area**.

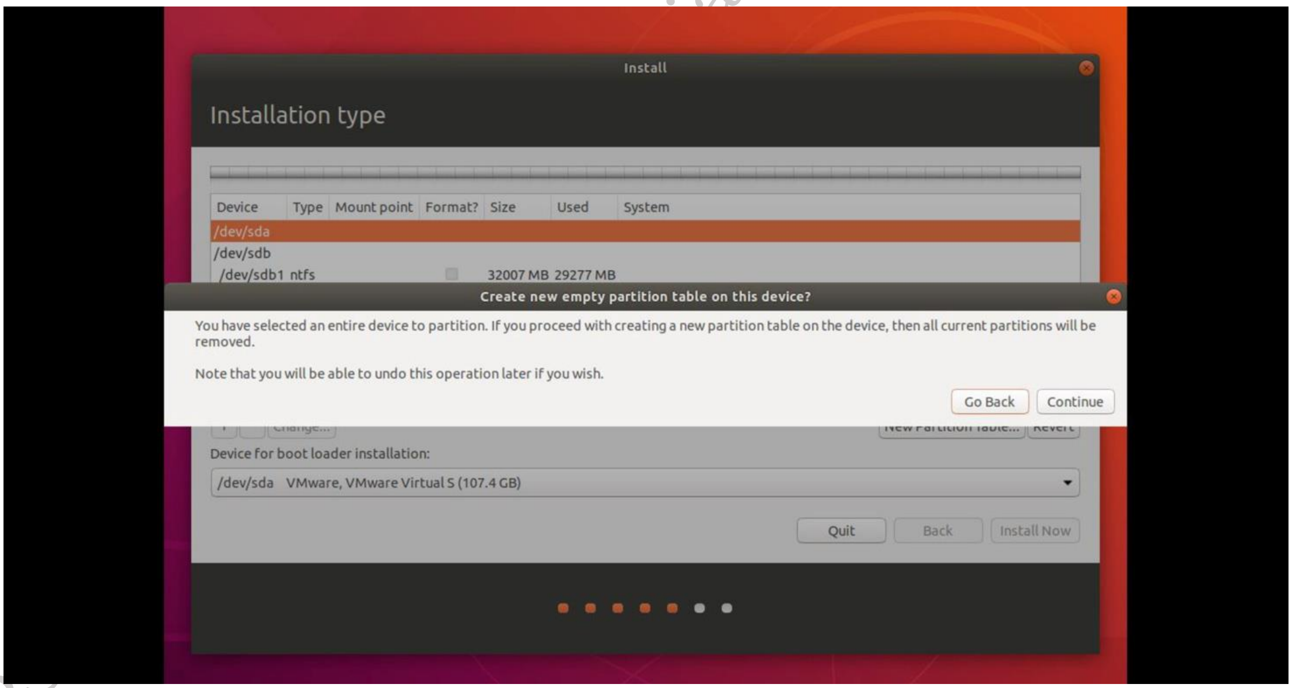


Fig. 4.10 Creating new partition table

A new partition is created with swap area of 2048 MB. Next create **/boot** partition, use **Ext4 journaling file system** as shown in figure 4.11.

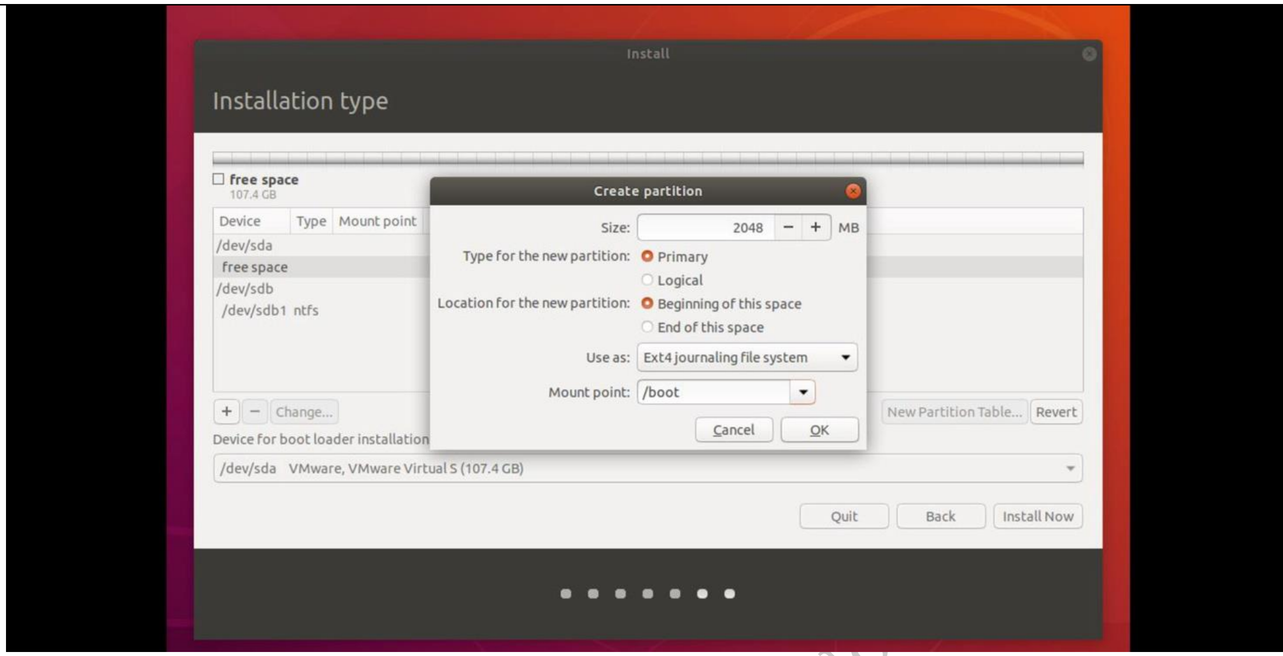


Fig. 4.11 Creating /boot partition

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 4.12.

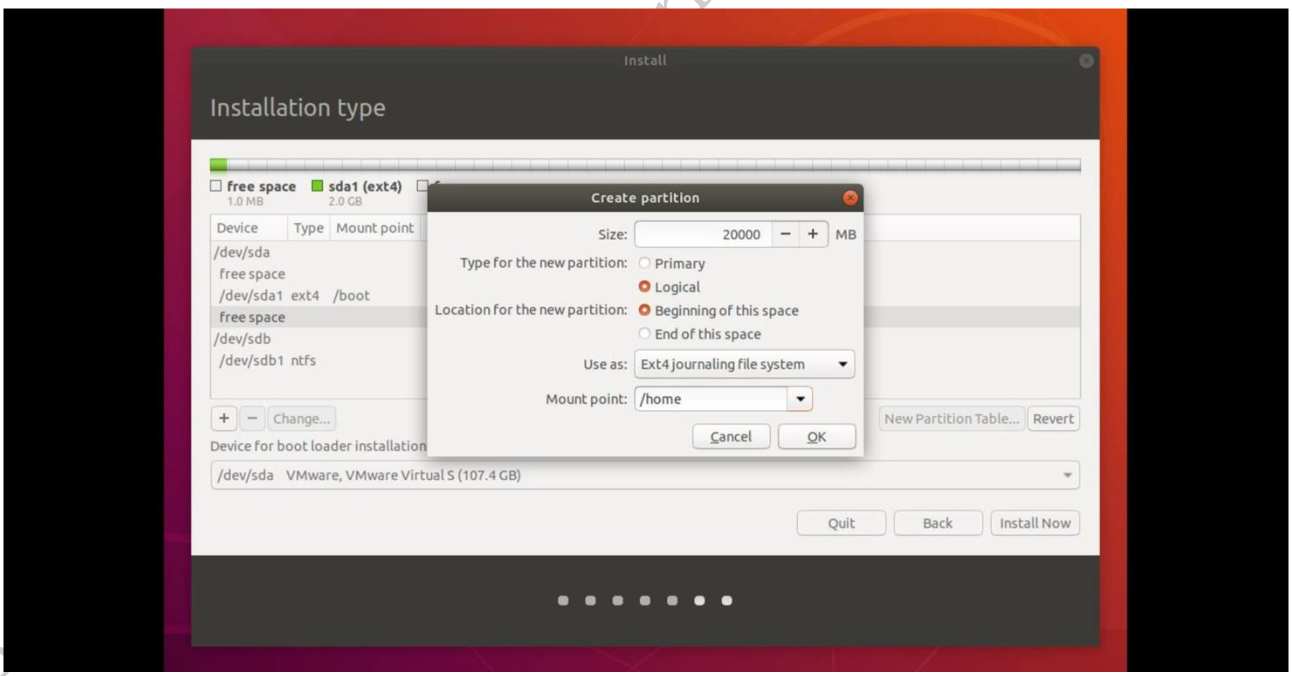


Fig. 4.12 Creating /home partition

Then you will need to create **/** partition, Using Ext4 journaling file system as shown in figure 4.13.

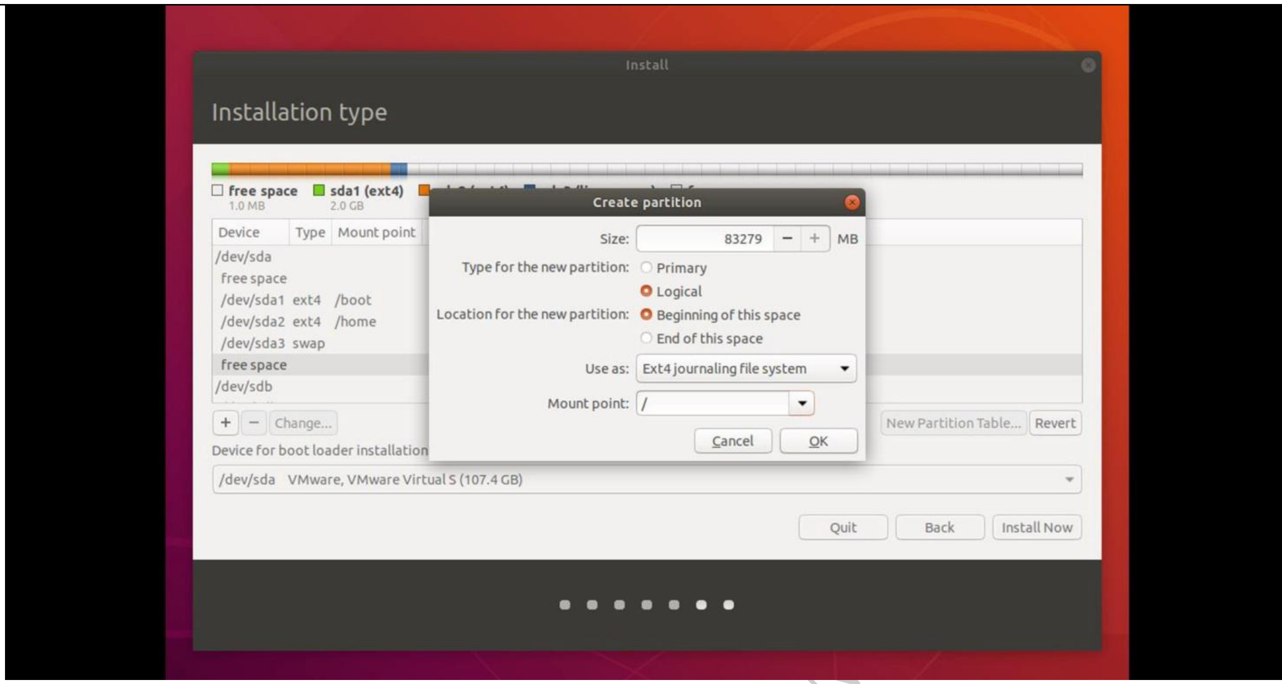


Fig. 4.13: Creating root (/) partition

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 4.14. To begin installation, click on the **'Install Now'** button.

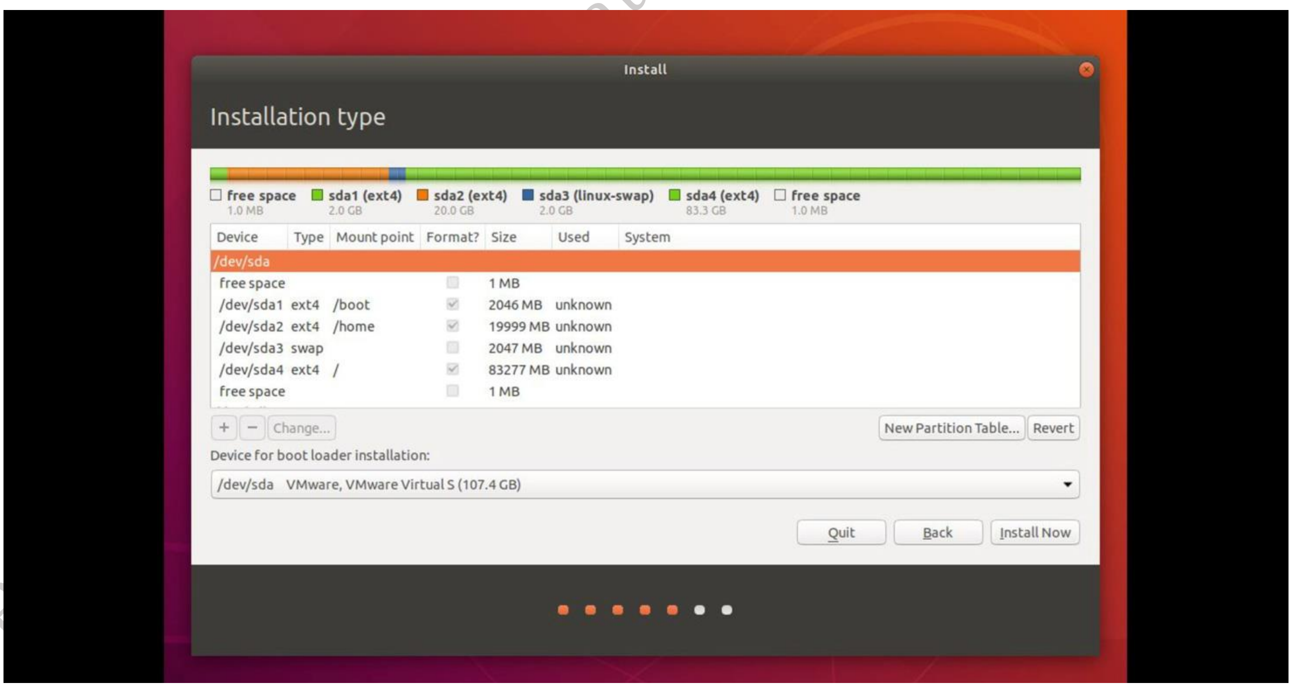


Fig. 4.14: Begin installation

Clicking on **Install Now** button, a small pane will appear with an overview of the storage options you have chosen as shown in figure 4.15. You can have the chance to go back by clicking on the

Go Back button if the details are incorrect.

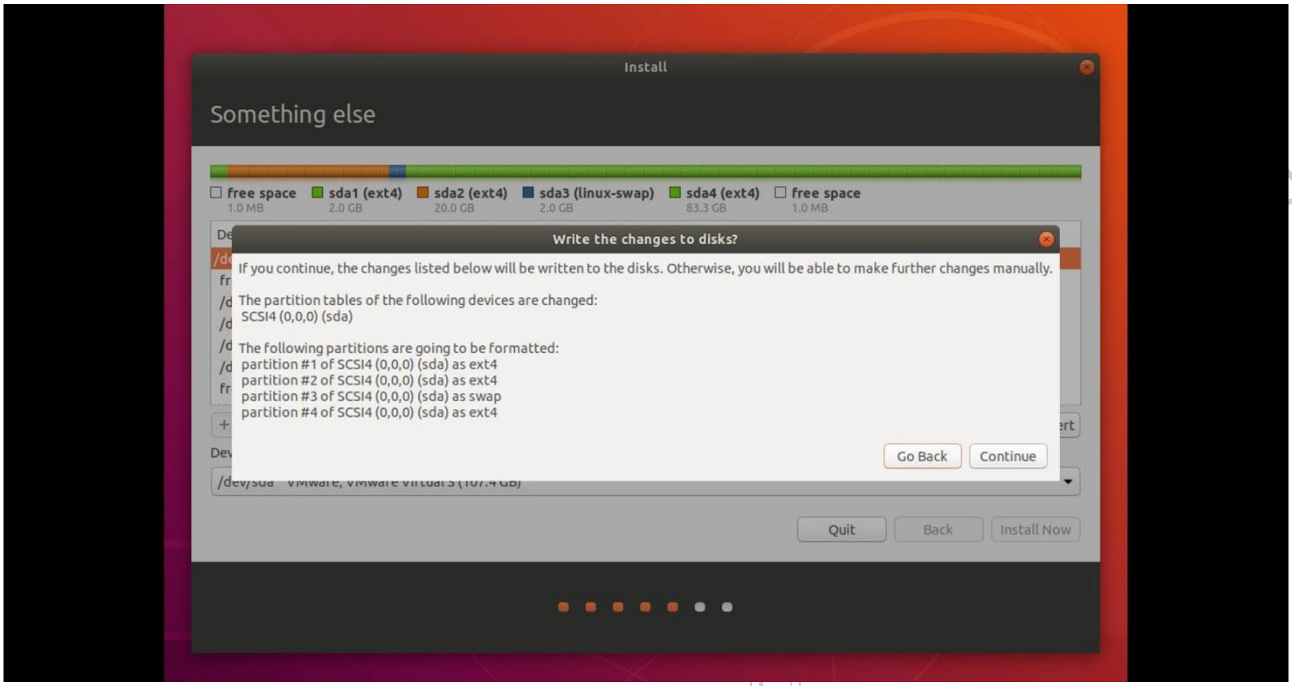


Fig. 4.15 Write changes to disk

Select your location

If you are connected to the internet, your location will be detected automatically. Check your location is correct and clicks '**Forward**' to proceed. If you're unsure of your time zone, type the name of a local town or city or use the map to select your location.

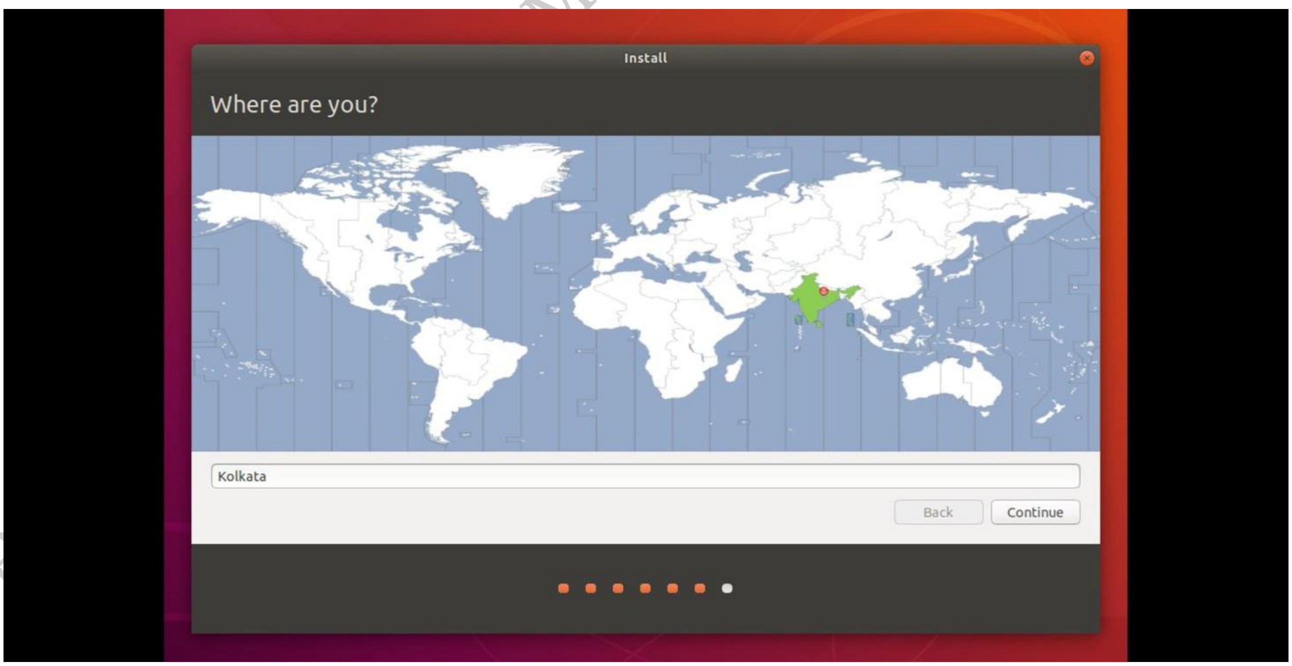


Fig. 4.16 Select your geographical location

Login details (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.

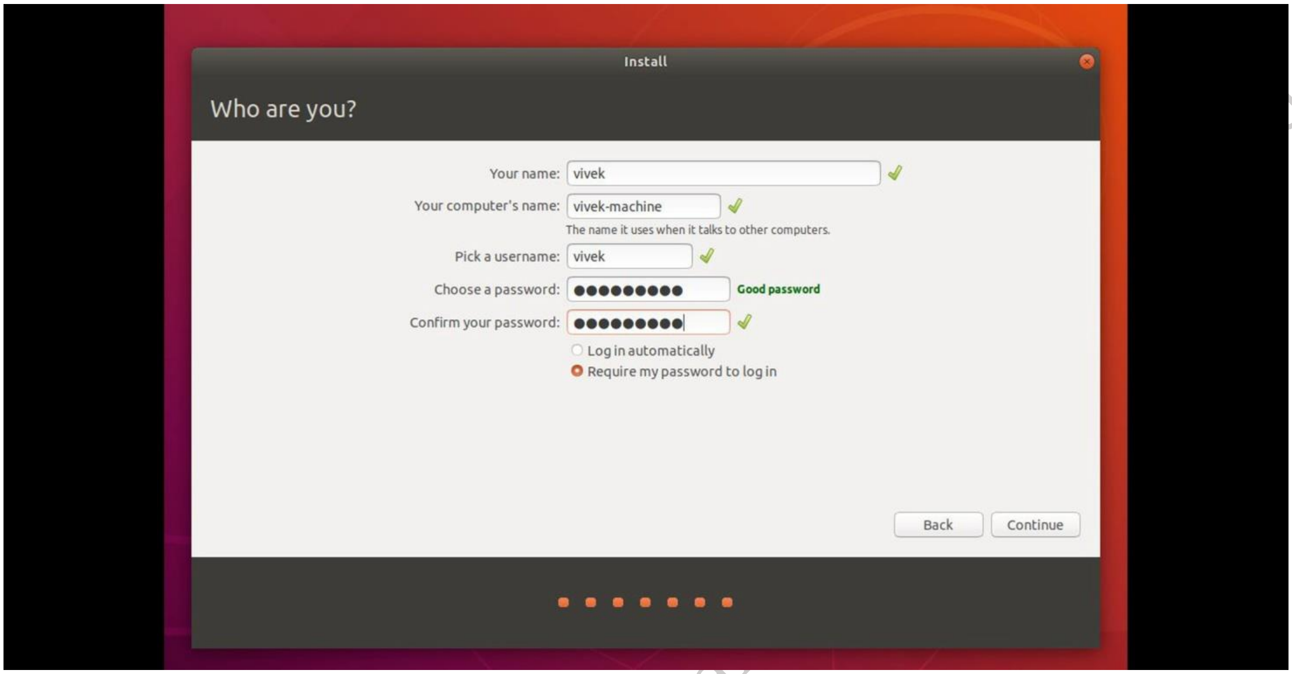


Fig. 4.17 Supplying user credentials © psscive

Next, enter a strong password (figure 4.17). 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, we recommend keeping automatic login disabled and enabling encryption. This should stop people accessing your personal files if the machine is lost or stolen.

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

Background installation

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

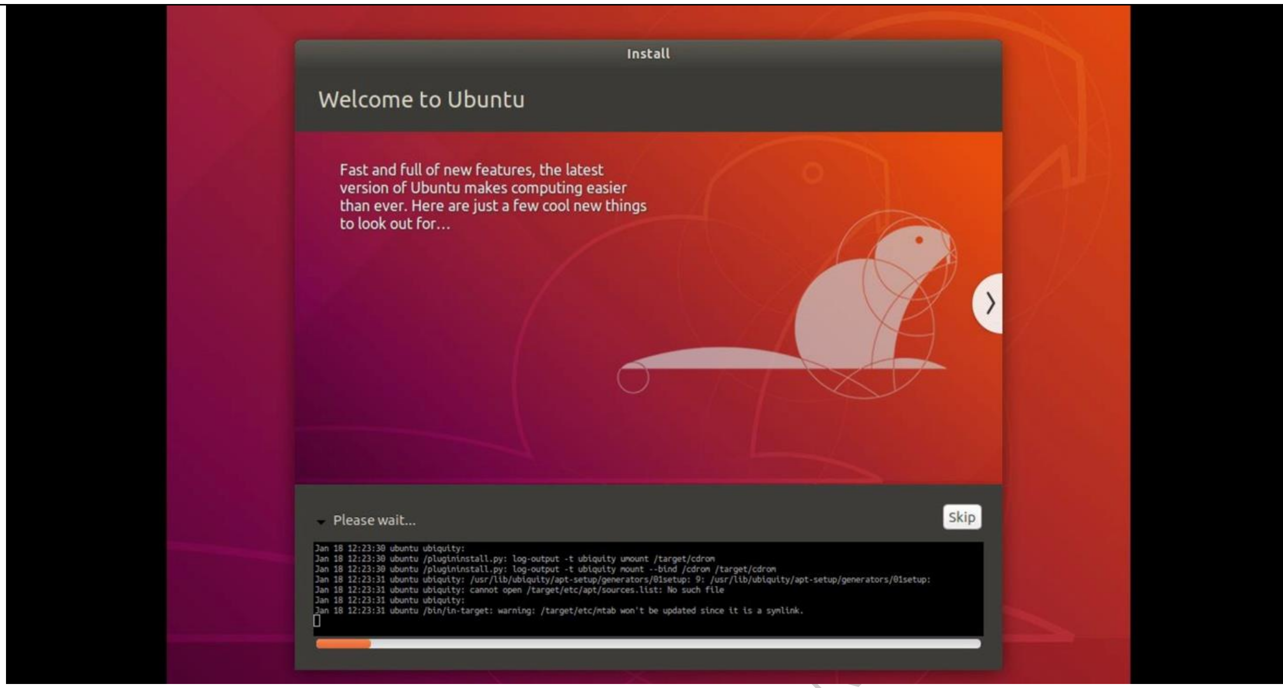


Fig. 4.18 Expanding background installation window

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.

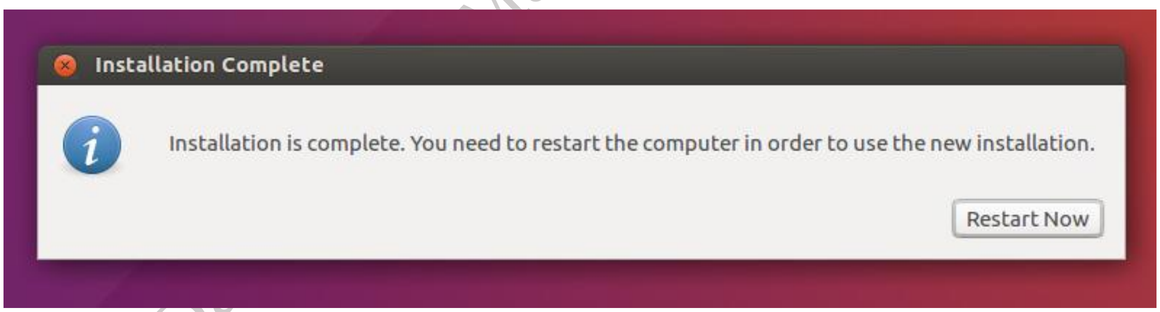


Fig. 4.19: Restart after installation complete

Congratulations! You have successfully installed the world's most popular Linux operating system!

Enter user credentials and hit **Sign In** button.

Fig. 4.20 Login to Ubuntu

It's now time to start enjoying Ubuntu!

Fig. 4.21 Ubuntu home screen

Install Ubuntu in VirtualBox

Installing Ubuntu in VirtualBox is a multistep process. First, VirtualBox will need to be downloaded and installed. Then, the preferred ISO file for the Ubuntu version you'd like to use must also be downloaded. Once you have those two things, you can head into VirtualBox and follow the guided wizard to set up an Ubuntu installation.

Navigate the VirtualBox website and download the latest version of VirtualBox. (Currently, it is 7.0.12. Make sure you click the proper host OS. There are options for Windows, macOS, and Linux.)

Double-click to launch the downloaded file to set up VirtualBox. (Your internet connectivity will briefly be interrupted as part of the setup while the network interfaces are installed.)

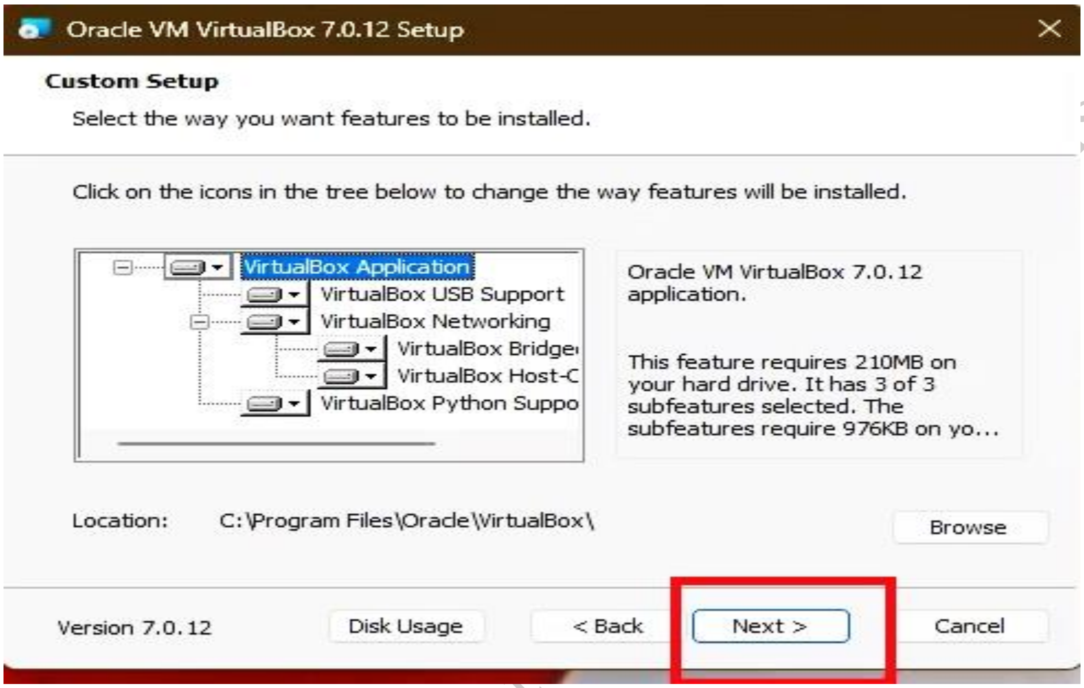


Fig. 4.22

1. Uncheck the box to Start Oracle VM VirtualBox. We won't need the app open right now, as we're going to download Ubuntu first. Click Finish.

Fig. 4.23

2. Navigate to the Ubuntu download webpage. Choose the latest LTS version, which has the most support. (As of writing, it's Ubuntu 24.04 LTS.)

3. Wait for the ISO to download. It could take a while depending on your internet speed.
4. Once the download is complete, launch VirtualBox. At the top of the app, choose New.

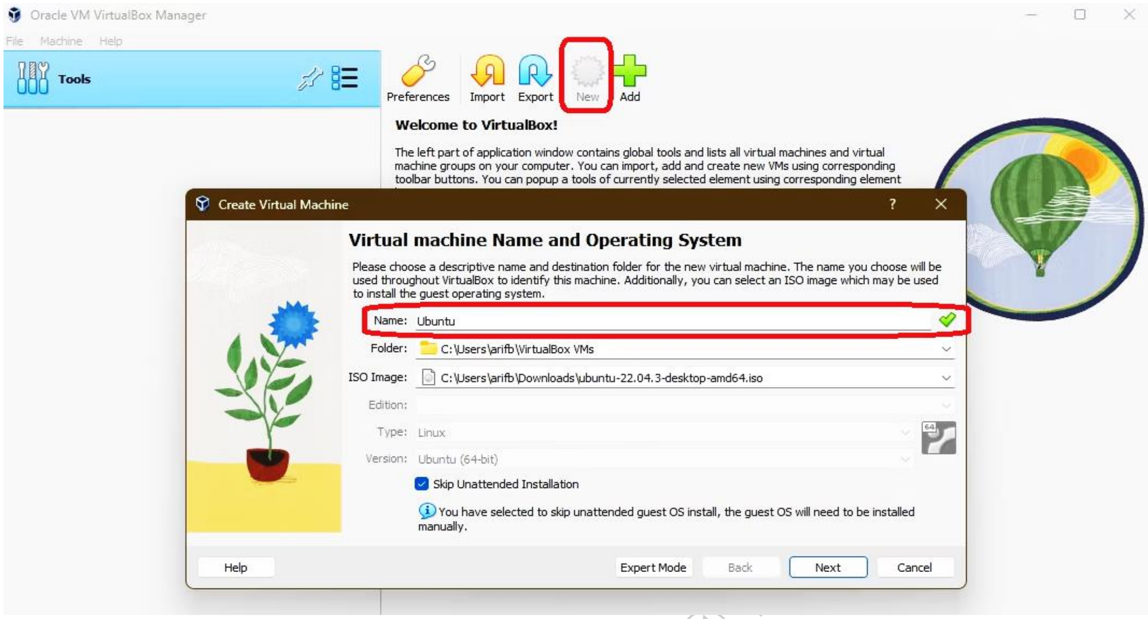


Fig. 4.24

5. Give your Virtual Machine a name. For this example, we're calling it Ubuntu.
6. Under ISO Image click the down arrow and choose Other.
7. Navigate to where Ubuntu's ISO file is saved and click Open.

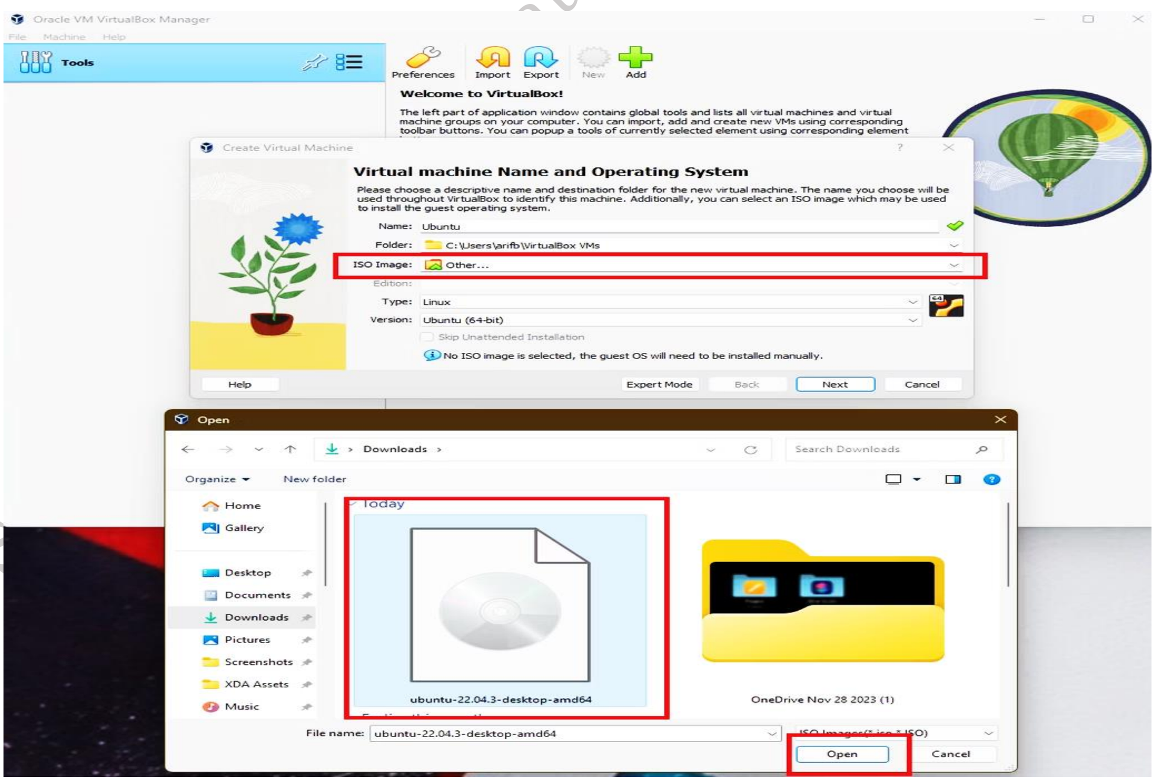


Fig. 4.25

8. Check the box for Skip Unattended Installation, then, Click Next.
9. Adjust the base memory available to Ubuntu. The more the better, since it will run faster. Keep in mind, if your primary system is low on physical RAM, the lower, the better to avoid slowing your main system too much. We suggest leaving it at the suggested amount.

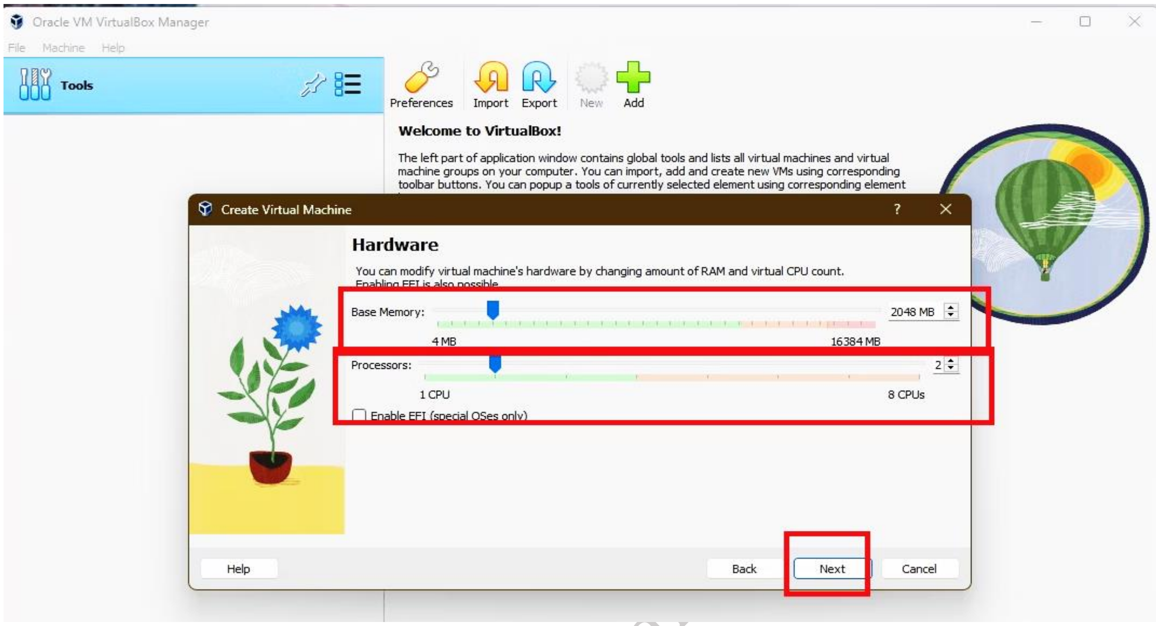


Fig. 4.26

10. Adjust the processors available. We suggest leaving it at the suggested amount.
11. Click Next and choose a size for your virtual hard disk. This is the space Ubuntu will be taking up. Again, the higher, the better. However, if your PC is low on space, the lower, the better. The installer will suggest an amount it thinks is right for your system.

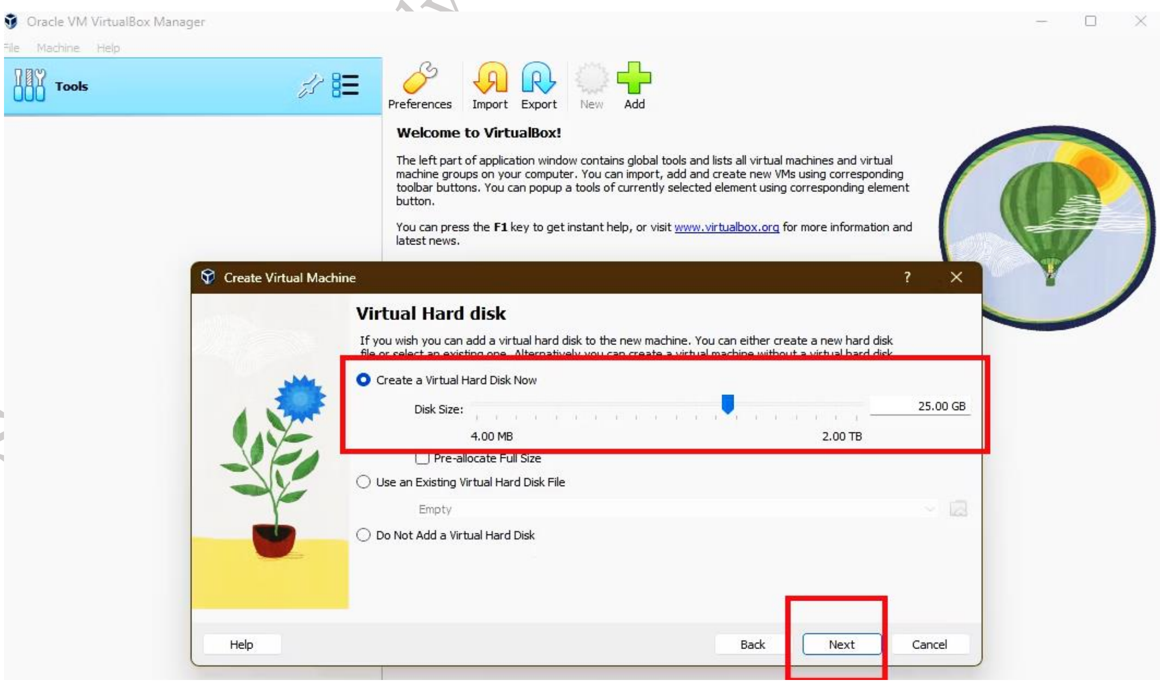


Fig. 4.27

12. Click Finish.
13. Once the virtual machine is added, click the Start button to get it running. To control the virtual machine, your primary keyboard and mouse movements will automatically be captured when you hover into the active VirtualBox window. To return control to your main OS, just click outside the window. If you're noticing issues with your keyboard or mouse, VirtualBox assigned you a Host Key that can be used to swap the keyboard and mouse manually to enter and exit control of the virtual machine. Usually, it is set to the Right Control Key.

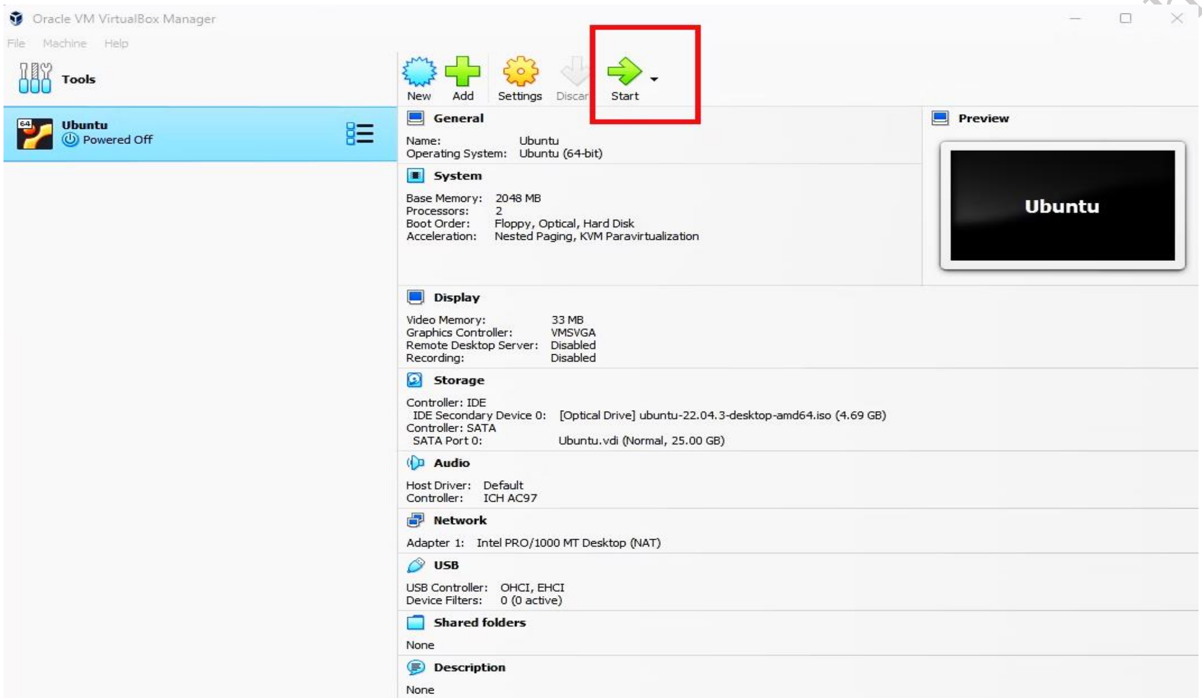


Fig. 4.28

14. Press Enter on the Try or Install Ubuntu option. If the sidebar bothers you, click the Delete notification button on the top left of the window to dismiss it.

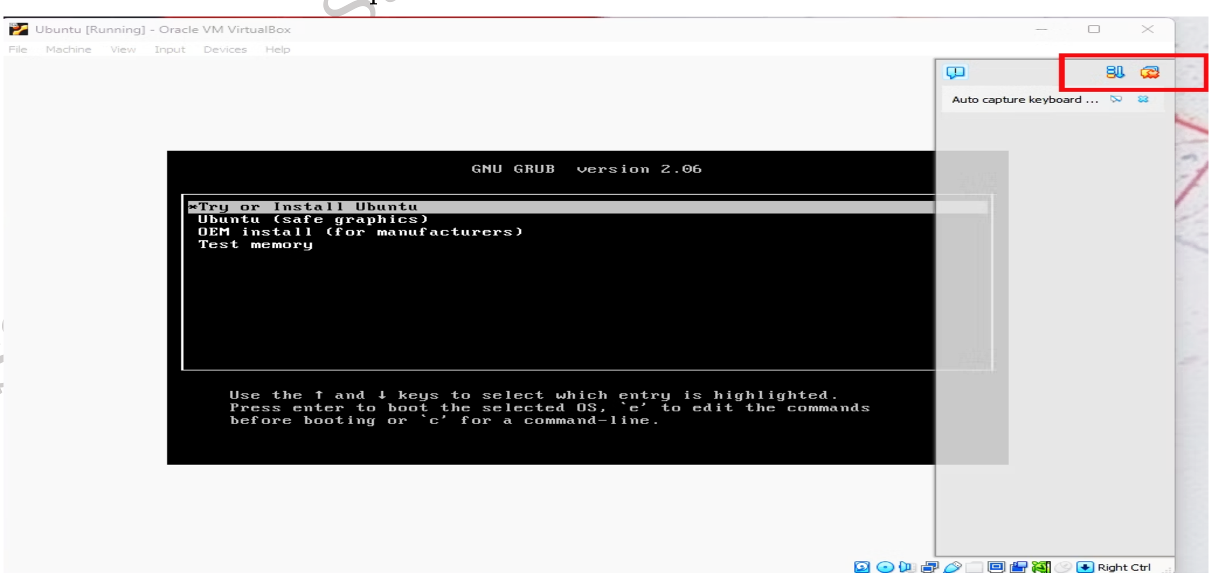


Fig. 4.29

15. Click the Install Ubuntu option and follow the steps on your screen.
16. We suggest choosing Normal Installation choosing to Download updates while installing Ubuntu, and Install third-party software.
17. If prompted, choose Erase disk and install Ubuntu.

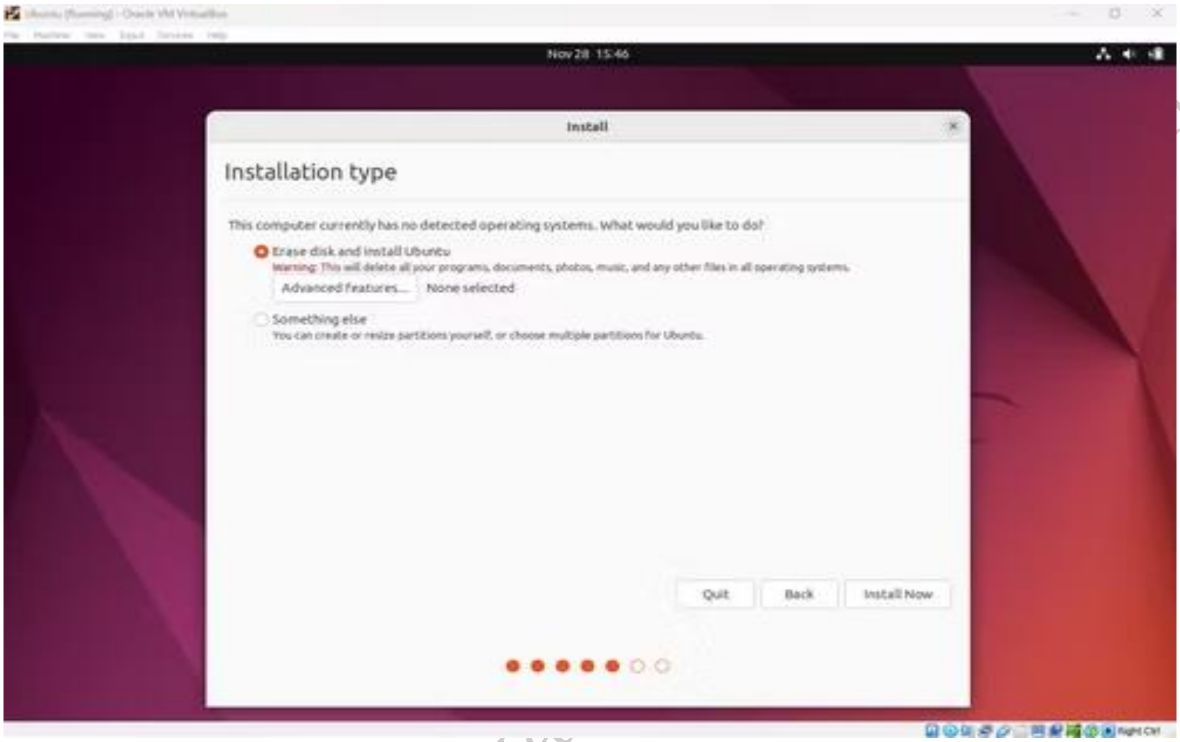


Fig. 4.29

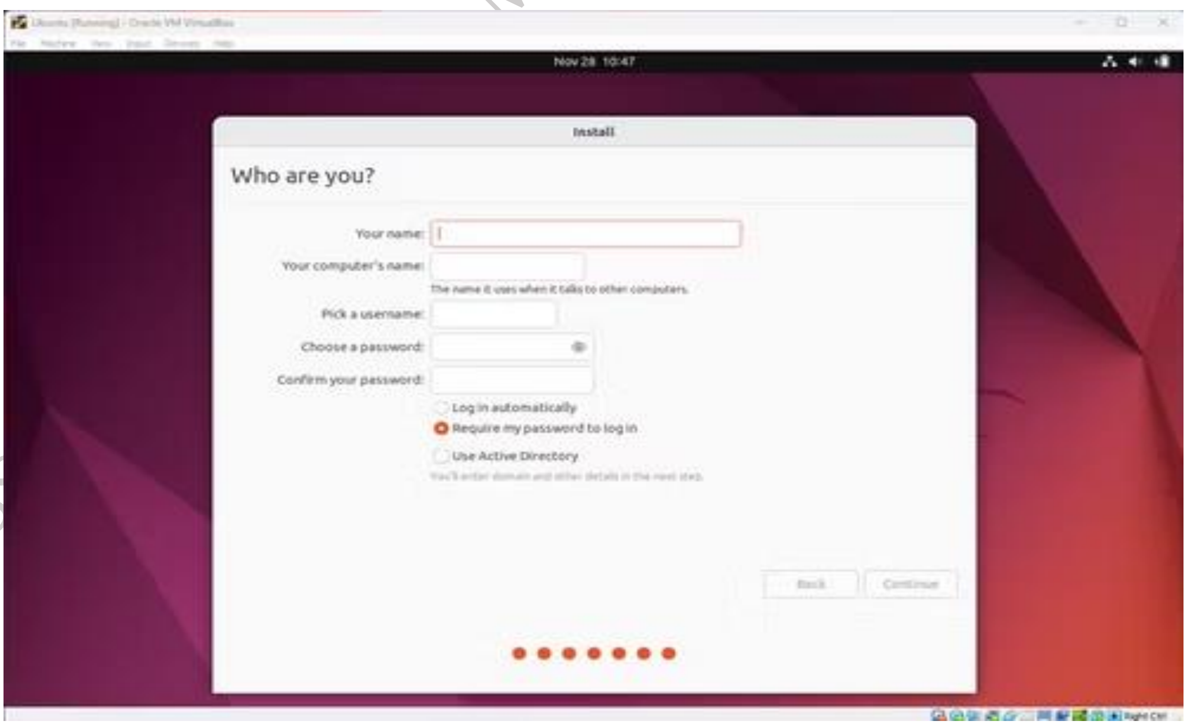


Fig. 4.30

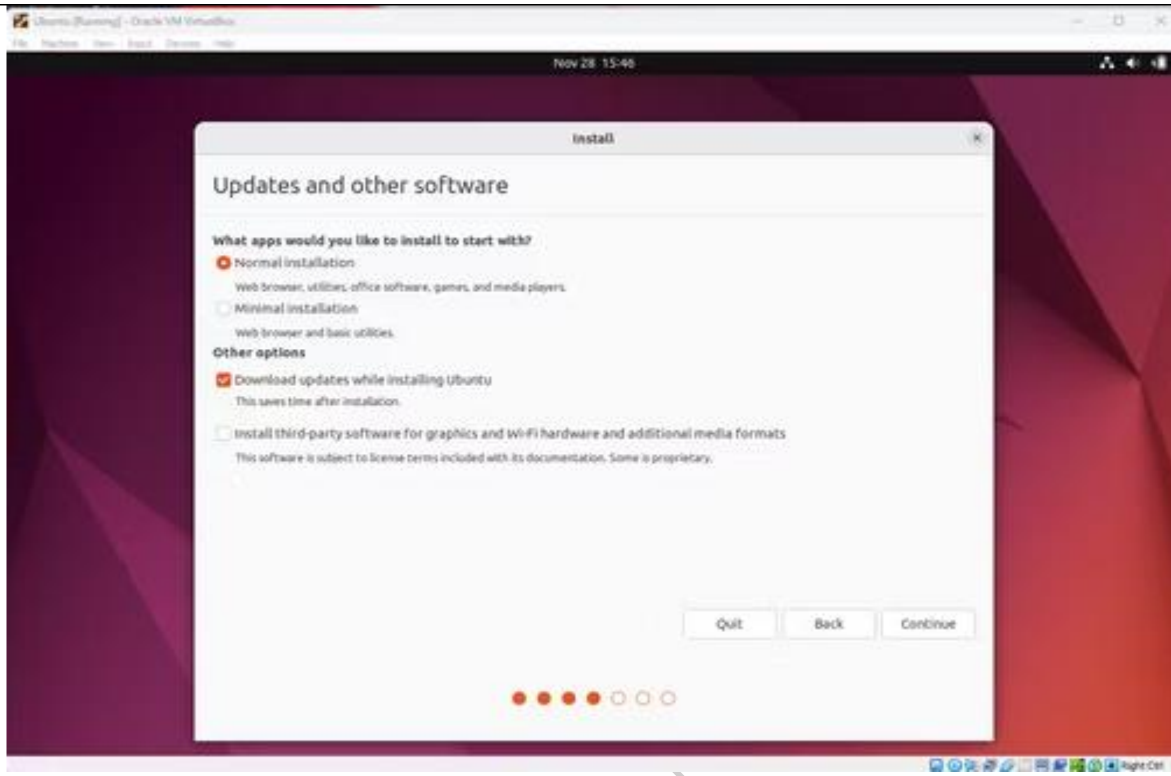


Fig. 4.31

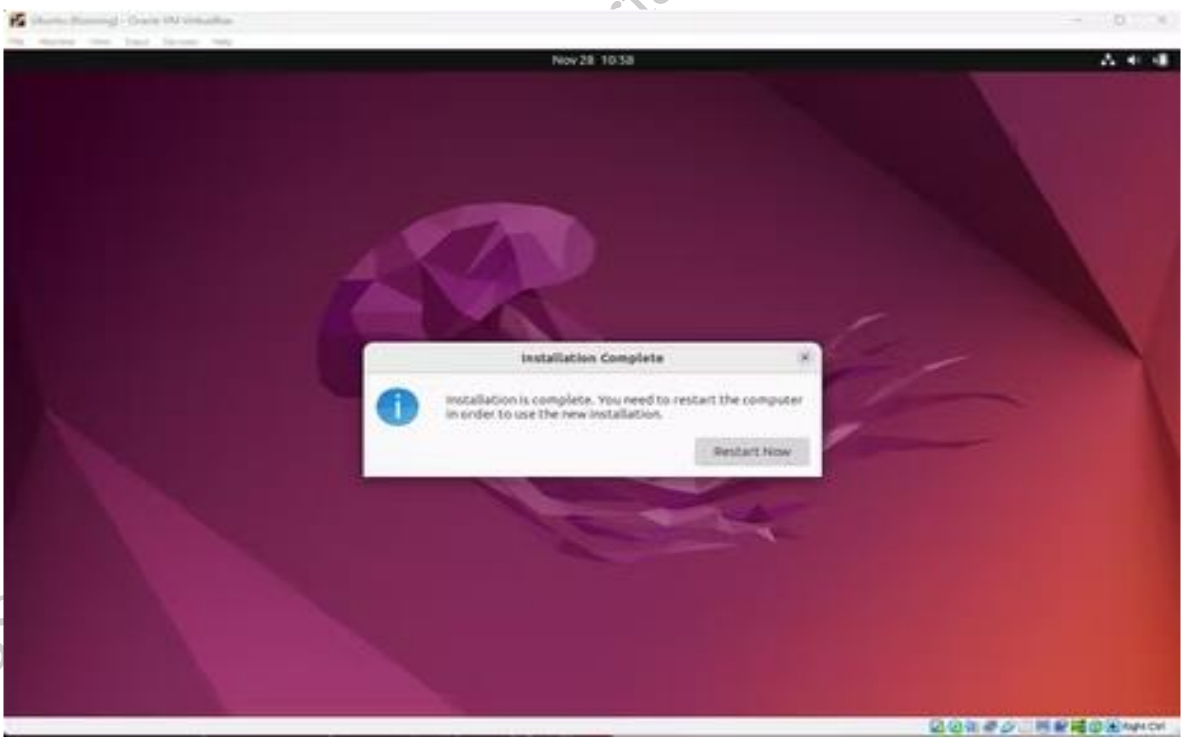


Fig. 4.32

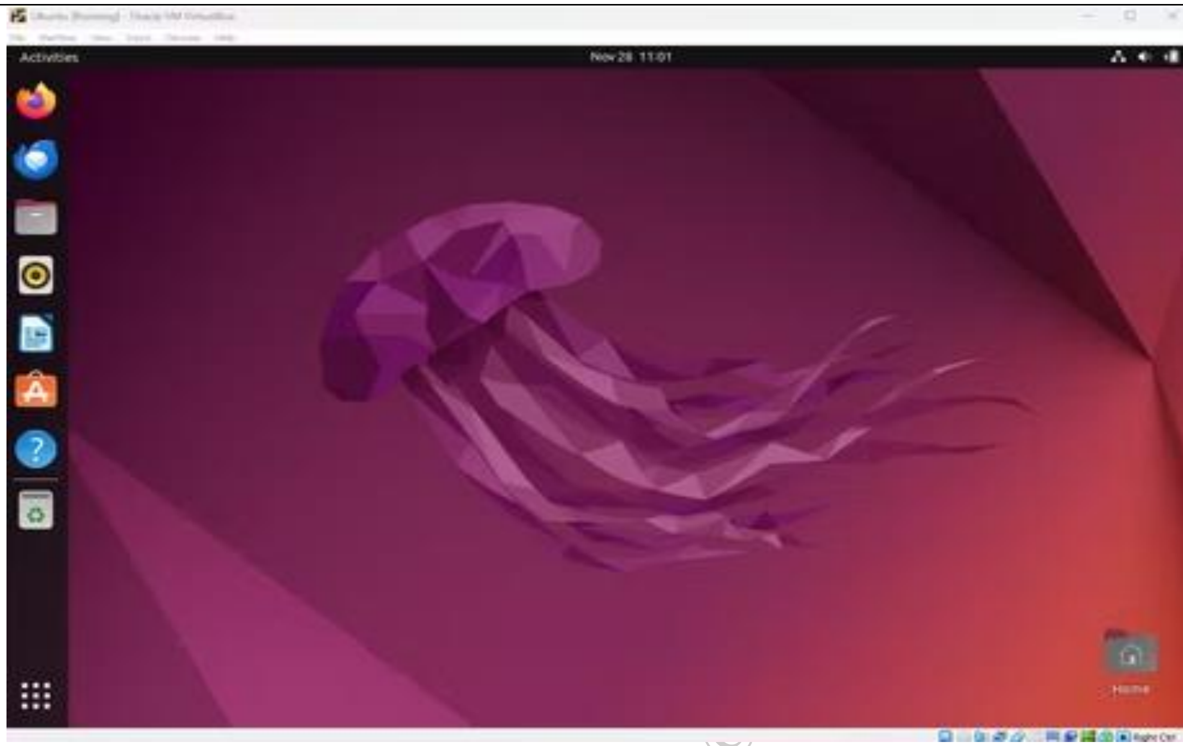


Fig. 4.33

18. You can give your install a name, and password, and continue with setup. You'll be prompted to reboot, and when finished, you'll be taken to your virtual Ubuntu desktop.

Check Your Progress

A. Multiple-choice questions (MCQs)

1. What is Linux primarily known for? (a) A type of software (b) An operating system (c) A programming language (d) A hardware component
2. Which of the following is a common programming language used in Linux development? (a) Python (b) HTML (c) CSS (d) SQL
3. What are the different types of Linux installation? (a) Network and Local (b) Basic and Advanced (c) Minimal and Complete (d) Desktop and Server
4. Which command is typically used to install packages in Ubuntu Linux? (a) install (b) add (c) apt-get (d) update
5. What is VirtualBox primarily used for? (a) Installing antivirus software (b) Running applications natively (c) Virtualization of operating systems (d) Managing files and folders

B. Fill in the Blank

1. The Linux operating system is known for its ________, allowing users to modify and distribute it freely.
2. To install Ubuntu Linux, users typically download the ________ file from the official website.

3. The command used to update package lists in Ubuntu is ________.
4. VirtualBox is a software application used for ________ operating systems on a single physical machine.
5. After the installation of Ubuntu Linux is complete, the user is prompted to ________ the system for the changes to take effect.

C. Ture or False

1. Linux is an open-source operating system, meaning its source code is freely available for anyone to view and modify.
2. The installation of Ubuntu Linux requires a paid license to use the operating system.
3. VirtualBox can be used to run multiple operating systems on a single computer simultaneously.
4. There is only one type of installation method available for Linux distributions.
5. After the installation of Ubuntu Linux, the user must manually configure the system settings before using it.

D. Short Questions

1. What is the primary difference between a desktop and server installation of Linux?
2. Explain the steps involved in performing a clean installation of Ubuntu Linux.
3. What programming languages are commonly used for development in the Linux environment?
4. Describe how to install Ubuntu Linux in VirtualBox and the benefits of using virtualization for this process.
5. What are the different types of Linux installations, and how do they cater to various user needs?

Session 5. Post installation and Configure Peripheral devices in Linux operating system

Post Installation task

Post-installation tasks in Ubuntu (or any Linux distribution) involve various steps to set up your system, customize settings, and ensure its secure and functional for your needs. Here are some common post-installation tasks:

Practical activity 5.1 Post installation tasks in Ubuntu

Step 1. Download and Install Latest Updates. Ubuntu automatically pushes the desktop notifications whenever new updates are available for download, or you can always manually check for available updates by launching Software Updater from the App tray or from the Terminal by using the following command.

$ sudo apt-get update && sudo apt-get upgrade -y

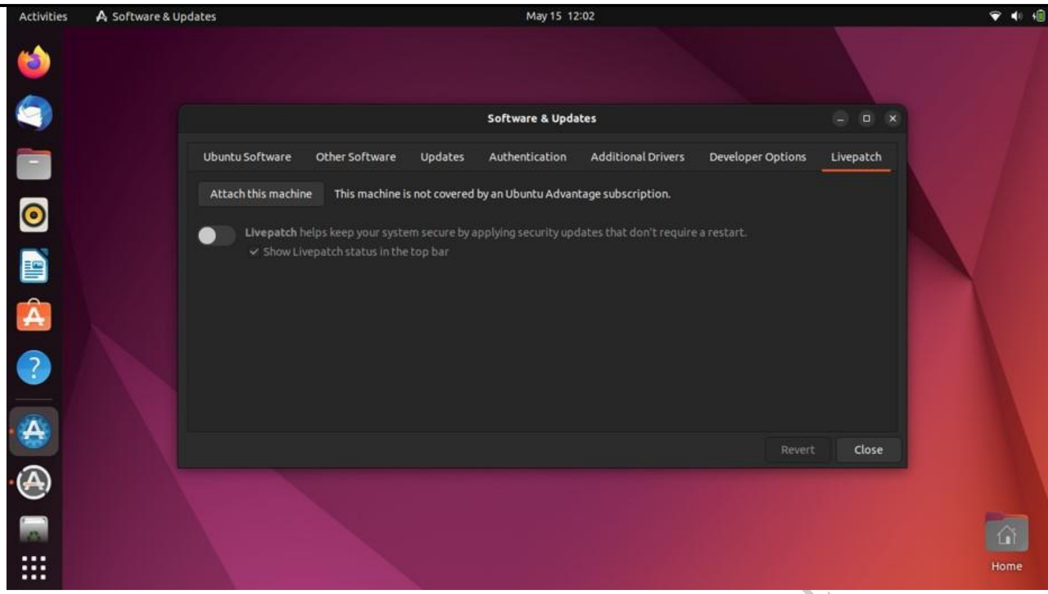


Fig. 5.1

Step 2. Set Up Livepatch. If you already have Ubuntu One account, then just follow this navigation. Open Software & Updates and Just click on the Livepatch tab, which is present at the right end of the window, as you can see in the above screenshot.

Fig. 5.2

Step 3. Install Missing Drivers. Follow this path to download and install additional missing drivers. Software & Updates -> Select Additional Drivers tab -> here; you will find the list of additional drivers which can be installed on the system.

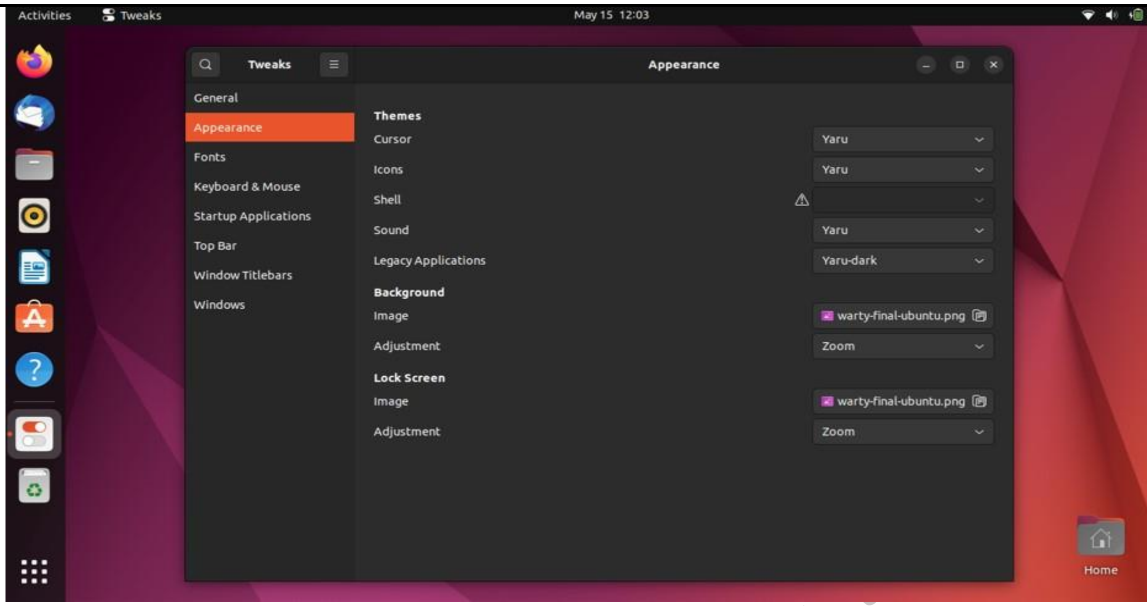


Fig. 5.3

Step 4. Install GNOME Tweak Tool. You can change the overall look and feel of the Ubuntu desktop environment, change default fonts, customize desktop icons, manage extensions and a whole lot of things.

$ sudo add-apt-repository universe

$ sudo apt install gnome-tweak-tool

Step 5. Enable Firewall. Simply follow these steps to enable it on your Ubuntu.

$ sudo ufw enable

To Manage it in GUI :

$ sudo apt-get install gufw

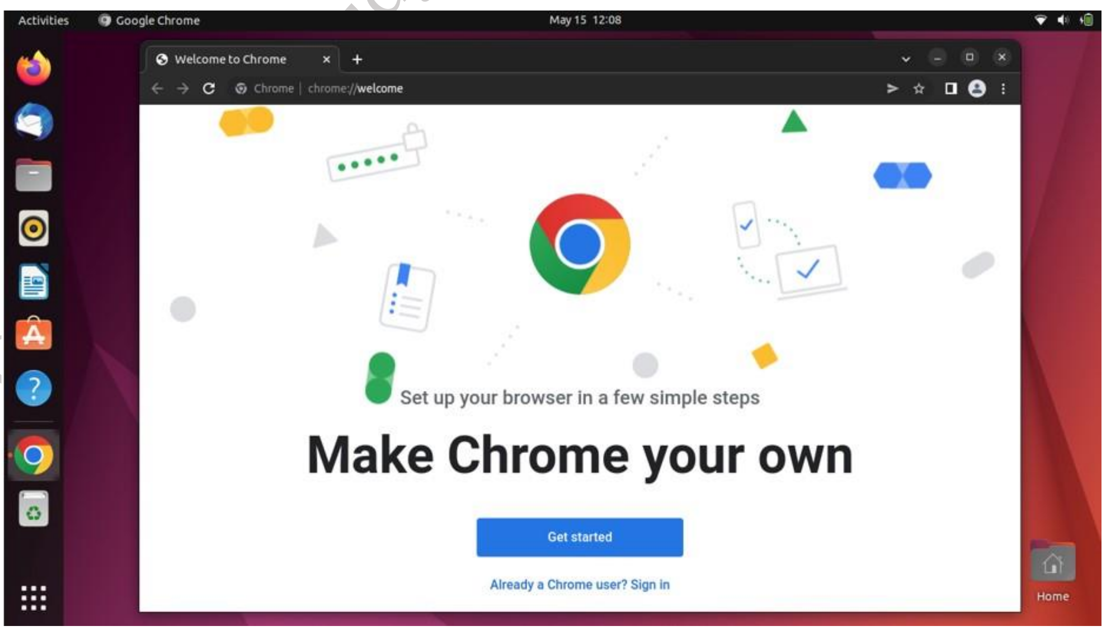


Fig. 5.4

Step 6. Install Your Favorite Web Browser. My favorite browser is Google Chrome; it simple and fast. Just download the .deb file from the following link, and then you are good to go.

https://www.google.com/chrome/

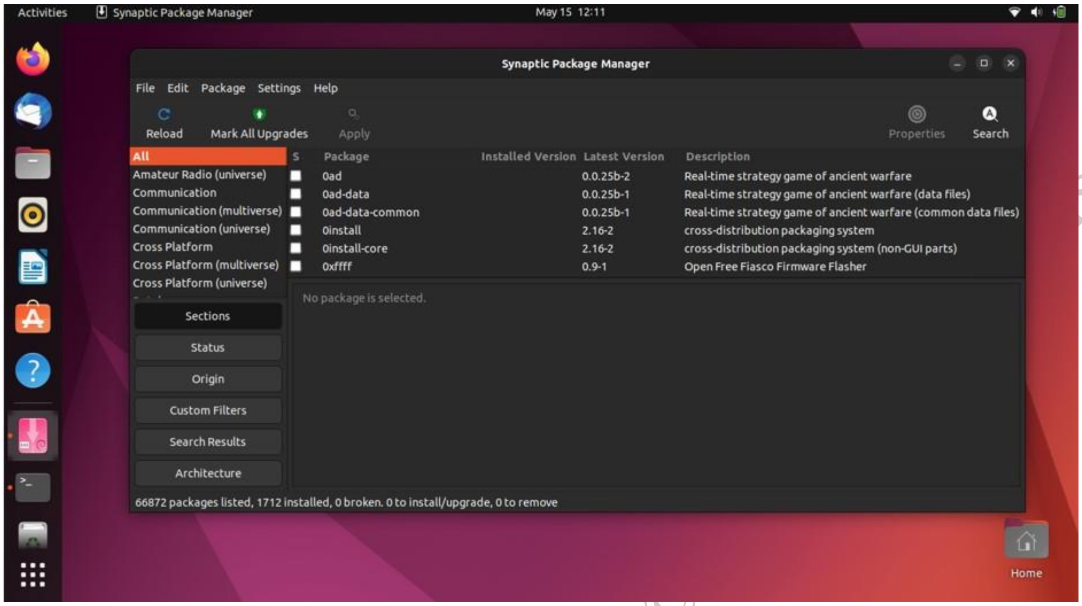


Fig. 5.5

Step 7. Install Synaptic Package Manager. You can download and install Synaptic Package Manager directly from Ubuntu Software Center or run the following command in Terminal.

$ sudo apt-get install synaptic

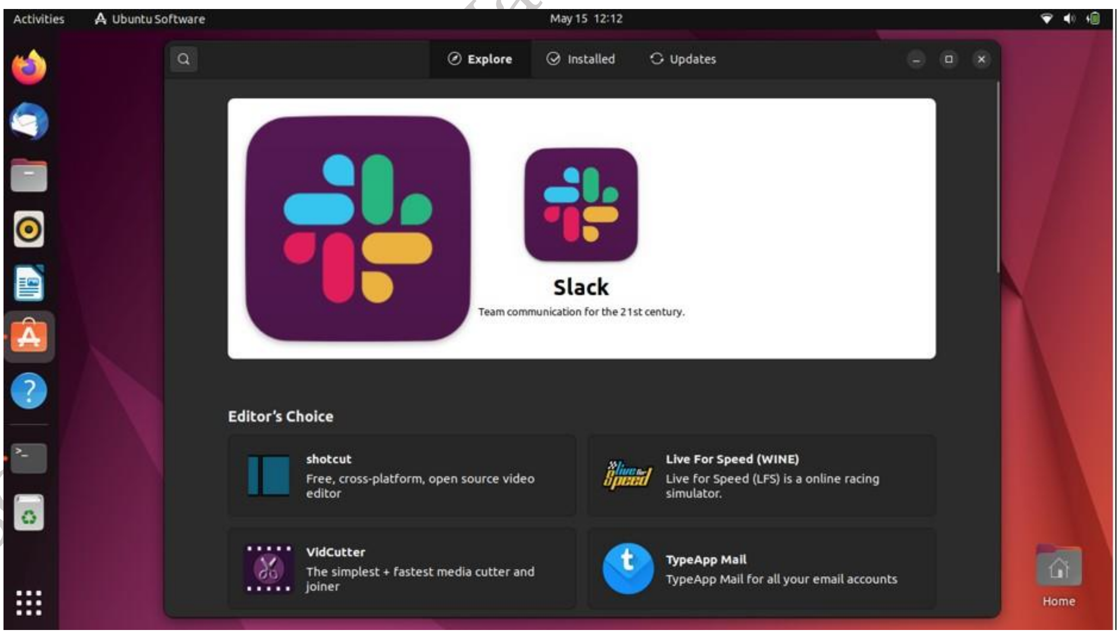


Fig. 5.6

Step 8. Download Applications from Software Center.

Step 5. Install Multimedia Codecs. install Multimedia Codecs directly from Ubuntu Software

Center or run the following command in Terminal.

$ sudo apt-get install Ubuntu-restricted-extras

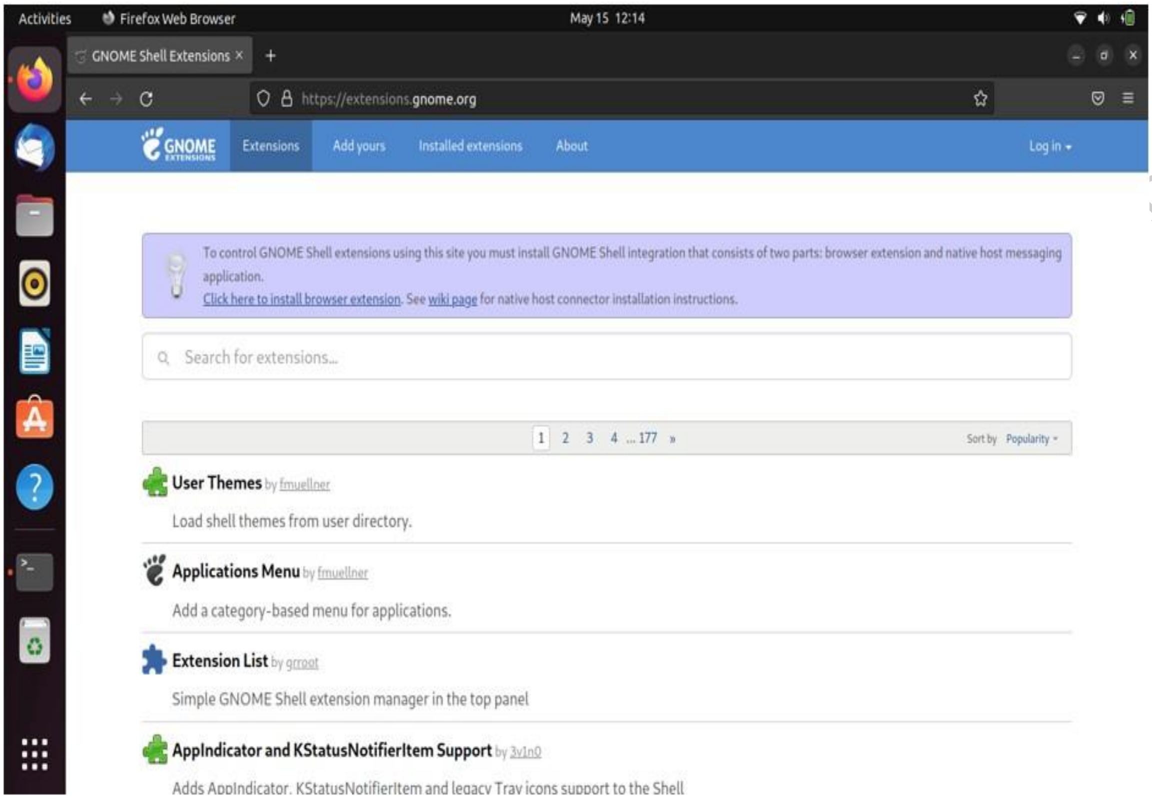


Fig. 5.7

Step 10. Install GNOME Extensions. Just go to https://extensions.gnome.org/ to download and install your preferred extensions.

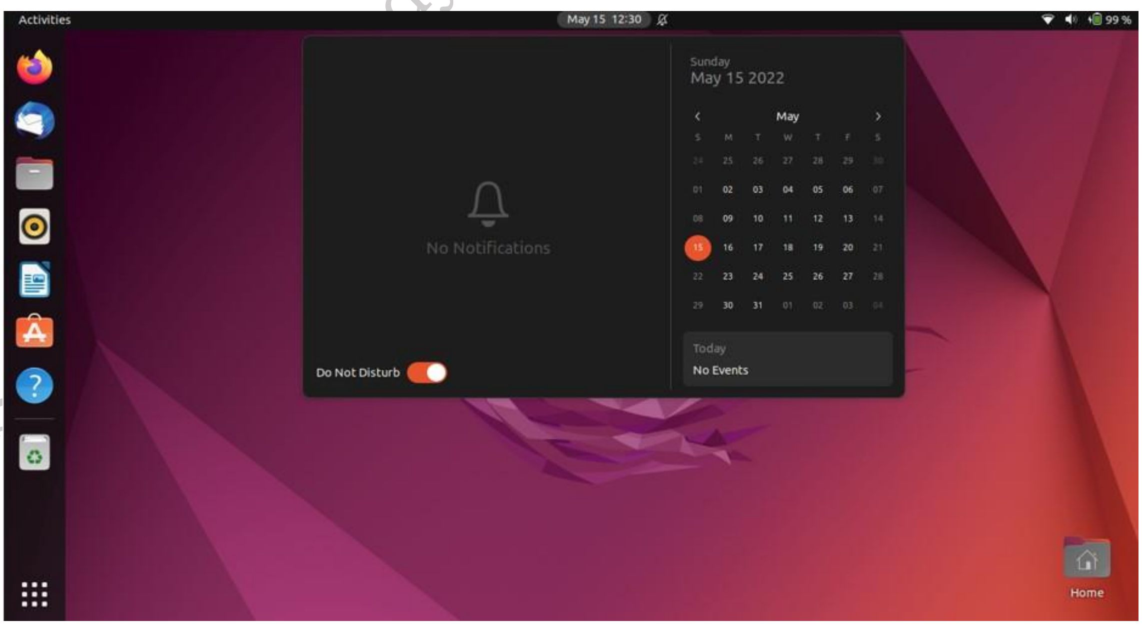


Fig. 5.8

Step 5. Setup Keyboard Shortcuts. Configuring keyboard shortcuts is simple and easy; just follow the path Settings -> Devices -> Keyboard, where you can set your personal preferences from the list of keyboard shortcuts.

Step 12. Improve Battery Performance. Just install TLP, which is a power management tool that works in the background to reduce battery usage.

sudo apt-get install tlp tlp-rdw

$ sudo systemct1 enable tlp

Step 13. Install WINE.WINE (Wine Is Not an Emulator) is not the perfect but easy and reliable tool to use Windows applications on Ubuntu. You can install WINE through Terminal using the following command.

$ sudo apt-get install wine64

Step 14. Must Know Commands for System Cleanup.

To clean partial packages:

$ sudo apt-get autoclean

To remove unused dependencies:

$ sudo apt-get autoremove

To auto cleanup apt-cache :

$ sudo apt-get clean

Static IP configuration:

Configuring a static IP address in Ubuntu involves modifying network configuration files. Here's a step-by-step guide:

Practical activity 5.2 static in address configuration on ubuntu desktop operating system:

Step 1. Click the network icon in the upper-right corner. Then expand the Wired Connected dropdown. Now, click on Wired Setting as shown below image.

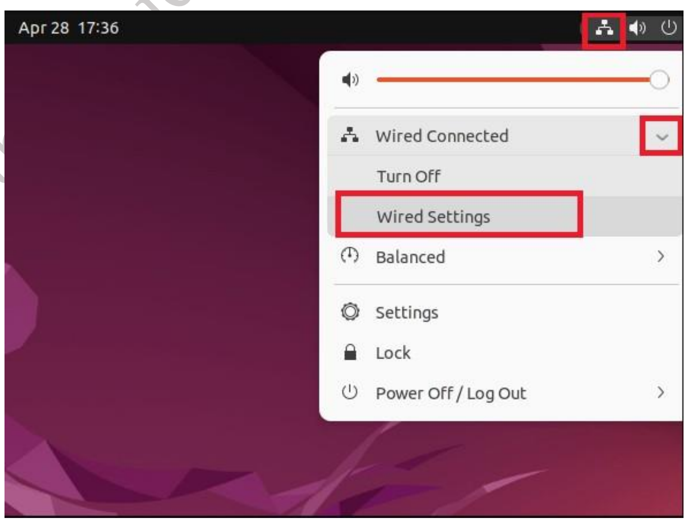


Fig. 5.9

Step 2. A network settings dialog box will appear. Now, click "Network" in left sidebar. Under the Wired section, click the Gear icon as showing in below image.

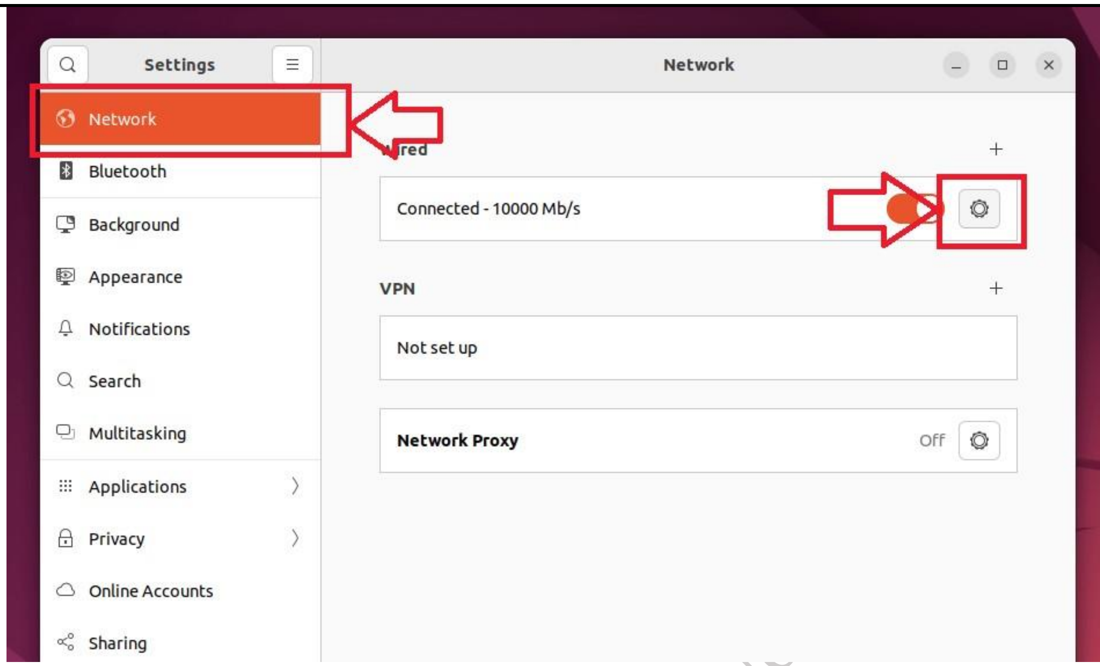


Fig. 5.10

Step 3. A new Wired dialog box will appear. Now, click on "IPv4" tab. Set IPv4 Method to Manual Input a valid IP address, Net mark and Gateway address. Set the DNS server (optional). Click Apply button to save changes.

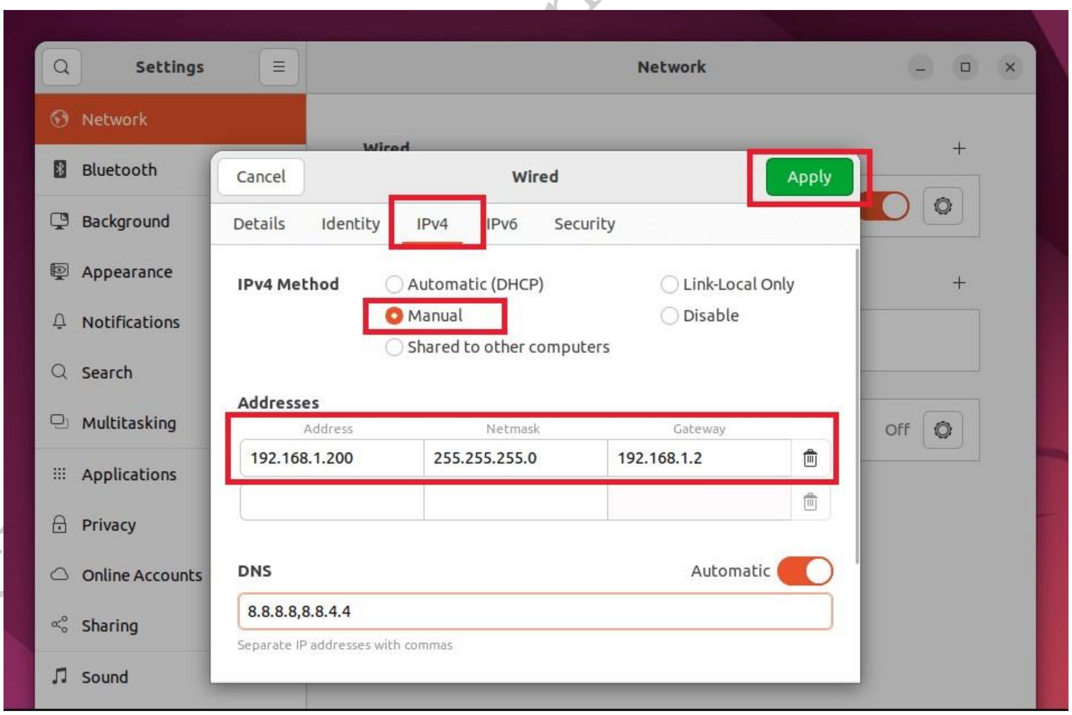


Fig. 5.11

Step 4. Finally disable and then again enable networking to apply changes.

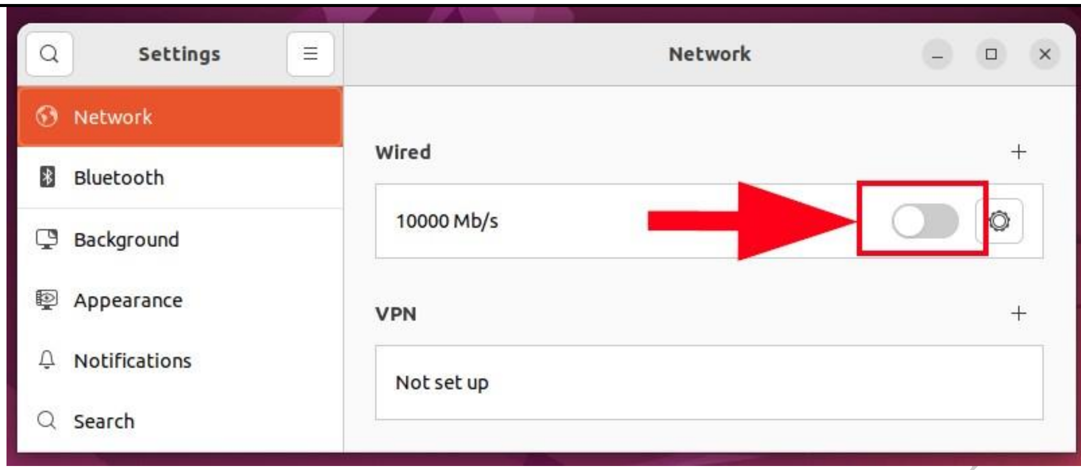


Fig. 5.12

Step 5. All done. Ubuntu Desktop system IP address is now changed.

Installation of Printer & Scanner Canon Printer Driver:

Step 1. Download Canon Software from the Canon Website. The most preferred method but you can find the software for your printer on Canon's website. Download the required Debian driver package for your printer and install it.

https://www.canon.co.uk/support/

Step 2. Install Canon Printer Driver Via PPA.

Run the following command to add the PPA

$ sudo add-apt-repository ppa:michael-gruz/canon

$ sudo apt-get update

Step 3. If the above PPA doesn't work for you, you can always go for the next PPA.

$ sudo add-apt-repository ppa:thierry-f/fork-michael-gruz

After installing PPA, open your browser and run the following address. http://localhost:631/

Step 4. Add Canon Printer via GUI in Ubuntu 22.04 LTS.Go to the settings menu first and find the "Printers" menu. Now plug in your printer and click on the search printer button on the "Printers" window. You will find the model of your printer and start adding it to your Ubuntu

Step 5. Install Canon Driver Via Synaptic Package Manager on Ubuntu 22.04 LTS.

Run the following aptitude command lines on your terminal shell to install the printer driver.

sudo apt install scangearmp2

sudo apt install cnijfilter2

Step 6. If you don't have the Synaptic package manager installed on your Ubuntu 22.04 LTS, run the following command on your terminal to install it.

sudo apt-get install synaptic

Step 7. Install Canon Printer Driver Via Foomatic DB

In this method, you can install the Canon printer driver via foomatic DB. First, run the following command line to install the Foomatic DB.

$ sudo apt-get install cups cups-client "foomatic-db*"

Or you can run the following alternative command given below to install foomatic db

$ sudo apt-get install -y foomatic-db

Now, you can try using your Canon printer on Ubuntu 22.04 LTS.

Basic Linux Commands:

List of Beginner Ubuntu Commands

mv: Short for move, this command can be used to move your files from one folder to another.

rm: Short for remove, this command is used to remove any files or folders.

cd: Short for change, you can use this command to change your current directory.

cp: Short for copy, this command can be used to copy files or folders in a directory.

chown: This command is used to change ownership of a file.

chmod: This command is used to change permissions on a file.

ls: Short for list, this command can be used to view all of the files and folders in your current working directory.

pwd: Short for print working directory, this command can be used to display the directory in which you are currently working.

sudo: Also referred to as superuser do, a sudo command allows you to run other commands with administrative privileges. This command is especially useful for modifying files in a directory that a user wouldn't necessarily have access to.

cd: Short for change directory, this command can be used to change the directory in which you are currently working. There are a variety of cd commands that can be used to take you to specific files or folders.

cd /: An alternate to a basic cd command, the cd / command can be used to take you to the root directory.

cd ...: This command can be used to take you up one directory level.

cd -: This command can be used to navigate to a previous directory.

Commands used for System Information

date

The simple "date" command displays the current date and time (including the day of the week, month, time, time zone, year).

Syntax: date

Example:

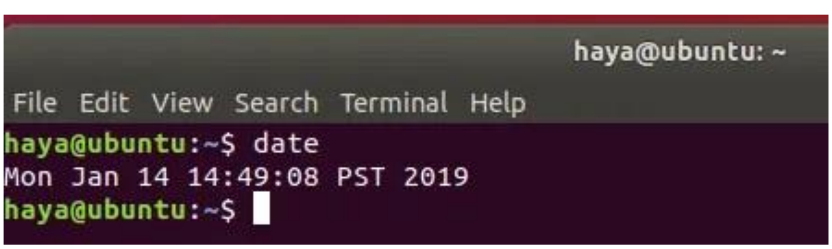


Fig. 5.13

a. TZ

By default, “date” command uses the time zone defined in path “/etc/localtime”. Linux user can change the time zone via Terminal by using command “TZ”.

Syntax: TZ=Name_of_Time_Zone date

Example:

TZ=GMT date

TZ=KSA date

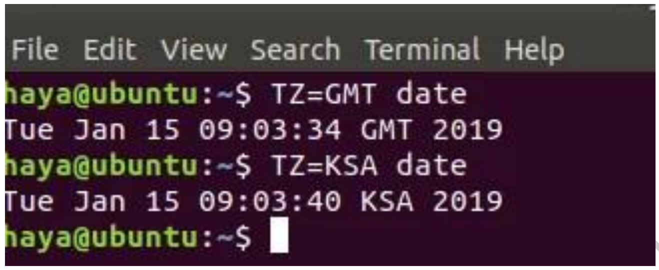


Fig. 5.14

b. –set

Linux allows its user to set the current date and time of the system manually. Syntax: date –set=”Date_in_format(YYMMDD) Time_in_format(HH:MM)”

Example:

Fig. 5.15

c. -d

To operate the system on a specific date, you can change the date by using “-d”. Syntax: date -d Date_to_operate_system_on

Example:

date -d now

date -d yesterday

date -d tomorrow

date -d last-Sunday

date -d “1997-04-22”

```
haya@ubuntu: ~
File  Edit  View  Search  Terminal  Help
haya@ubuntu:~$ date -d now
Tue Jan 15 01:05:40 PST 2019
haya@ubuntu:~$ date -d yesterday
Mon Jan 14 01:05:43 PST 2019
haya@ubuntu:~$ date -d tomorrow
Wed Jan 16 01:05:45 PST 2019
haya@ubuntu:~$ date -d last-sunday
Sun Jan 13 00:00:00 PST 2019
haya@ubuntu:~$ date -d "1997-04-22"
Tue Apr 22 00:00:00 PDT 1997
haya@ubuntu:~$
```

Fig. 5.16

df

The command "df" shows the amount of disk space used and disk space available on every file system containing each filesystem's name and its path.

Syntax: df

Example:

```
haya@ubuntu: ~
File  Edit  View  Search  Terminal  Help
haya@ubuntu:~$ df
Filesystem     1K-blocks    Used Available Use% Mounted on
udev             4042616       0   4042616   0% /dev
tmpfs             814448    2056    812392   1% /run
/dev/sda1       31862608 6315736  23905300  21% /
tmpfs            4072224       0   4072224   0% /dev/shm
tmpfs               5120       4      5116   1% /run/lock
tmpfs            4072224       0   4072224   0% /sys/fs/cgroup
/dev/loop0         89088   89088         0 100% /snap/core/4917
/dev/loop2         35584   35584         0 100% /snap/gtk-common-themes/319
/dev/loop1         14848   14848         0 100% /snap/gnome-logs/37
/dev/loop4        144384  144384         0 100% /snap/gnome-3-26-1604/70
/dev/loop3          3840    3840         0 100% /snap/gnome-system-monitor/51
/dev/loop5         58496   58496         0 100% /snap/powershell/14
/dev/loop6          2432    2432         0 100% /snap/gnome-calculator/180
/dev/loop7         13312   13312         0 100% /snap/gnome-characters/103
tmpfs             814444      16    814428   1% /run/user/121
tmpfs             814444      40    814404   1% /run/user/1000
haya@ubuntu:~$
```

Fig. 5.17

a. df -h

The command "df -h" shows the same result as the command "df" but now the data is in a more human-readable form which can be easily comprehended by a new user.

Syntax: df -h

Example:

```
haya@ubuntu:~$ df -h
Filesystem      Size  Used Avail Use% Mounted on
udev            3.9G     0  3.9G   0% /dev
tmpfs           796M  2.1M  794M   1% /run
/dev/sda1        31G  6.1G   23G  21% /
tmpfs           3.9G     0  3.9G   0% /dev/shm
tmpfs           5.0M  4.0K  5.0M   1% /run/lock
tmpfs           3.9G     0  3.9G   0% /sys/fs/cgroup
/dev/loop0       87M   87M     0 100% /snap/core/4917
/dev/loop2       35M   35M     0 100% /snap/gtk-common-themes/319
/dev/loop1       15M   15M     0 100% /snap/gnome-logs/37
/dev/loop4      141M  141M     0 100% /snap/gnome-3-26-1604/70
/dev/loop3      3.8M  3.8M     0 100% /snap/gnome-system-monitor/51
/dev/loop5       58M   58M     0 100% /snap/powershell/14
/dev/loop6      2.4M  2.4M     0 100% /snap/gnome-calculator/180
/dev/loop7       13M   13M     0 100% /snap/gnome-characters/103
tmpfs           796M   16K  796M   1% /run/user/121
tmpfs           796M   40K  796M   1% /run/user/1000
```

Fig. 5.18

free

The command "free" displays the amount of free and used memory in the complete system. Syntax: free

Example:

```
haya@ubuntu: ~
File  Edit  View  Search  Terminal  Help
haya@ubuntu:~$ free
              total        used        free      shared  buff/cache   available
Mem:        8144452     1461076     5809724       17828      873652     6403092
Swap:       1508584           0     1508584
haya@ubuntu:~$
```

Fig. 5.19

free

Ps

The command "ps" which is also known as process status command is used to provide information about the processes currently running on the system, including their respective process identification numbers (PIDs).

Syntax: ps

Example:

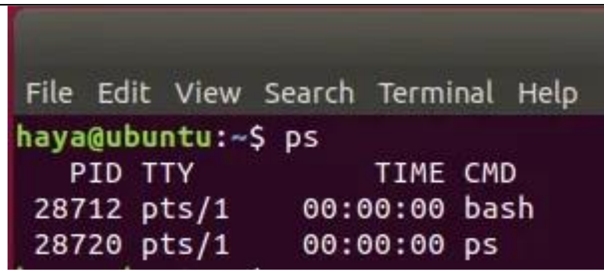


Fig. 5.20

uptime

The command "uptime" provides information about how long the system has been running in one line. Result for this command includes the current time, the time duration system has been running for, the number of users who are currently logged on, and the system load averages for the past 1, 5, and 15 minutes respectively.

Syntax: uptime

Example:

Fig. 5.21

w

The command "w" displays the detailed information about the users who are logged in the system currently.

Syntax: w

Example:

Fig. 5.22

passwd

The command "passwd" stands for password and it is used to change the password of the user.

Syntax: passwd user_name

Example:

passwd my_user

```
haya@ubuntu:~$ passwd haya
Changing password for haya.
(current) UNIX password:
Enter new UNIX password:
Retype new UNIX password:
passwd: password updated successfully
haya@ubuntu:~$
```

Fig. 5.23

exit

The command "exit" as the name says it is used to exit from the system and log out from the current user.

Syntax: exit

Example:

```
haya@ubuntu: ~/Desktop
File Edit View Search Terminal Help
haya@ubuntu:~/Desktop$ exit
logout
There are stopped jobs.
```

Fig. 5.24

shutdown

The command "shutdown" is used to shut down the system.

Syntax: shutdown

Example:

```
haya@ubuntu:~/Desktop$ shutdown
Shutdown scheduled for Tue 2019-01-15 22:43:52 PST, use 'shutdown -c' to cancel.
```

Fig. 5.25

Commands used for File Handling

mkdir

The command "mkdir" allows users to create directories/folders in the system. The user running this command must have suitable rights over the parent directory to create a directory or they will receive an error.

Syntax: mkdir New_Directory's_Name

Example: mkdir NewDirectory

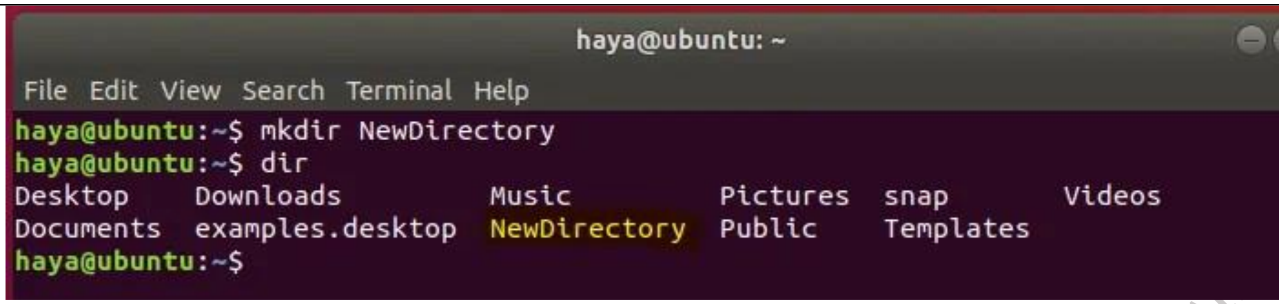


Fig. 5.26

Entering the command "mkdir NewDirectory" will create the directory named as NewDirectory in the current directory.

rmdir

The command "rmdir" allows users to remove directories/folders from the system. The user running this command must have suitable rights over the parent directory to remove a directory or they will receive an error.

Syntax: rmdir Directory's_Name

Example: rmdir NewDirectory

Fig. 5.27

Entering the command "rmdir NewDirectory" will remove the directory named as NewDirectory in the current directory.

rm

The command "rm" is used to remove files from the directory.

Syntax: rm file's_name

Example: rm Test_File

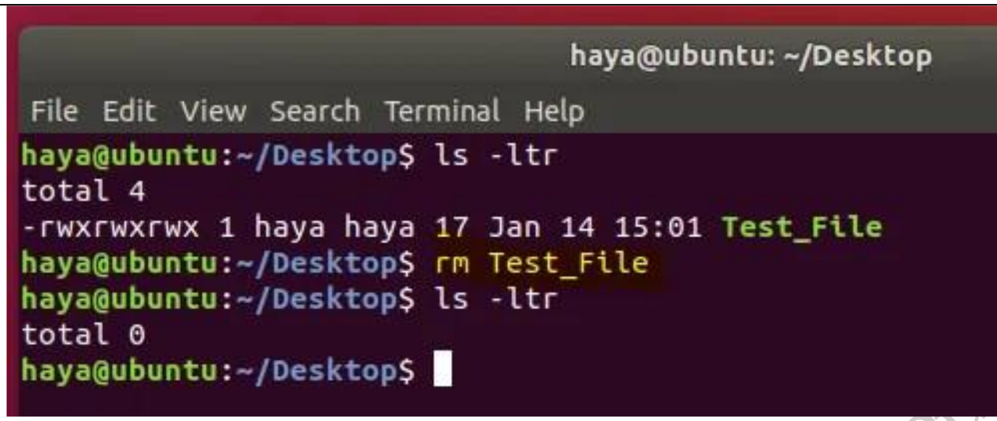


Fig. 5.28

This above-mentioned command will remove the file "Test_File" from the Desktop directory.

mv

The command "mv" is used for two purposes

- To move files or directories from one path to another path in the system.
- To rename a file or folder.

a. "mv" to Move Files

Syntax: mv Source_File_name Destination_File_Name

Example: Consider having two files in a directory (File1 and File2). Entering the command "mv File1 File2" will move data of File1 to File2 and delete source file(i.e. File1) from the system.

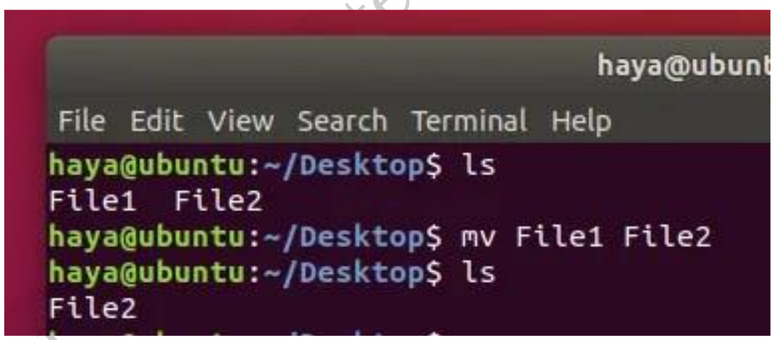


Fig. 5.29

b. "mv" to Rename Files

Syntax: mv File_name New_name_for_file

Example: Consider having two files in a directory (File1 and File2). Entering the command "mv File1 File_Rename" will rename File1 to File_Rename in the same directory.

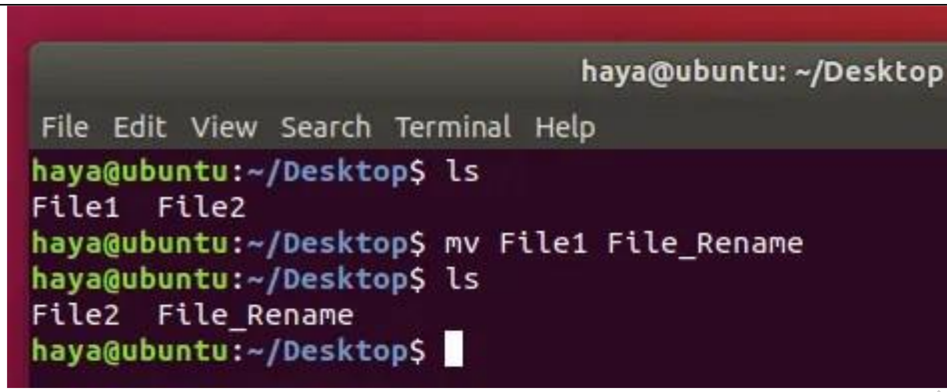


Fig. 5.30

cp

The command “cp” is used to copy data from a source file to the destination file. Its function is almost like the command “mv”. The only difference is by using the command “cp” the source file is not removed from the directory after its data is moved to the destination file.

Syntax: cp source_file_name destination_file_name

Example: cp A B

Consider having two files (A and B) in Desktop Directory. Entering the command “cp A B” will copy all the data from file A to file B and user can still access both files (A and B).

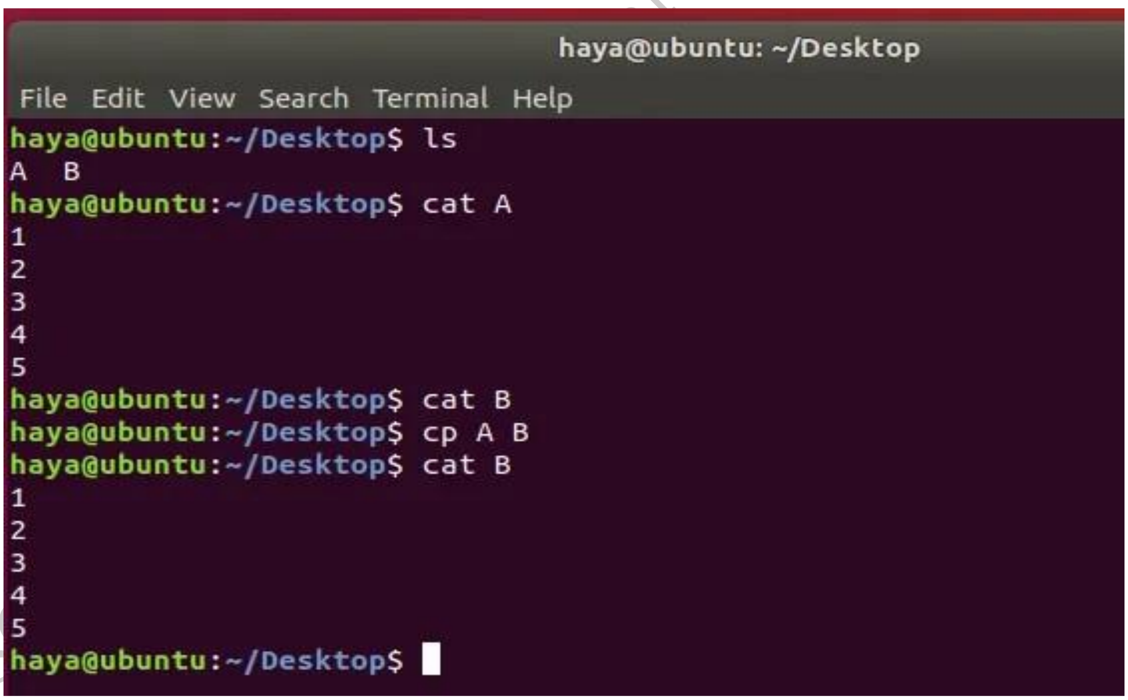


Fig. 5.31

cat

The command “cat” is a reverse of the command “tac”. It is used to display each line of the file starting from the first row and finishing on its last row.

This command is more frequently used than “tac”.

Syntax: cat file_name

Example: cat Test_File

Consider having a file named Test_File as shown below, "cat" command will display its data on the screen.

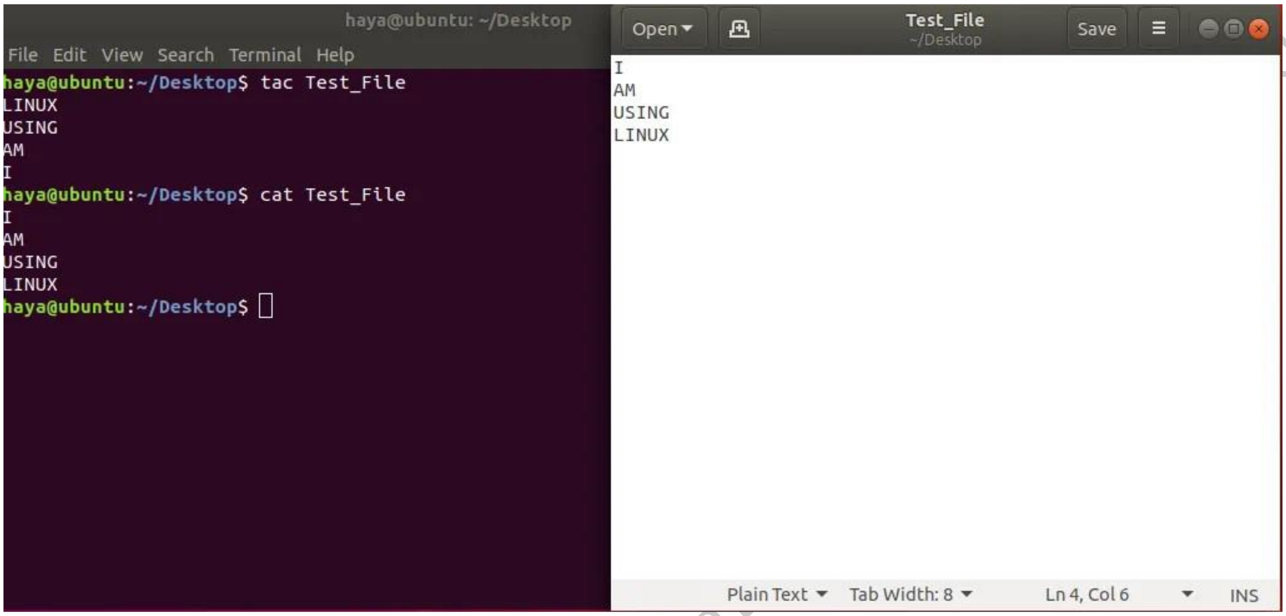


Fig. 5.32

cat File1 File2

Consider having two files (File1 and File2) in the Desktop directory. Via above-mentioned cat command, the User can display data from both the files on their screen.

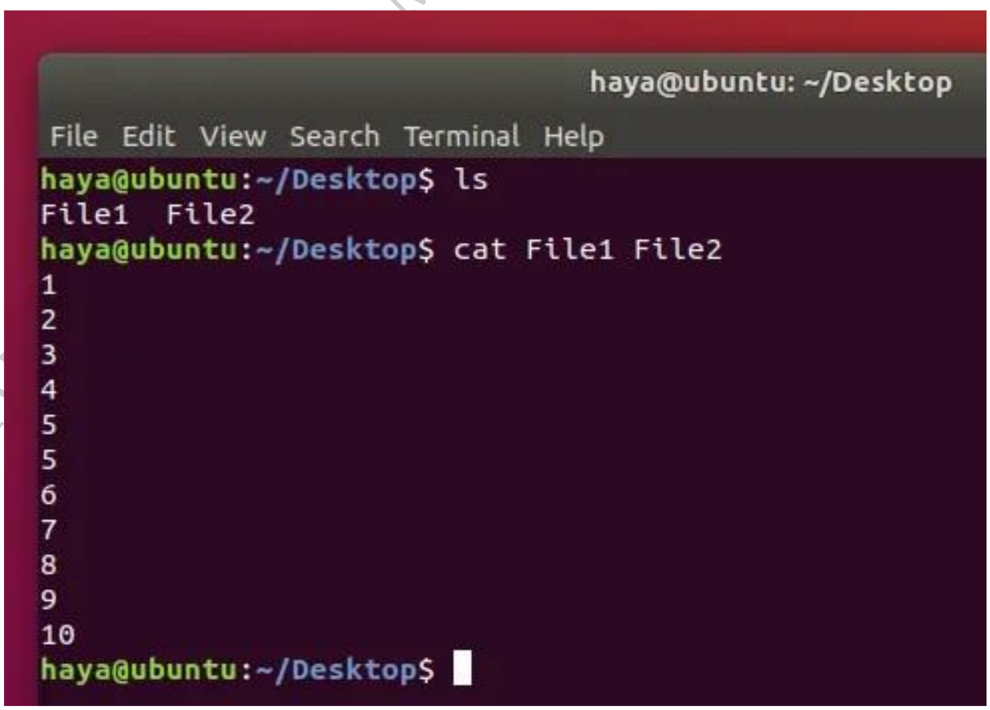


Fig. 5.33

cat File1 File2 >File_Output

Consider having two files (File1 and File2) in the Desktop directory. Via above-mentioned cat command the user can create a new file (File_Output) and append data from both the files (File1 and File2) into this new file named as File_Output by using operand “>”.

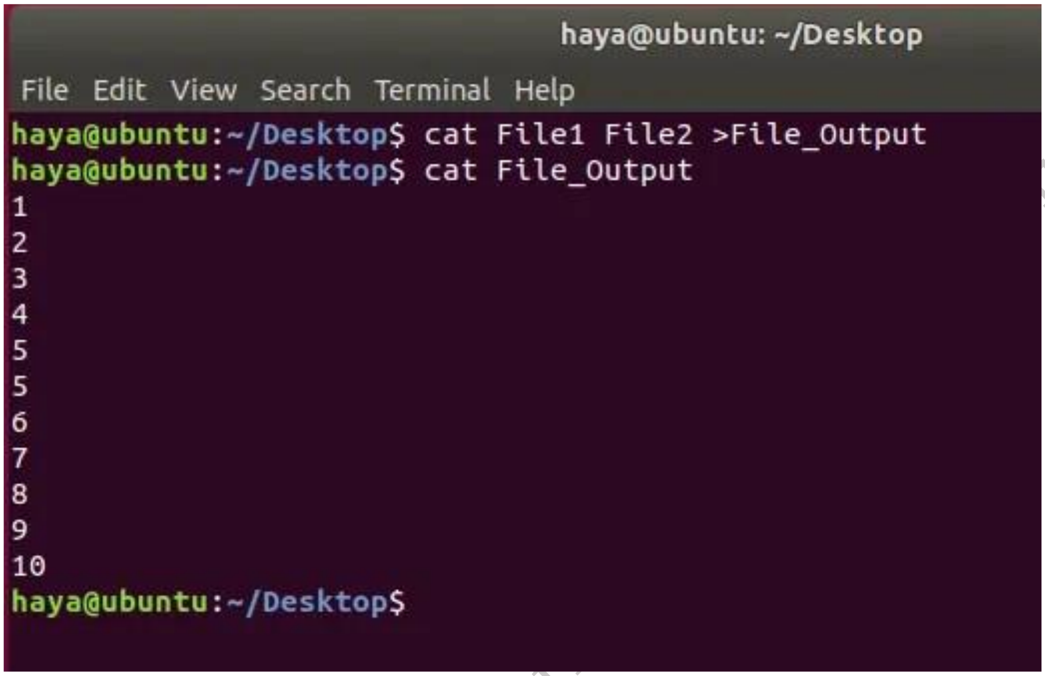


Fig. 5.34

head

The command “head” prints the top N rows of data of the given input or file. By default, it prints the first 10 lines of the specified files.

Syntax: head -n File_name

Example: head -5 New_Test.txt

The above-mentioned command will only print first 5 rows of the file New_Test.txt

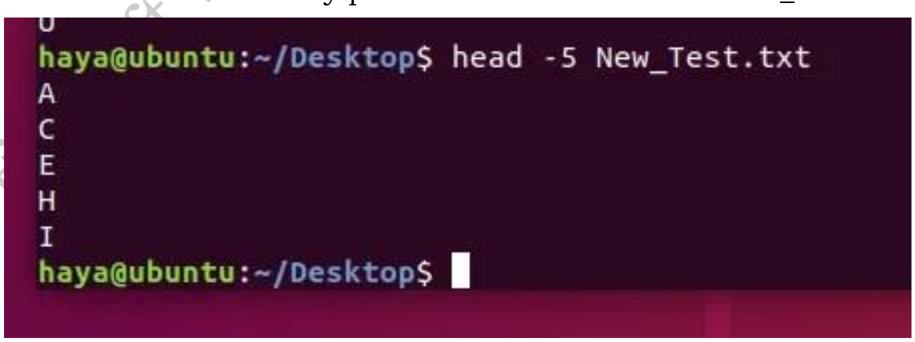


Fig. 5.35

tail

The command “tail” prints the last N rows of data of the given input or file. By default, it prints the last 10 lines of the specified files.

Syntax: tail -n File_name

Example: tail -5 New_Test.txt

The above-mentioned command will only print last 5 rows of the file New_Test.txt.

Fig. 5.36

echo

The command "echo" used to display any expression that is passed as an argument.

Syntax: echo expression_to_be_displayed

Example: echo user

This command displays the expression "user" on the screen.

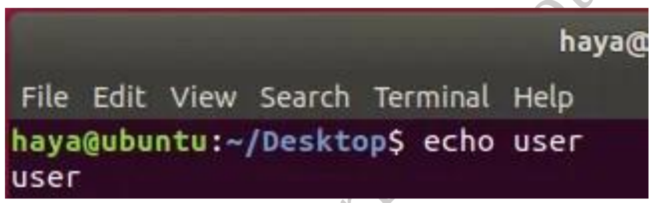


Fig. 5.37

grep

The command "grep" is used to search for a text in the specified file/folder.

Syntax: grep "expression_to_be_Searched" file_name_to_search_in

Example: grep "Are" B

The above-mentioned command will search for the word "Are" in the text of the file B.

Fig. 5.38

zip

The command "zip" is used to compress one or more files and store them in a new file with .zip extension.

Syntax: zip new_zip_file_name.zip

Example: zip Files.zip Check.txt Test.txt Output.txt

The above-mentioned command will compress all three files (Check.txt, and Test.txt and Output.txt) and store these in a new file which we're creating through this command i.e. Files.zip.

```
haya@ubuntu: ~/Desktop
File  Edit  View  Search  Terminal  Help

haya@ubuntu:~/Desktop$ zip Files.zip Check.txt Test.txt Output.txt
  adding: Check.txt (stored 0%)
  adding: Test.txt (stored 0%)
  adding: Output.txt (stored 0%)
haya@ubuntu:~/Desktop$ ls -ltr
total 8
-rw-rw-r-- 1 haya haya  17 Jan 14 17:36 Check.txt
-rw-rw-r-- 1 haya haya   0 Jan 14 17:59 Output.txt
-rw-r--r-- 1 haya haya   0 Jan 14 18:09 Test.txt
-rw-r--r-- 1 haya haya 477 Jan 14 18:11 Files.zip
```

Fig. 5.39

unzip

The command "unzip" is used to decompress a .zip file and extract all the files within to current directory.

Syntax: unzip zip_file_name.zip

Example: unzip Files.zip

Consider having a zip File named as Files.zip with a compressed .txt file in it. The above-mentioned command will help you unzip the file (Files.zip) and extract the .txt file from it to the current directory.

```
haya@ubuntu: ~/Desktop
File  Edit  View  Search  Terminal  Help
haya@ubuntu:~/Desktop$ unzip Files.zip
Archive:  Files.zip
replace Check.txt? [y]es, [n]o, [A]ll, [N]one, [r]ename: n
replace Test.txt? [y]es, [n]o, [A]ll, [N]one, [r]ename: n
replace Output.txt? [y]es, [n]o, [A]ll, [N]one, [r]ename: r
new name: Trying.txt
 extracting: Trying.txt
haya@ubuntu:~/Desktop$ ls -ltr
total 8
-rw-rw-r-- 1 haya haya  17 Jan 14 17:36 Check.txt
-rw-rw-r-- 1 haya haya   0 Jan 14 17:59 Trying.txt
-rw-rw-r-- 1 haya haya   0 Jan 14 17:59 Output.txt
-rw-r--r-- 1 haya haya   0 Jan 14 18:09 Test.txt
-rw-r--r-- 1 haya haya 477 Jan 14 18:11 Files.zip
haya@ubuntu:~/Desktop$
```

Fig. 5.40

sudo

The command "sudo -I" is used to continue the session as a root user which has a lot more privileges than normal system user.

Syntax: sudo -i

Example:

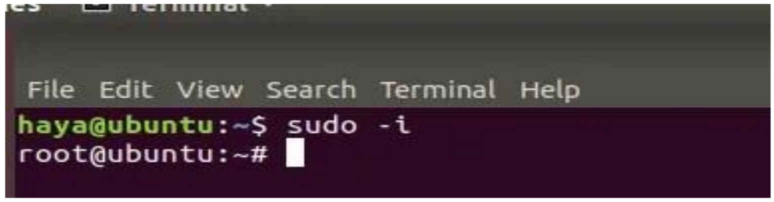


Fig. 5.41

Basic Commands

history

The simple command "history" displays the list of all commands entered since the user started the session.

Syntax: history

Example:

Note: To clear all the previous history use command "history -c".

Fig. 5.42

help

The command of "help" provides you help to learn about all the built-in commands.
Syntax: help

Example:

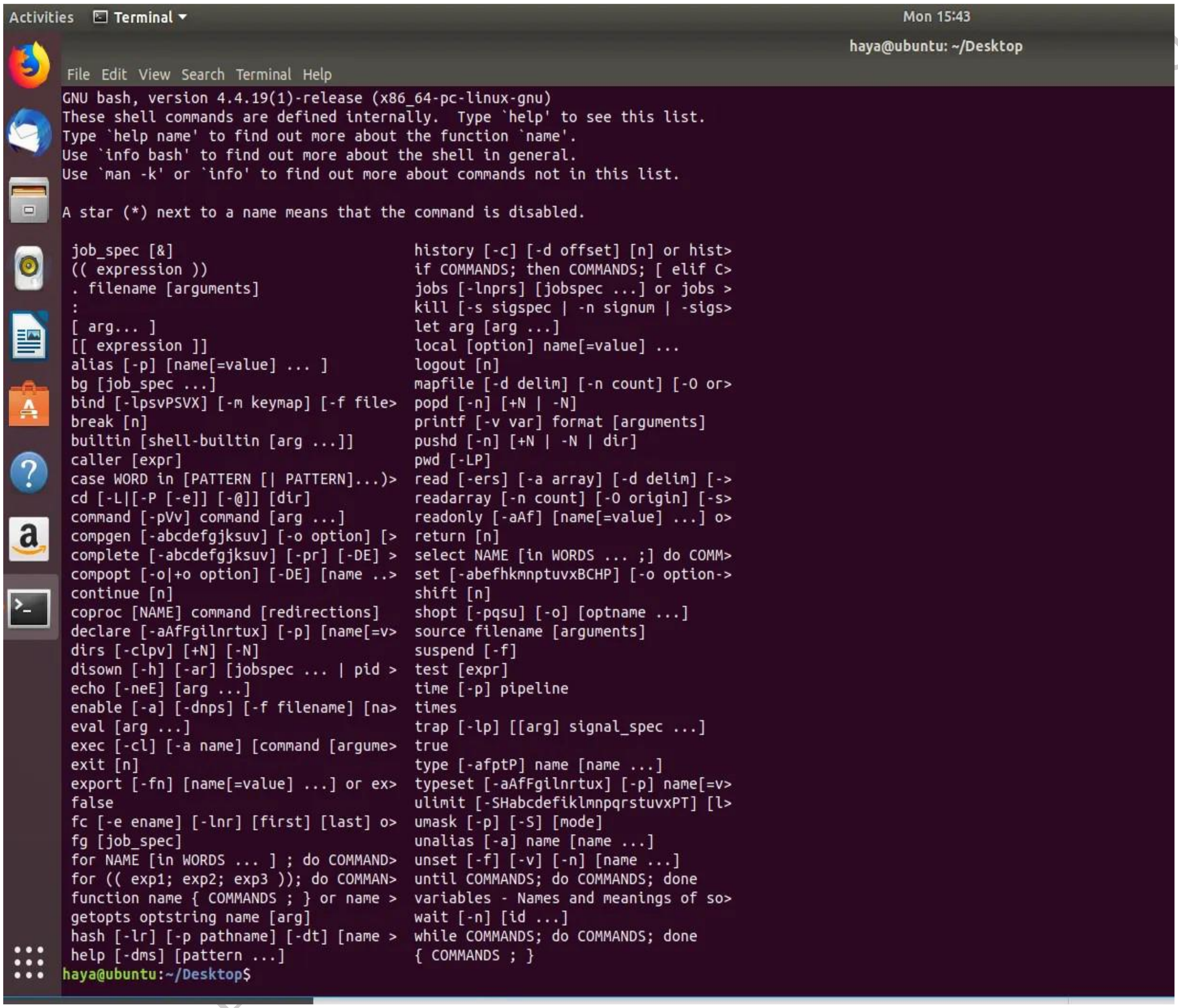


Fig. 5.43

man

The command of "man" stands for manual and it is used to display the user manual of any built-in Linux command.

Syntax: man command_name

Example: man vim

This command displays the user manual of the built-in Linux command "vim".

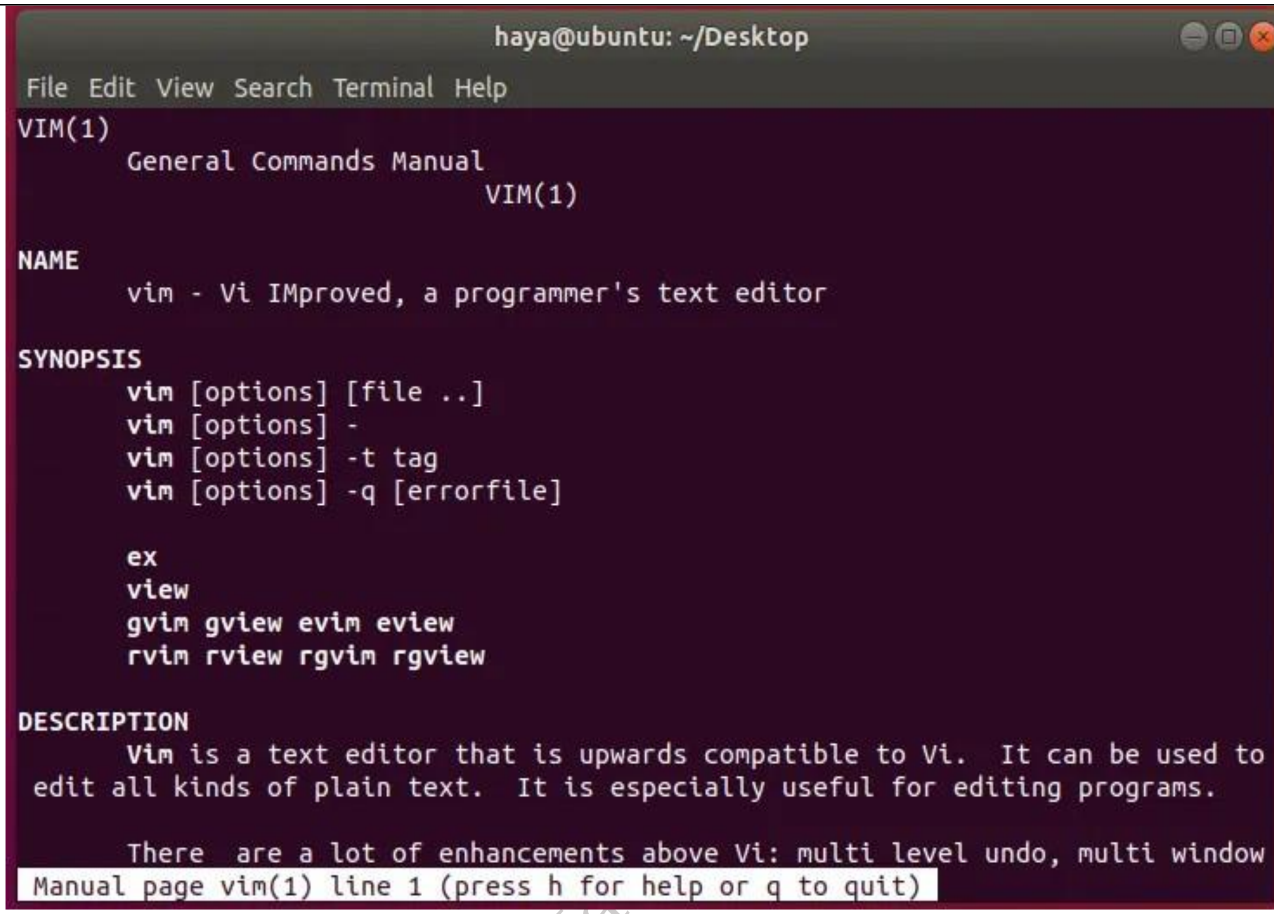


Fig. 5.44

dir

The command “dir” stands for directory and it is used to display the list of all directories or folder in the current directory.

Syntax: dir

Example:

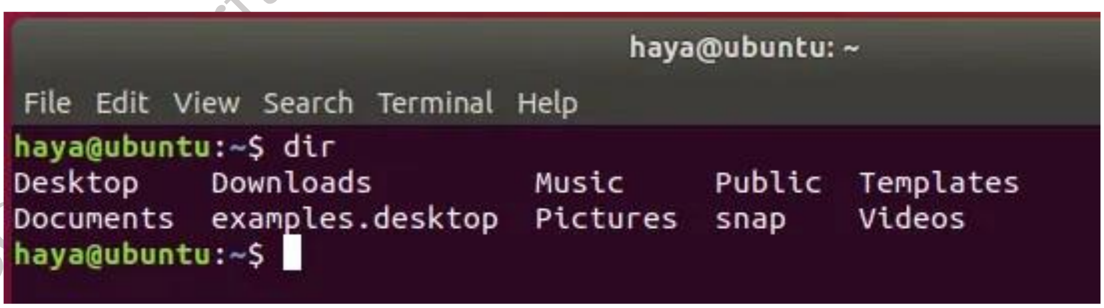


Fig. 5.45

ls

The command “ls” displays the list of all directories, folder, and files present in the current directory.

Syntax:

- ls
- Ls -ltr

Example: ls

The above-mentioned command displays the name of directories, folders, and files

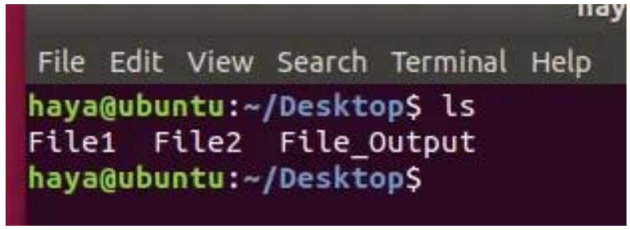


Fig. 5.46

ls -ltr

The above-mentioned command displays the name of directories, folders, files with their respective owner name, group's name and rights your user have over these.

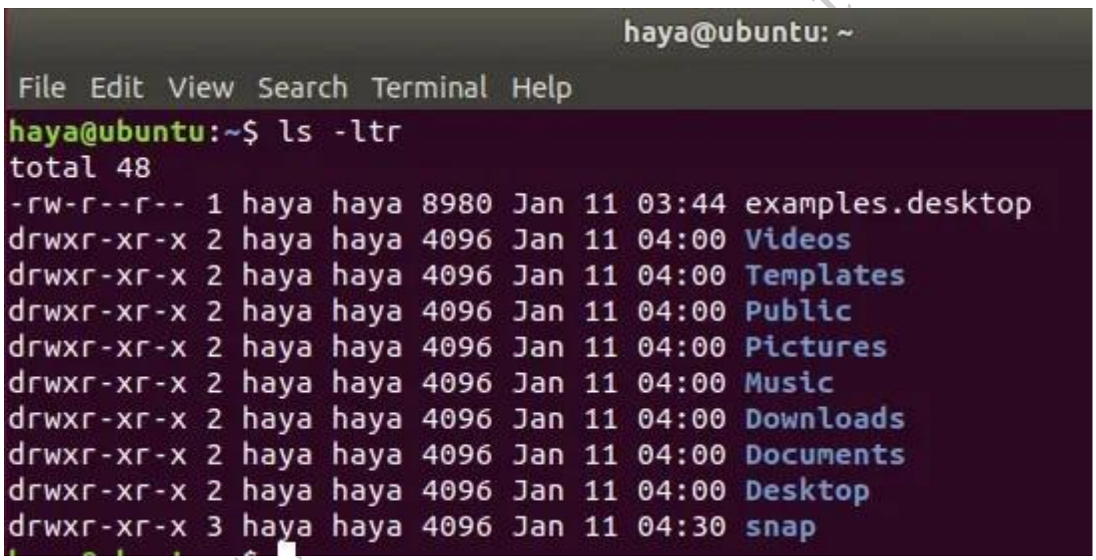


Fig. 5.47

cd

The command "cd" stands for change directory and it is used to change the current directory user is operating in via Terminal.

Syntax:

- cd destination_directory's_name (to move forward from your current directory to the next directory within current directory)
- cd .. (to move back in the previous directory from your current directory)

Example: cd Desktop

This command takes you from Directory /home/user to the destination directory which is /home/user/Desktop.

Note: You cannot only use cd when the destination directory is within your current directory.

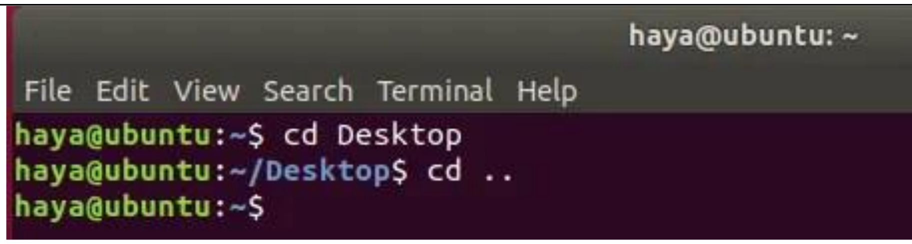


Fig. 5.48

cd ..

This command takes you from directory /home/user/Desktop back to /home/user.

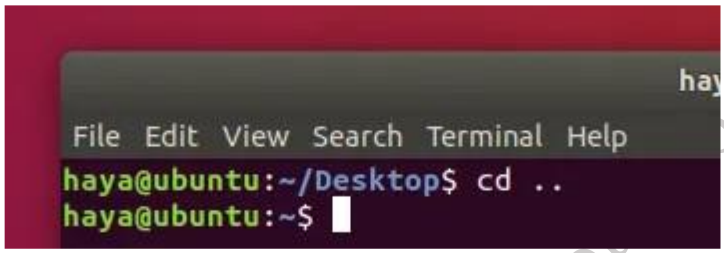


Fig. 5.49

pwd

The command "pwd" displays the path of the current directory user is operating in via Terminal. Syntax: pwd

Example:

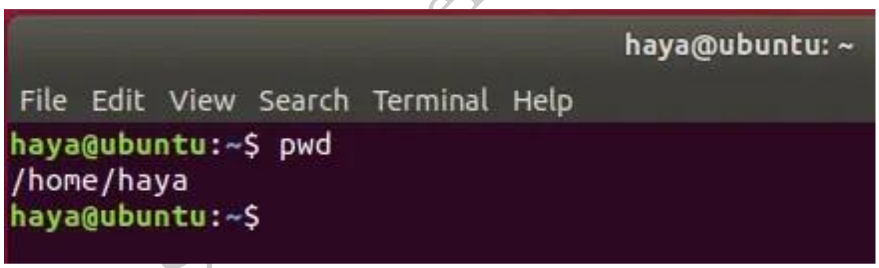


Fig. 5.50

clear

The command "clear" is to clear the screen of Terminal.

Syntax: clear

Example: clear

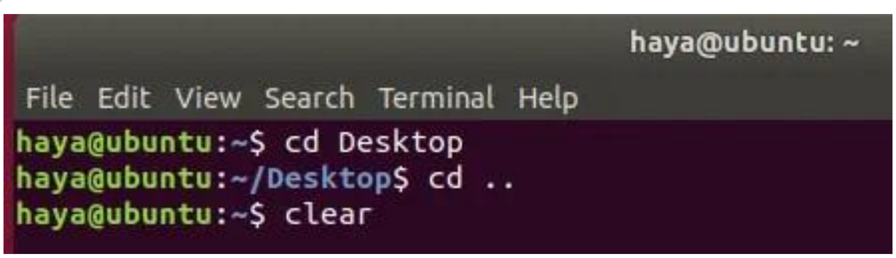


Fig. 5.51

Before

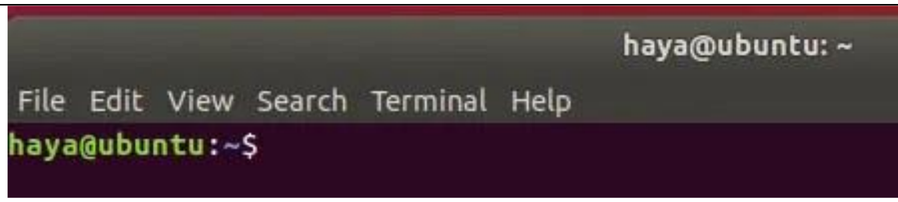


Fig. 5.52

After

whereis

The command "whereis" is self-explanatory, as it displays the path where the package for specific built-in Linux command locates.

Syntax: whereis command_name

Example:

whereis zip

whereis help

whereis cat

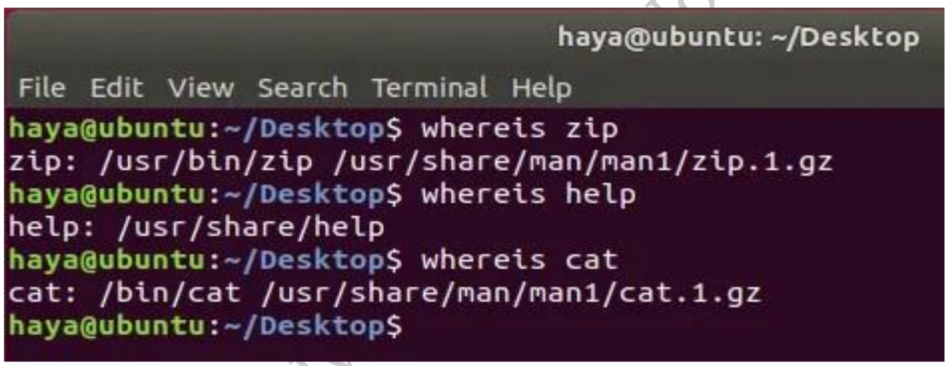


Fig. 5.53

whatis

The command "whatis" is also self-explanatory, as it displays a brief description of what is the functionality of specific built-in Linux command.

Syntax: whatis command_name

Example:

whatis cat

whatis help

whatis zip

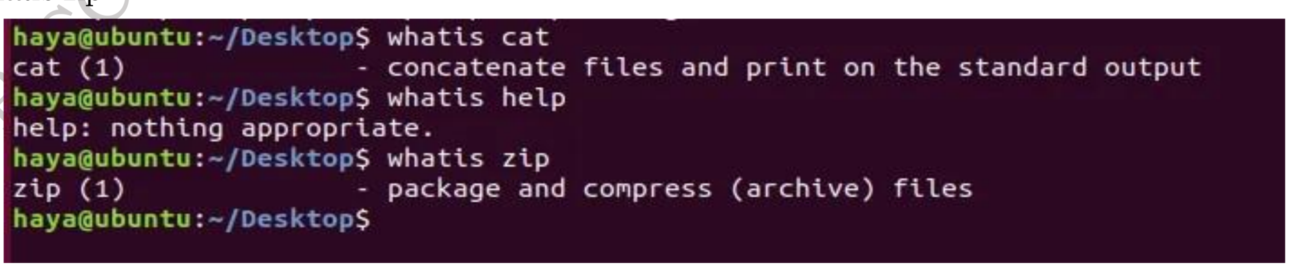


Fig. 5.54

Downloading and installing Debian Packages: To download and install Debian packages, you can use a package manager like aptitude or synaptic, or you can use the command line:

- **Download the package**
- Check the package's architecture: Make sure the package's architecture matches your platform.
- Install the package: You can use a package manager like aptitude or synaptic, or you can use the command line:
- Use a package manager: Aptitude is the preferred program for daily package management from the console. You can use it through a visual interface or directly from the command line. For example, to install the foo package, you can run aptitude install foo.
- Use the command line: You can use the dpkg and apt-get command line tools:

```
sudo dpkg -i /absolute/path/to/deb/file
sudo apt-get install -f
```

You can also install a custom package by copying it to the config/packages.chroot/ directory. Packages in this directory will be automatically installed into the live system during build.

Linux File System

The Linux file system is a multifaceted structure comprised of three essential layers. At its foundation, the Logical File System serves as the interface between user applications and the file system, managing operations like opening, reading, and closing files. Above this, the Virtual File System facilitates the concurrent operation of multiple physical file systems, providing a standardized interface for compatibility. Finally, the Physical File System is responsible for the tangible management and storage of physical memory blocks on the disk, ensuring efficient data allocation and retrieval. Together, these layers form a cohesive architecture, orchestrating the organized and efficient handling of data in the Linux operating system.

Linux File System Structure

A file system mainly consists of 3 layers. From top to bottom:

1. Logical File System: The Logical File System acts as the interface between the user applications and the file system itself. It facilitates essential operations such as opening, reading, and closing files. Essentially, it serves as the user-friendly front-end, ensuring that applications can interact with the file system in a way that aligns with user expectations.

2. Virtual File System: The Virtual File System (VFS) is a crucial layer that enables the concurrent operation of multiple instances of physical file systems. It provides a standardized interface, allowing different file systems to coexist and operate simultaneously. This layer abstracts the underlying complexities, ensuring compatibility and cohesion between various file system implementations.

3. Physical File System: The Physical File System is responsible for the tangible management and storage of physical memory blocks on the disk. It handles the low-level details of storing and retrieving data, interacting directly with the hardware components. This layer ensures the efficient allocation and utilization of physical storage resources, contributing to the overall performance and reliability of the file system.

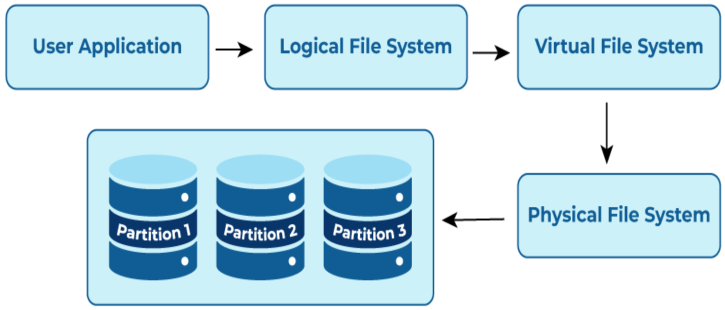


Fig. 5.55: Architecture of a File system

Characteristics of a File System

Space Management: how the data is stored on a storage device. Pertaining to the memory blocks and fragmentation practices applied in it.

Filename: a file system may have certain restrictions to file names such as the name length, the use of special characters, and case sensitive-ness.

Directory: the directories/folders may store files in a linear or hierarchical manner while maintaining an index table of all the files contained in that directory or subdirectory.

Metadata: for each file stored, the file system stores various information about that file's existence such as its data length, its access permissions, device type, modified date-time, and other attributes. This is called metadata.

Utilities: file systems provide features for initializing, deleting, renaming, moving, copying, backup, recovery, and control access of files and folders.

Design: due to their implementations, file systems have limitations on the amount of data they can store.

Linux File Systems:

1) ext (Extended File System): Implemented in 1992, it is the first file system specifically designed for Linux. It is the first member of the ext family of file systems.

2) ext2: The second ext was developed in 1993. It is a non-journaling file system that is preferred to be used with flash drives and SSDs. It solved the problems of separate timestamp for access, inode modification and data modification. Due to not being journaled, it is slow to load at boot time.

3) Xiafs: Also developed in 1993, this file system was less powerful and functional than ext2 and is no longer in use anywhere.

4) ext3: The third ext developed in 1999 is a journaling file system. It is reliable and unlike ext2, it prevents long delays at system boot if the file system is in an inconsistent state after an unclean shutdown. Other factors that make it better and different than ext2 are online file system growth and HTree indexing for large directories.

5) JFS (Journaled File System): First created by IBM in 1990, the original JFS was taken to open source to be implemented for Linux in 1995. JFS performs well under different kinds of load but is not commonly used anymore due to the release of ext4 in 2006 which gives better performance.

6) ReiserFS: It is a journal file system developed in 2001. Despite its earlier issues, it has tail packing as a scheme to reduce internal fragmentation. It uses a B+ Tree that gives less than linear time in directory lookups and updates. It was the default file system in SUSE Linux till version 6.4, until switching to ext3 in 2006 for version 10.2.

7) XFS: XFS is a 64-bit journaling file system and was ported to Linux in 2001. It now acts as the default file system for many Linux distributions. It provides features like snapshots, online defragmentation, sparse files, variable block sizes, and excellent capacity. It also excels at parallel I/O operations.

8) SquashFS: Developed in 2002, this file system is read-only and is used only with embedded systems where low overhead is needed.

9) Reiser4: It is an incremental model to ReiserFS. It was developed in 2004. However, it is not widely adapted or supported on many Linux distributions.

10) ext4: The fourth ext developed in 2006, is a journaling file system. It has backward compatibility with ext3 and ext2 and it provides several other features, some of which are persistent pre-allocation, unlimited number of subdirectories, metadata checksumming and large file size. ext4 is the default file system for many Linux distributions and also has compatibility with Windows and Macintosh.

11) btrfs (Better/Butter/B-tree FS): It was developed in 2007. It provides many features such as snapshotting, drive pooling, data scrubbing, self-healing and online defragmentation. It is the default file system for Fedora Workstation.

12) bcachefs: This is a copy-on-write file system that was first announced in 2015 with the goal of performing better than btrfs and ext4. Its features include full filesystem encryption, native compression, snapshots, and 64-bit check summing.

13) Others: Linux also has support for file systems of operating systems such as NTFS and exFAT, but these do not support standard Unix permission settings. They are mostly used for interoperability with other operating systems.

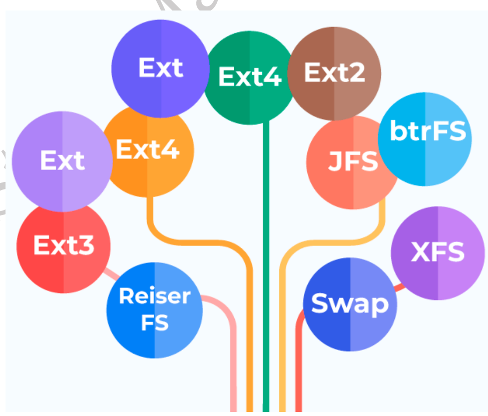


Fig. 5.56: Types of Linux File System

Check Your Progress

A. Multiple Choice questions

1. What command is used to display the current IP configuration in Linux? (a) ipconfig (b) ifconfig (c) ping (d) netstat
2. Which command is used to change the directory in Linux? (a) ls (b) cd (c) mkdir (d) pwd

3. What is the purpose of the command chmod in Linux? (a) To change the current directory (b) To change file permissions (c) To copy files (d) To move files
4. Which command is used to list the files and directories in the current working directory? (a) cat (b) ls (c) touch (d) cp
5. In Linux, the root directory of the file system is represented by which symbol? (a) / (b) \ (c) ~ (d) .

B. Fill in the blanks

1. The command used to change file permissions in Linux is __________.
2. To view the current network configuration in Linux, you can use the command __________.
3. In Linux, the root directory is represented by the symbol __________.
4. The command __________ is used to create a new directory in Linux.
5. The structure of files and directories in Linux is organized in a hierarchical format, often referred to as the __________.

C. State true or False for the following

1. In Linux, the root directory is denoted by the symbol \.
2. The command ping can be used to test the connectivity between two network devices.
3. A static IP address changes every time the device is restarted.
4. The rm command is used to remove files or directories in Linux.
5. The Linux file system is organized in a flat structure without any directories.

D. Short Answer Type Questions

1. What steps are involved in performing post-installation tasks in a Linux system?
2. What is the difference between dynamic IP configuration and static IP configuration in Linux?
3. Name three basic Linux commands and explain their primary functions.
4. Which command would you use to delete a file in Linux, and what is its syntax?
5. How does the Linux file system structure differ from the file system structures of other operating systems, such as Windows?

Module 3 BASIC OF ELECTRONICS, TOOLS AND EQUIPMENT

Module Overview

Electricity plays a pivotal role in modern society, powering the majority of electronic devices essential to our daily lives. The computer, a key electronic device, operates primarily on electricity, as do its peripheral devices. Ensuring a consistent and proper power supply is crucial for the optimal functioning of electronic equipment. To address this, protective measures such as surge protectors and uninterruptible power supplies (UPS) are employed, emphasizing the indispensability of electricity in the world of computing.

This unit delves into the foundational concepts of electricity, encompassing electrical quantities and the diverse array of electronic components. A critical aspect of this understanding involves the power supply, an electrical device dedicated to delivering the necessary operating voltage to computers. Power supplies for PCs necessitate a minimum load, with specific requirements like 7A at 5V and 6.5A at 12V. The power demands of modern PCs fall within the range of 60W to 250W, highlighting the importance of a reliable power source. Notably, the electronic components within computers demand very low DC voltage, underscoring the precision required in managing electrical power within the intricate computing environment. As technology advances, the synergy between electricity and computing remains integral to the seamless operation of electronic systems.

Learning Outcomes

After completing this module, you will be able to:

- Understand and apply the fundamental principles of electronics, including voltage, current, resistance, and power.
- Identify and explain the functions of key electronic components and their roles in circuit design and operation.
- Explain the functions of various electrical and mechanical components in a computer system and their interconnections.
- Demonstrate the use of tools and measuring instruments for diagnosing, repairing, and maintaining electronic circuits and computer systems.

Module Structure

Session 1. Basic concepts of Electronics

Session 2. Electronic Circuit Components

Session 3. Functions of Various Electrical and Mechanical Parts and modules in a Computer syste

Session 4. Tools and Equipment and Measuring instruments

Session 1. Basic concepts of Electronics

1.0 INTRODUCTION

Electricity has an important place in modern society. In the current age, most of the electronic devices work on electricity. Computer is electronic device which mainly works on electricity. The peripheral devices attached to the computer also work on electricity. It is necessary to provide the 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 works 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.

1.1 ELECTRICITY

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

1.1.1 Energy Foundation

Everything in the universe solid, liquid, gases are made up of atoms. Atoms are the building blocks of the universe. Atoms are so small that millions of them would fit on the head of a pin.

The centre of an atom is called the nucleus. Atoms consist of sub atomic particles – protons, electrons and neutrons. Electrons spin around the nucleus in shells a great distance from the nucleus. Protons carries positive (+) charge, electrons carry negative (-) charge, neutrons are neutral. The positively charge protons attract negatively charge electrons and hence holding the atomic structure as shown in Figure 1.1.

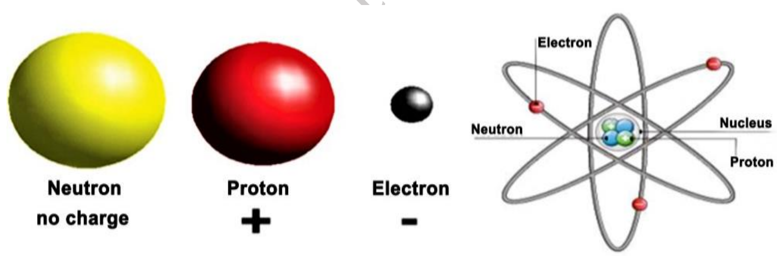


Fig.1.1: Atomic structure, Courtesy

1.2 Conductors and Insulators

When electrons move among the atoms of matter, an electric current is created. As in case of piece of wire, the electrons are passed from atom to atom, creating an electrical current from one end to another.

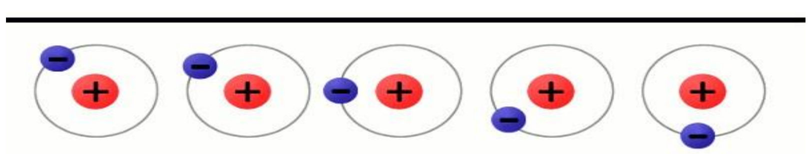


Fig.1.2 Atom in the wire which shows electrons travel from one atom to another atom

1.2.1 Conductors: The material, in which the electrons are loosely held, can move very easily. These are called conductors. The metals like copper, aluminium or steel are good conductors of electricity.

Fig.1.3 Different metal which can be used as conductors

1.2.2 Insulators: The materials which hold their electrons very tightly, do not allow to move 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.1.4 Different materials which can be used as an insulator

1.3 ELECTRICAL QUANTITIES

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

1.3.1 Voltage

Voltage is the potential difference between two points. Voltage 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'**.

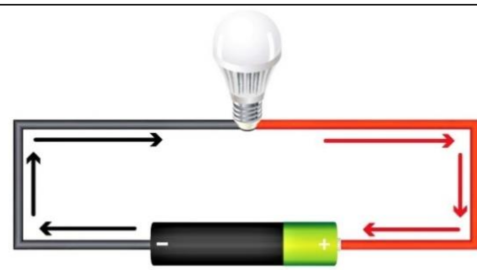


Fig.1.5 Voltage in the form of battery is applied across the LED bulb

1.3.2 Current

Electric charge often called as current. It is the flow of electrons. These electrons carry the charge. The electrons flow from one place to another. The amount of charge with electrons flowing from one place to another is called electric current in figure 1.7. Unit of current is ampere (A). Symbolic representation of current is 'I'or 'i'.

I= Q/t

Where,

'I' is the current,

'Q' is the amount of charge in coulombs

't' is the time in seconds

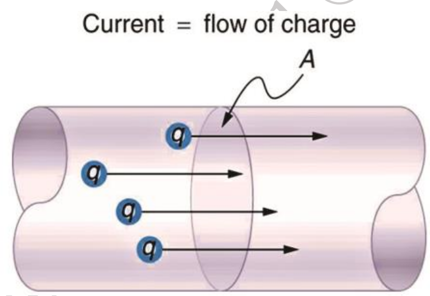


Fig. 1.6: Flow of charge through a cross section 'A'

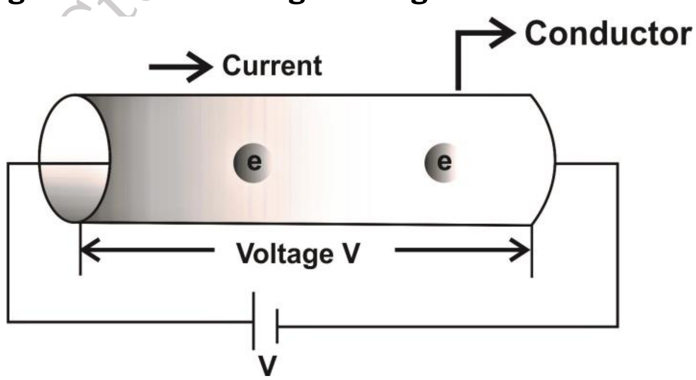


Fig.1.7 Flow of electrons in the conductor

1.3.3 Resistance

As its name suggests, it resists the flow of electron and hence electric current in the circuit. Conceptually the resistance controls the flow of electric current. The resistance is represented by the symbol "R". The SI unit of electrical resistance is the ohm (Ω).

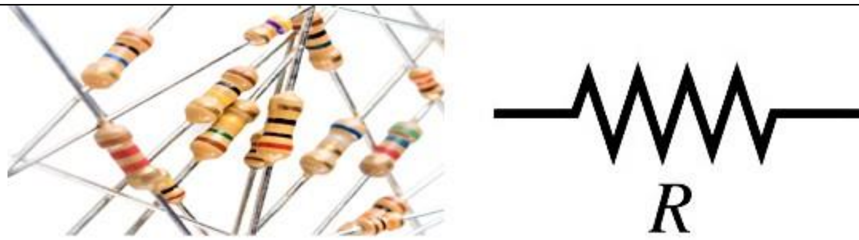


Fig.1.8 Resistor and its symbol

1.4 ELECTRONIC COMPONENTS – ACTIVE AND PASSIVE COMPONENTS

An electronic circuit is composed of various electronic components. Electronic components usually have two or more leads which can be fitted into the PCB to form a working electronic circuit. Electronic components are mainly classified into two classes – **Active and Passive components**.

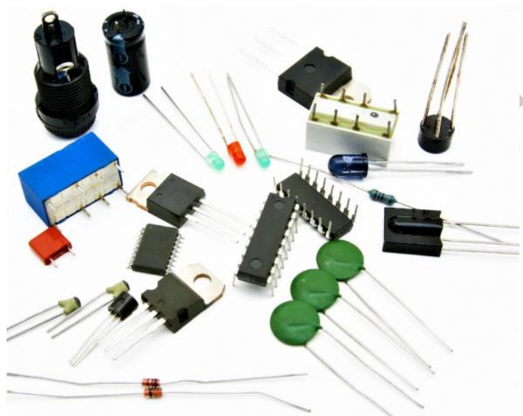


Fig.1.9 Different types of components used in electrical and electronics

1.4.1 Active components: Active components produce energy in the form of Voltage or Current. These components are required 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.

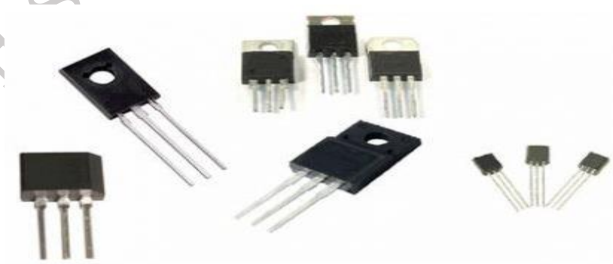
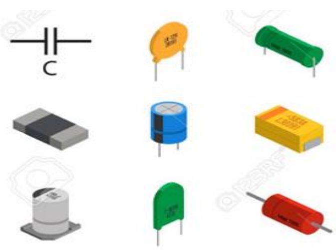
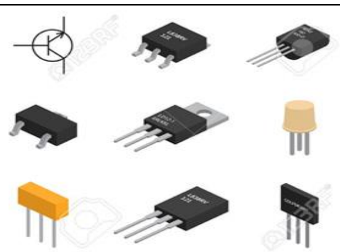
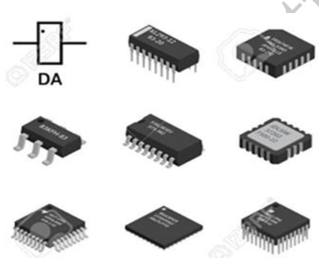
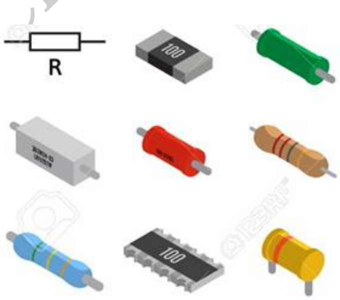


Fig.1.10 Active components

1.4.2 Passive components: Passive components which 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 1.11.

Fig.1.11 Passive components

Assignment: Identify the components used in electrical and electronics.	
Pictorial representation of the component	Write down the name and identify which category it belongs i.e. Active or Passive
	Name of component…………………….. Active ☐ Passive ☐
	Name of component………………………. Active ☐ Passive ☐
	Name of component………………………. Active ☐ Passive ☐
	Name of component………………………. Active ☐ Passive ☐

1.5 PASSIVE COMPONENTS

1.5.1 Resistor

Resistors are the basic component in an electronic circuit which is used to generate Voltage and Current in the circuit. Resistor opposes movement of electrons. This opposition is called as resistance. Resistance is measured in ohms (Ω). The standard resistor values are 10 Ω, 12 Ω, 15 Ω, 18 Ω, 22 Ω, 27 Ω, 33 Ω, 47 Ω, 82 Ω.

Color bands on the resistors are used to represent the resistance values on each of the resistor. There are 4 band, 5 band and 6 band resistors.

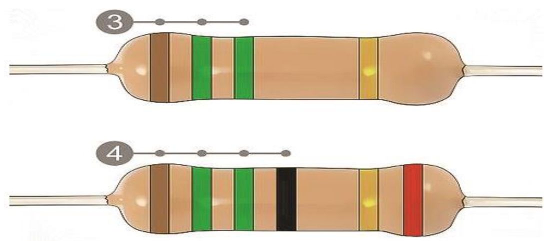


Fig. 1.12: 4 band and 5 band color coded resistor

In 4 band resistors as shown Figure 1.13, 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 5 bands resistor first three bands represent significant digit, forth band represents multiplier and fifth band represent tolerance.

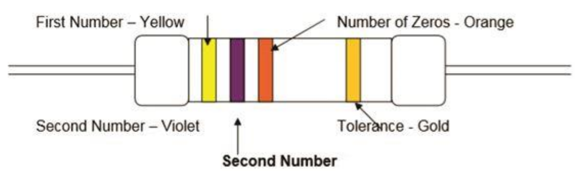


Fig. 1.13: Four band Resistor Specification

Each color on the color coded resister has the specific value as per the color scheme shown in figure 1.14.

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

Fig. 1.14 Colour Code

The tolerance gives an upper and lower value the resistor must be in, take the following example for a 100Ω resistor:

Tolerance	Colour	Stated Resistor Value	Allowed Upper Value	Allowed Lower Value
+/- 1%	Brown	100Ω	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

Fig. 1.15 Tolerance value

Resistance calculation using Color Codes:

The resistance of the resister in figure 1.15 is calculated as:

First Band Yellow Second Band Violet Multiplier Number of zeros Third Band Orange, Tolerance Yellow = 4, Violet = 7, Orange = 3 number of zeros, Gold = 5% tolerance.

Hence Resistance = 47000 Ω (or 47 kΩ), 5% tolerance.

According to Ohm's Law, Power is calculated as the product of Voltage and Resistance.

Alphanumerically Coded (Surface Mounted) Resistors

Surface mounted resistors are rectangular in shape as shown in figure 1.16(a). Surface mount resistor have leads which are coming out from the resistor, these leads are used for mounting of resistor on the PCB. Some surface mount resistor uses plates on the bottom side of resistor.

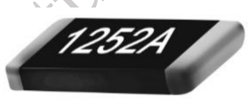


Fig. 1.16 (a), Courtesy: http://bit.ly/2uVGOc9Fig. 1.16(b), Courtesy: http://bit.ly/2uVGOc9

The first 2 or 3 numbers printed on the surface mount resistor represents significant digits and the last digit represents the number of zero that should follow. For example, as shown in figure 1.16(b), a resistor reading 1252 indicates a value 125200 ohm, for tolerance value use the letter at the end of the code.

Compare the letter at the end of the code with the tolerance it represents as shown in figure 1.16(b).

There are two types of resistor, they are Fixed Resistor and Variable Resistor

Fixed resistor:

The resistors made up of ceramic body and are 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.

- 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.

- Carbon Composition is made up of carbon clay composition with plastic coating around it.
- Carbon Pile is made up of a stack of carbon disks compressed between two metal contact.
- Carbon film is deposited on an insulating substrate and cut into thin resistive path.
- Metal Film is cylindrically shaped and coated with Nickel Chromium.
- Metal Oxide Film is made up of tin oxide.
- 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 10-250ppm/K.

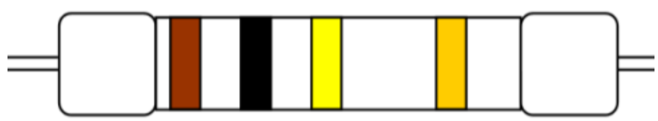
Fig.1.17 (a) Fixed resistor

Fig.1.17 (b) Variable resistor

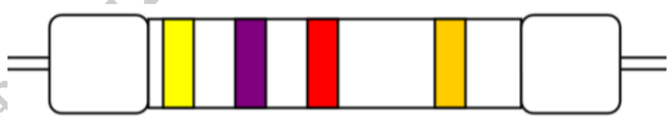
Variable resistor

Variable Resistors are the resistors in which the resistance can be continually altered and is not fixed. A variable resistor has 3 terminals out of which 2 are connected to the ends of the track and a third terminal is connected to the wiper. The motion of the wiper allows in increasing and decreasing resistance. Potentiometer, Rheostat and Trim Pot are the variable resistor as shown in figure 1.17.

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



Brown-black-yellow-yellow



Yellow-violet-red-yellow

Red-red-brown-yellow

1.5.2 Capacitor

A capacitor is a passive electronic component used to store electric charge. The unit for measuring capacitance is Farads. In a capacitor energy is stored in the form of electric field. Capacitor have two parallel sections, between this section energy is stored. The standard capacitor values are 1, 10,100, 510, 910pF. Capacitors are also marked with color bands to denote value. The first 2 bands are the first and second digit whereas the third band denotes the multiplier. The capacitor and its symbol are shown in figure below.

Fig. 1.18 (a) Capacitor **(b) Capacitor Symbol**

The capacitance of capacitor can vary from – 20% to +80% of actual capacitance. The parameters of capacitor are maximum voltage, capacitance, tolerance. Maximum voltage defines the maximum voltage value of capacitor. The figure 1.19 shows the various parameters of a capacitor.

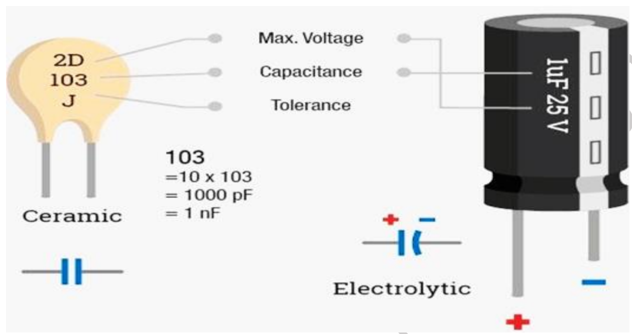


Fig. 1.19 Parameters of capacitor

The capacitor is marked with the value of capacitance and voltage. You can calculate the amount of charge in the capacitor with the 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 materials used in the capacitor plates. They are Ceramic Capacitors, Film Power Capacitors, Super Capacitors and Variable Capacitors.

- **Ceramic Capacitors:** Ceramic capacitors 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 film power capacitors, 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:** Super capacitors are electrochemical capacitors with no specific dielectric in it. The storage of charge is obtained by either separation of charge or redox reactions.
- **Variable Capacitors:** All the above-mentioned capacitors are fixed capacitors which cannot vary their capacitance. A variable capacitor can vary its capacitance by mechanical motion.

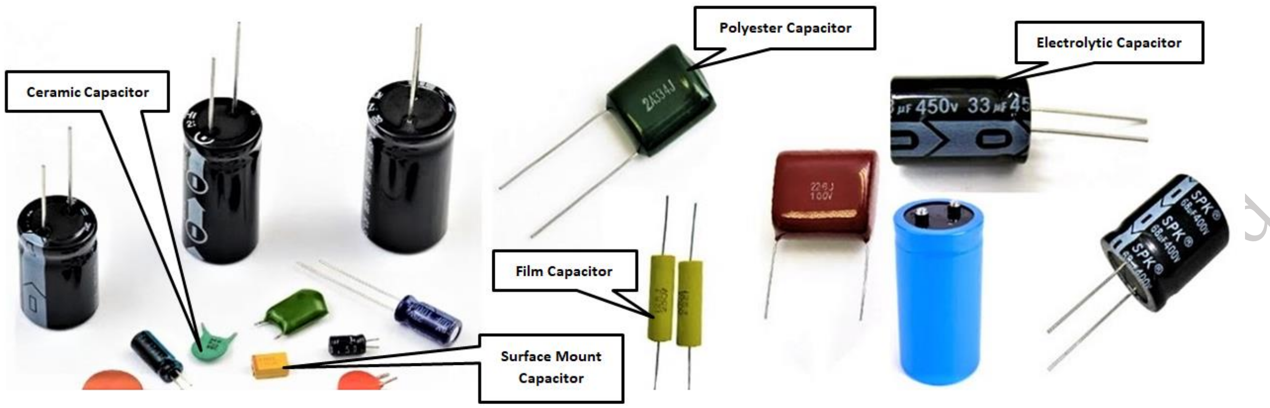


Fig.1.20 Different types of capacitors

1.5.3 Inductor

An inductor is a two terminal electric 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%.

Inductor is a conductor wire wound into coil. Inductors are made up of insulating wire like copper wire wound on a plastic or ferromagnetic material. The inductor and its symbol is shown in figure 1.21.

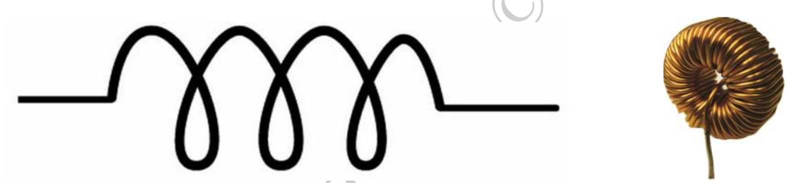


Fig. 1.21 (a) Inductor (b) Symbol of inductor

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 passed normally through it thus resisting any change in the flow of current.

Types of inductor

The types of inductors are: Air core inductor, Ferromagnetic core inductor, 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 or ferromagnetic material.

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

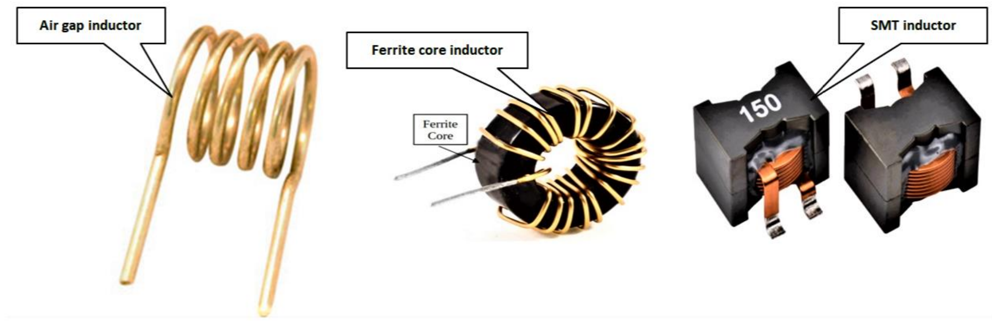


Fig.1.22 Different types of inductor

1.6 ACTIVE COMPONENTS

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

1.6.1 Semiconductor

Semiconductors are materials whose conductivity has between conductors and insulators. Electronics device are made up of semiconductor material. In semiconductor industry silicon and germanium are used. Semiconductors materials are of two types which are as follows:

Intrinsic (pure), it is a pure form of a semiconductor. The pure word here specifics that this semiconductor does not contain any other impurity atom.

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

- When pentavalent impurity atom is added an extrinsic semiconductor is formed which is known as **P-type semiconductor.**
- When trivalent impurity atom is added an extrinsic semiconductor is formed which is known as **N-type semiconductor.**

1.6.2 Diode

A diode is an electronic device which allows current to flow easily in the circuit. The most common form of diode is P-N junction diode.

When two semiconductors i.e. P-type semiconductor and N-type semiconductor are combined to form new component, which is known as **diode**. The diode and its symbol is shown in figure 1.23.

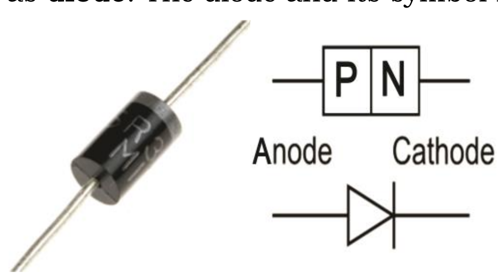


Fig. 1.23 (a) Diode (b) Diode symbol

The silver ring in figure 1.24 represents the cathode of a diode.

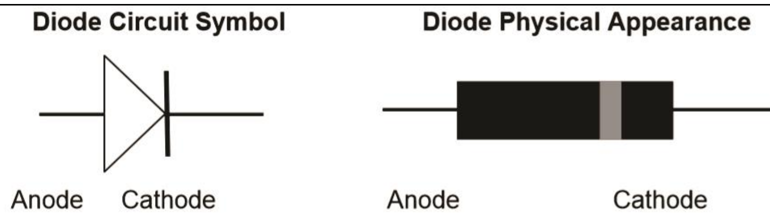


Fig. 1.24 Terminals of diode

Diode passes current only in one direction. The P-side is called anode and the N-side is called cathode. When the anode and cathode of a PN-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 acts 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 diode are connected to the negative terminal of the battery and N-side of the diode is connected to positive terminal of the battery, diode is said to be **reverse biased** or we can say that diode will acts as an open switch (it will be turned “OFF”). In reverse-biased condition, diode will not pass the current through it.

Diode can be connected in forward bias and reverse bias as shown in figure. 1.36.

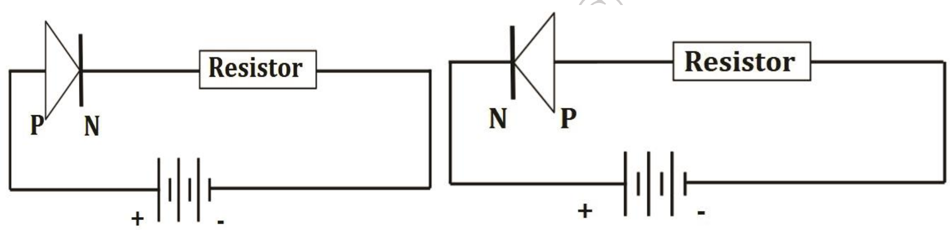


Fig. 1.25 (a): Diode connected in Forward bias (b) Diode connected in Reverse bias

There are various types of diodes such as Avalanche Diode, Crystal Diode, Light Emitting Diode (LED), Photodiode, Varactor Diode, Zener Diode.

1.6.2 Transistor

Transistor is an active semiconductor device formed by 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, where the two layers touch each other is called as **junction**. The junction where emitter layer and base layer touch each other is named as **emitter base junction**. The junction where collector layer and base layer touch each other is named as **collector base junction.**

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 emitter in transistor which acts as source of charge carrier (i.e. electrons and holes in semiconductor). The tap at the ground is similar to the base of transistor; this tap controls the flow of water likewise base control the flow of charge carrier. Bucket at the ground collect the water coming from the storage tank likewise collector of transistor collects the charge carriers coming from emitter.

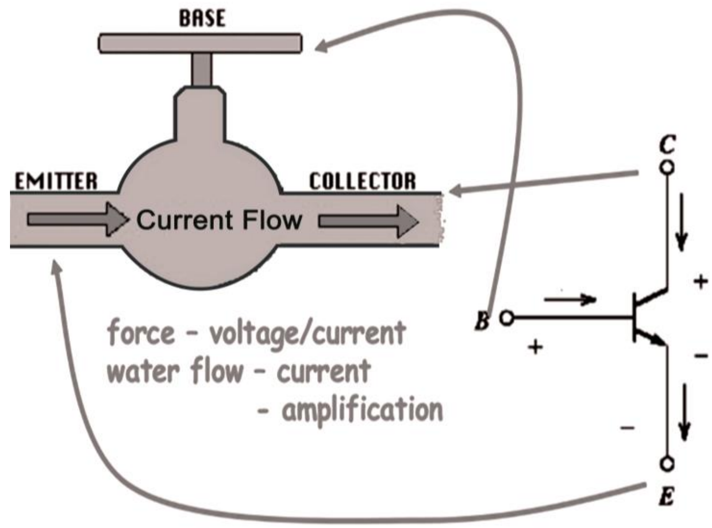


Fig.1.26 Analogy of transistor

Identifying BJT Terminals:

Keep the transistor such that the flat surface facing towards you as shown in the below figure 1.27(a) and figure 1.27(b):

We know that 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 is shown in figure 1.27.

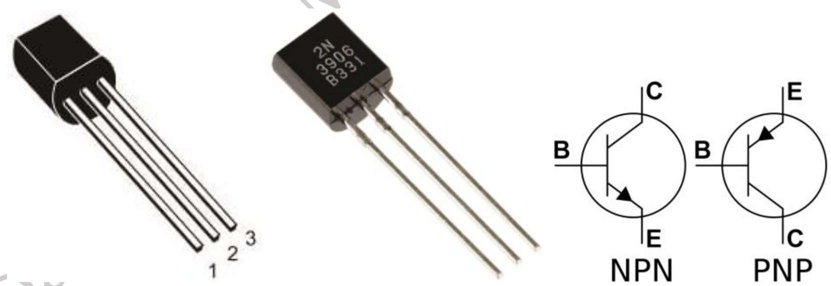


Fig. 1.27 (a) Bipolar Junction Transistor (b) Symbol of BJT

The figure 1.28 shows the details junctions of BJT.

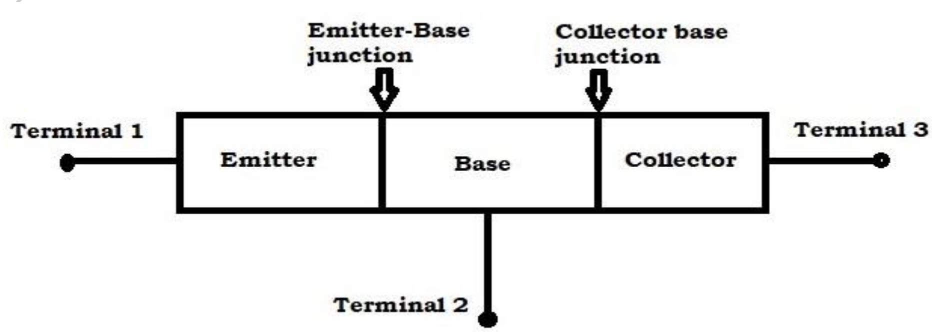


Fig. 1.28 EB and CB junction of bipolar junction transistor

1.7 TRANSFORMER

Transformer 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 step-up or step down the AC voltage. Transformer does not change the frequency of applied AC signal.

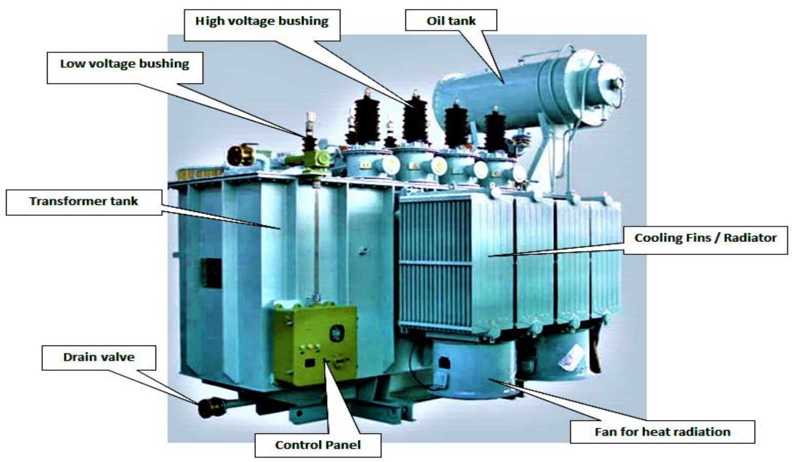


Fig. 1.29 Transformer Parts

Transformer 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 transformer.

Based on the purpose, there are different types of transformer such as Power transformers, Instrument transformers, RF transformers, Audio Transformers. However, in computers the step down transformer, centre-taped and high frequency transformer are used.

Fig. 1.30 Different types of transformer

1.8 INTEGRATED CIRCUIT (IC)

Digital ICs are used in computers, computer networks. An integrated circuit is a combination of electronic components on single piece (or "chip") of semiconductor material as shown in figure 1.31. Integrated circuit has large numbers of tiny transistors into a small chip and results in circuits that are smaller, cheaper, and faster. Integrated circuit has number of pins. The internal structure of IC is shown in figure 1.32.

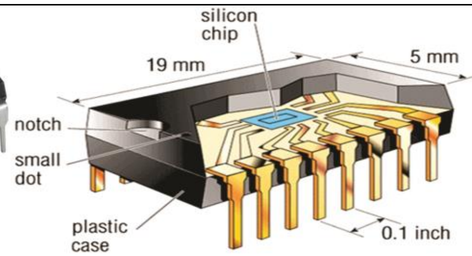


Fig. 1.31 Integrated Circuit **Fig. 1.32 Internal structure of IC**

1.9 SEMICONDUCTOR MEMORY

Semiconductor memory is an electronic data storage device which is implemented on integrated circuits (IC). As we have discussed semiconductors have conductivity in between conductors and insulators. Electronic devices are made up of semiconductor material. In semiconductor industry silicon and germanium are widely used. In computer memory is a physical electronic device. It is 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 memories include RAM, ROM and secondary memories are: Hard Disk Drive, CD/DVD, Magnetic Tape, Pen Drive etc. The primary memory can be classified into the two types: Read Only Memory (ROM) and Random-Access Memory (RAM).

Fig. 1.33: Primary Memory (a) RAM (b) ROM

Check Your Progress

A. Multiple Choice questions

1. What is the unit of electric current? (a) Ohm (b) Coulomb (c) Ampere (d) Volt

2. Which of the following is a passive electronic component? (a) Resistor (b) Transistor (c) Diode (d) Operational Amplifier

3. Which device converts alternating current (AC) to direct current (DC)? (a) Transformer (b) Rectifier (c) Inductor (d) Capacitor

4. The ability of a material to store electrical energy in an electric field is called (a) Resistance (b) Inductance (c) Conductance(d) Capacitance

5. What is the primary function of a diode? (a) To store energy (b) To amplify signals (c) To allow current in one direction only (d) To resist the flow of current

B. Fill in the blanks

1. The unit of electric resistance is the __________.
2. The component that stores electrical energy in an electric field is called a __________.
3. The flow of electric charge is known as __________.
4. A material that allows electricity to flow easily is called a __________.
5. The device used to convert AC to DC is called a __________.

C. State true or False for the following

1. A resistor stores electrical energy in a circuit.
2. The flow of electric current is measured in amperes (A).
3. A diode allows current to flow in both directions.
4. A capacitor stores energy in the form of an electric field.
5. Silicon is commonly used as a conductor in electronics.

D. Short Answer Type Questions

1. What is Ohm's Law?
2. What is a semiconductor?
3. What is the difference between alternating current (AC) and direct current (DC)?
4. What is the function of a diode?
5.. Define electrical resistance.

Session 2. Electronic Circuit Components

Electronic Circuits

A certain number of components when connected on a purpose in a specific fashion makes a circuit. A circuit is a network of different components. There are different types of circuits.

The following Figure 2.1 shows different types of electronic circuits. It Circuit Boards which are a group of electronic circuits connected on a board.

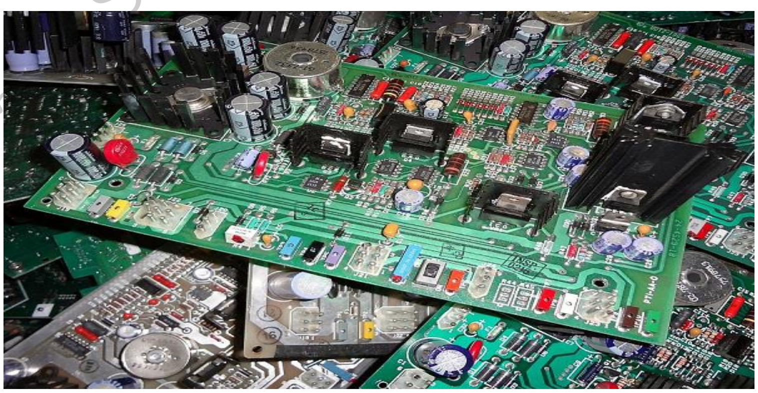


Fig. 2.1: Electronic circuits boards

Electronic circuits can be grouped under different categories depending upon their operation, connection, structure, etc.

Active Circuit

A circuit that is build using Active components is called as Active Circuit. It usually contains a power source from which the circuit extracts more power and delivers it to the load. Additional Power is added to the output and hence output power is always greater than the input power applied. The power gain will always be greater than unity.

Passive Circuit

A circuit that is build using Passive components is called as Passive Circuit. Even if it contains a power source, the circuit does not extract any power. Additional Power is not added to the output and hence output power is always less than the input power applied. The power gain will always be less than unity.

Electronic circuits can also be classified as Analog, Digital, or Mixed.

Analog Circuit

An analog circuit can be one which has linear components in it. Hence it is a linear circuit. An analog circuit has analog signal inputs which are continuous range of voltages.

Digital Circuit

A digital circuit can be one which has non-linear components in it. Hence it is a non-linear circuit. It can process digital signals only. A digital circuit has digital signal inputs which are discrete values.

Mixed Signal Circuit

A mixed signal circuit can be one which has both linear and non-linear components in it. Hence it is called as a mixed signal circuit. These circuits consist of analog circuitry along with microprocessors to process the input.

Depending upon the type of connection, circuits can be classified as either Series Circuit or Parallel Circuit. A Series Circuit is one which is connected in series and a parallel circuit is one which has its components connected in parallel.

A basic idea about electronic components, their purpose which will help us build better circuits for different applications. Whatever might be the purpose of an electronic circuit to process, to send, to receive, to analyze, the process is carried out in the form of signals.

Introduction to Analog Circuits

Analog Circuits: Circuits that process continuous signals. These signals vary smoothly over a range of values and are used in applications like audio, video, and sensors.

Basic Components

Resistors: Resist the flow of electric current, measured in ohms (Ω).

Capacitors: Store and release electrical energy, measured in farads (F).

Inductors: Store energy in a magnetic field when electrical current passes through, measured in henrys (H).

1. Series Connection

In a series circuit, components are connected end-to-end, forming a single path for the current to flow. Here are the key points:

Current (I): The same current flows through each component in a series circuit. This is because there's only one path for the current to take.

Voltage (V): The total voltage across the series circuit is the sum of the voltages across each component. V_{total}=V1+V2+V3+...

Resistance (R): The total resistance in a series circuit is the sum of the individual resistances. R_{total}=R1+R2+R3+...

Example: Imagine connecting three resistors in a series. If the resistances are R1, R2, and R3, the total resistance would be R_{total}=R1+R2+R3

2. Parallel Connection

In a parallel circuit, components are connected across the same two points, providing multiple paths for the current. Here's what happens in parallel circuits:

Current (I): The total current in the circuit is the sum of the currents through each parallel branch. I_{total}=I1+I2+I3+...

Voltage (V): The voltage across each component in a parallel circuit is the same.

Vtotal=V1=V2=V3

Resistance (R): The total resistance in a parallel circuit is less than the smallest individual resistance. It can be calculated using the formula:

1/R_{total}=1/R1+1/R2+1/R3+...

Example: If you have three resistors with resistances R1, R2, and R3 connected in parallel, the total resistance is found using the reciprocal formula above.

An electric circuit is classified into two types - Series circuit and Parallel circuit.

Series Circuit

In this type of a circuit, all components are connected as a chain and the current flowing through each one of them is the same all over the circuit. There is a single route through which the current flows. So, the current passes through each and every component.

Suppose, a battery and two electric bulbs are connected along a single path in such a way that it will form a close circuit. Therefore, current flowing through each bulb remain same, whereas voltage will get divide across each bulb.

Opening or breaking any point in a series circuit causes the whole circuit to stop functioning, which then needs to be replaced. Suppose, if one of the bulbs is fused, the electric path becomes incomplete, and another bulb is also turning off.

Series circuits are used in a variety of applications. These include thermostats, water heaters, refrigerators, and most light switches. Figure 2.4 shows the bulbs connected in series. The figure 2.4(a) shows schematic diagram and figure 2.4(b) shows circuit diagram of series connection.

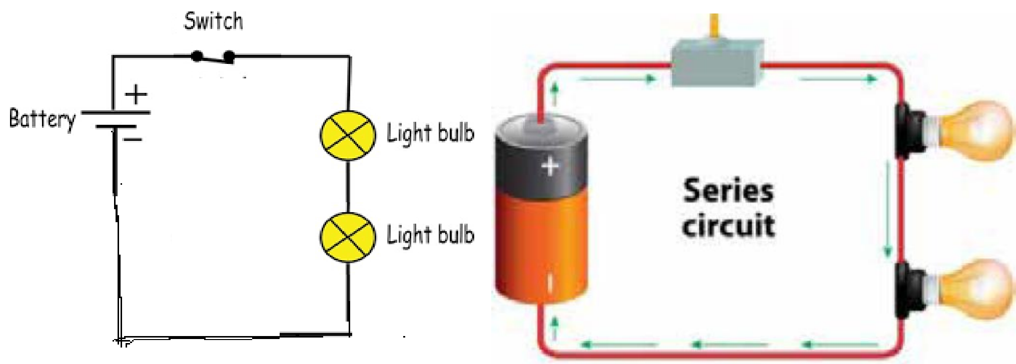


Fig. 2.2: A series circuit (a) Schematic Diagram (b) circuit diagram

Parallel Circuit

In this type of a circuit, two or more than two components are connected in parallel. In a parallel circuit, the components are of the same voltage. The current flow varies across the components.

Suppose, a battery is connected to two electric bulbs in such a way that each bulb is placed in a separate path forming a close circuit with a common battery. Therefore, current flowing through each bulb divides, whereas voltage across each bulb remains same.

If any point of the circuit gets damaged, only that part needs to be replaced. Suppose, if one of the bulbs is fused, only one electric path breaks, another bulb connected in other path will not get effected. Parallel circuits are the standard circuits found in home electrical wiring and offer distinct advantages over other circuits. Figure 2.5 shows the circuit diagram of parallel connection in symbolic as well as actual connected components.

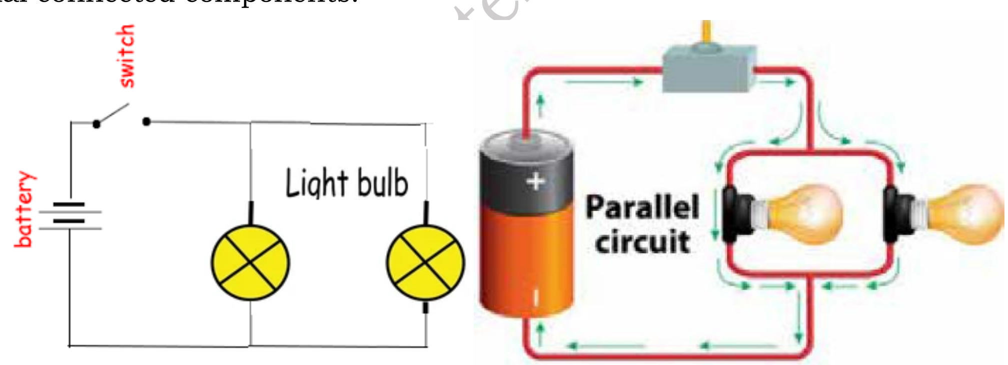


Fig.2.3: A parallel circuit (a) Schematic Diagram (b) circuit diagram

Comparison of series and parallel circuits

Table 2.1 The general comparison of series and parallel circuits.

Series	**Parallel**
The same amount of current flows through all the components	The current flowing through each component combines to form the current flow through the source.
In an electrical circuit, components are arranged in a line	In an electrical circuit, components are arranged parallel to each other
When resistors are put in a series circuit, the	When resistors are put in a parallel circuit,

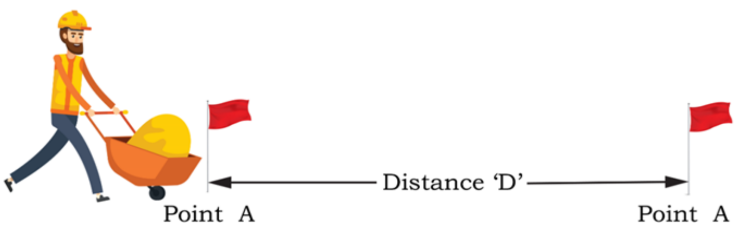
voltage across each resistor is different even though the current flow is the same through all of them.	the voltage across each of the resistors is the same. Even the polarities are the same
If one component breaks down, the whole circuit will burn out.	Other components will function even if one component breaks down, each has its own independent circuit
If V_t is the total voltage then it is equal to $V_1 + V_2 + V_3$	If V_t is the total voltage then it is equal to $V_1=V_2=V_3$

Parameters of Electric Circuit

Electricity comes into existence whenever there is a flow of electric charge between any two components. The main parameters associated with electricity are as follows.

Voltage

Let us understand the concept of voltage. Consider a situation, a person needs to pick a stone from one-point A and drop it at point B. To complete this task, he has to do some work as shown in Figure 2.4.



In the same way, voltage is amount of work done required to move one coulomb charge from one-point A to point B. Mathematical expression for voltage is written as:

$V=W/Q$

where,

'V' is the voltage,

'W' is the work in joule,

'Q' is the charge in coulomb

Alessandro Volta (1745–1827)

Voltage establish a potential difference in an electric circuit between two points i.e. one point is at higher potential and other at lower potential.

In an electric circuit, battery is used as a source of electric potential. Inside a battery, stored chemical energy provides the energy required to move the electrons in an electric circuit. Typical, general-purpose battery is shown in Figure 2.5.

Fig. 2.5 General-purpose battery

When voltage source such as battery is connected to an electric circuit, negatively charged particles(electrons) are pulled towards higher potential (+) or positive terminal of the battery, while positively charged particles are pulled towards lower potential (-) or negative terminal of the battery. Therefore, the current in a wire or resistor always flows from higher voltage towards lower voltage as shown in Figure 2.6.

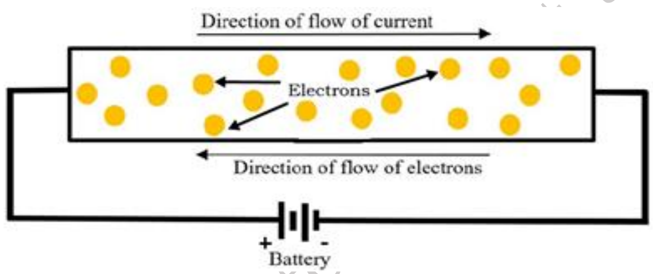


Fig. 2.6 Flow of electrons on application of DC supply

A voltmeter is used to measure the voltage or potential difference between two points in an electric circuit. Value of voltage is measured in volt or joules per coulomb. Symbolic representation of voltage is **'V'** or **'v'**. When one joule of work is done to move one coulomb charge from one point to other point the potential difference between two points is said to be one volt.

Let's look at the hydraulic or heat analogy shown below in the figure 2.7to understand it better.

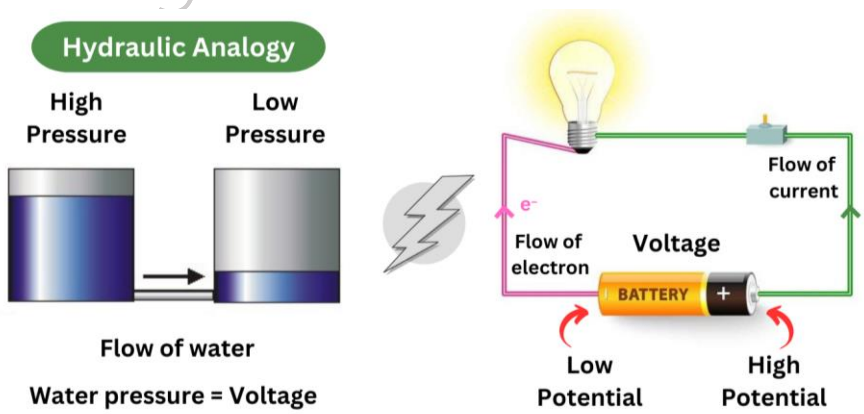


Fig. 2.7 hydraulic or heat analogy of voltage

Note: A force that causes electricity to move across a wire/cable is known as voltage. Volt is the unit of voltage and is denoted with letter V.

Example – How much work is requires to move charge of 2 C across two points having a potential difference 12 V?

Solution – Given, amount of charge Q, that flows between two points at potential difference V (= 12 V) is 2 C. Thus, the amount of work done 'W' in moving the charge is

W = VQ

= 12 V × 2 C

= 24 J

Assignment

- Calculate, the amount of work requires to move a 5 C charge between the two points having a potential difference 10 V.
- Calculate, the amount of charge requires when the 24 J of work is performing to move charge in potential difference of 8V.

Electric Current

The flow of electric charges is called electric current. The electrons carry charges with them. These electrons flow from one place to another. The amount of current flowing from one place to another determines, the amount of charge flowing through a section of conductor in specific time. Measuring unit of current is ampere (A). Symbolic representation of current is 'I'. Mathematically, it can be written as,

I= Q/t

Where,

'I' is the current,

'Q' is the amount of charge in coulombs

't' is the time in seconds

André-Marie Ampère (1775–1836)

If one coulomb charge passes through a cross-section area 'A' in one second, then it will represent the current of 1 ampere. Conventionally, the direction of current is taken as opposite to the flow of electrons.

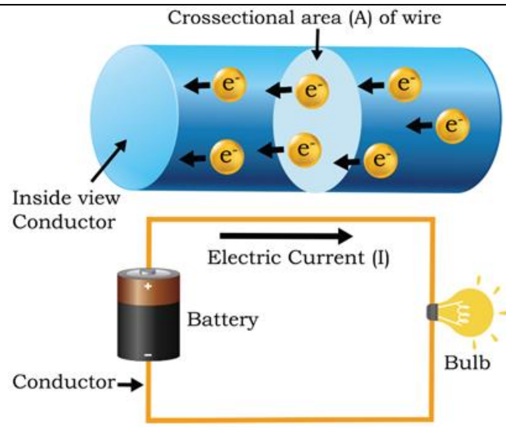


Fig. 2.8 Flow of charge through a cross section 'A'

Electric current, or simply current, is the flow of electric charge carried through electrons moving across wires. It is shown below in the figure 2.9. Ampere is the unit of current and is denoted with letter I.

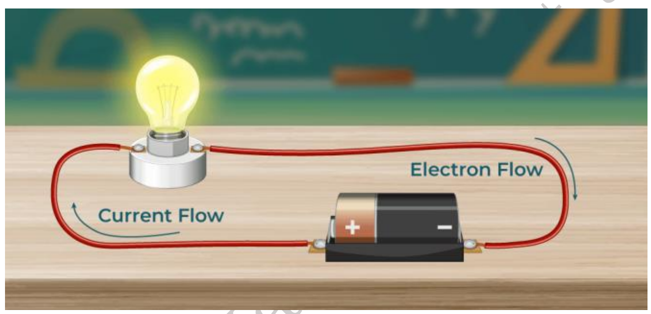


Fig. 2.9 current flow in the circuit

Example – Calculate the amount of current flowing through a wire. When the amount of charge is 5 coulombs and the time is 10 seconds.

Solution – We will use the relation between the current, charge and time.

I= Q/t

I= 5/10

I= 0.5 Ampere

Assignment

1. Calculate the amount of current drawn by radio. When amount of charge flow is 120 coulombs in 1 minute.
2. Consider an electric circuit in which LED is used for indication. While observing it was found that, the rate of charge used by the LED is 180 coulombs in 2.5 minutes. Calculate the current drawn by the LED.
3. What are the basic elements required to form an electric circuit?

AC and DC Current

Depending upon the movement of electrons in an electric circuit, current can be classified as (1) Direct current (DC) (2) Alternating current (AC)

The main difference between AC and DC lies in the direction in which the electrons flow. In DC, the electrons flow steadily in a single direction, while electrons keep switching directions, going forward and then backwards in AC.

(1) Direct Current (DC)

It is unidirectional in nature, that is movement of electrons takes place only in one direction. This means that current flow only in one direction. Typical, electric circuit having a DC voltage source and DC current characteristics of DC current flowing through the circuit are shown in Figure 2.10.

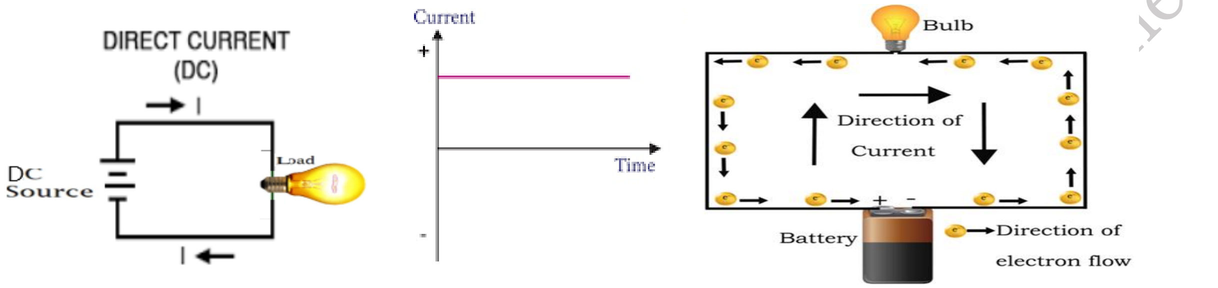


Fig. 2.10 DC Current flowing through the circuit

DC voltage source such as batteries and cells produce direct current. Typical DC voltage source are shown in Figure — Direct current is used in wall clock, remote control, motor vehicles, cell phone and many more.

Fig. 2.11 Various sources of DC voltage source

(2) Alternating current (AC)

It is bidirectional in nature, that is movement of electrons takes place in two directions. This means that current flows in two directions. The Figure 2.9 shows typical AC source is applied in an electric circuit and the characteristics of AC current flowing through the circuit.

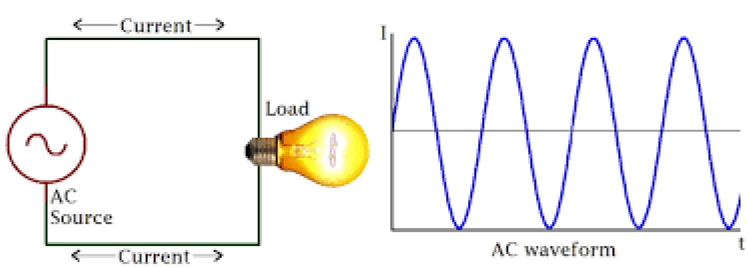
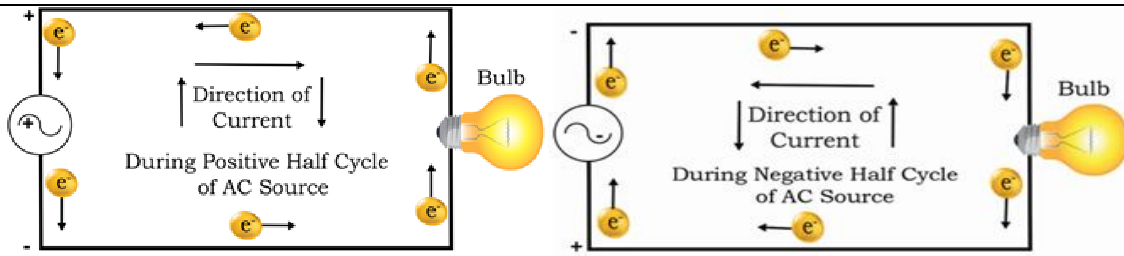


Fig. 2.12 AC Current flowing through the circuit



a) Positive half of AC source is applied in an electric circuit b) Negative half of AC source is applied in an electric circuit

AC voltage source like AC generator produces alternating current. Hydel power plants, thermal power plants and many more are the places, where AC voltage is generated. In India, standard AC generating frequency (f) of alternating current is 50 hertz. Generators at the power plants works continuous to produce AC voltage. As a backup for few hours' diesel generator are used to provide power supply for appliance in case of power cut or unavailability of generating power supply. Alternating current is used in ceiling fan, cooler, washing machine and many more. Various AC generators are shown in Figure 2.13.

Fig. 2.13 Various AC generators

Difference between AC and DC current

The table 2.2 below compares the behaviour of AC and DC current

DC Current	AC Current
DC can be defined as the flow of current in which the drift of electrons remains steady in a single direction.	AC current can be defined as the flow of current in which electrons keep switching directions, going either forward or backward.
The magnitude of induced current remains constant.	The magnitude of induced current varies with time.

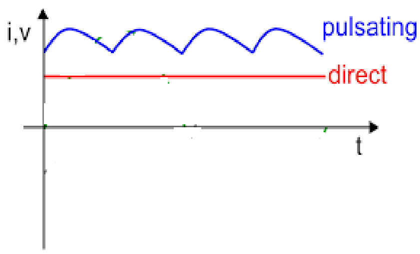
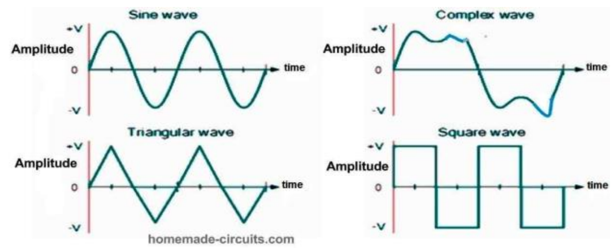
<table>
<tr>
<td>Types of DC signals are pure DC and pulsating DC.

</td>
<td>Types of AC signals are sinusoidal, triangular, square wave signals

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Table 2.3 Difference between AC and DC current

Know More...

Frequency can be defined as “the number of cycles in one second”. In Figure 2.14, point A to point B represents one cycle. Hertz (Hz) is the measuring unit of frequency.

Example: 50 Hz represents 50 cycles in 1 second.

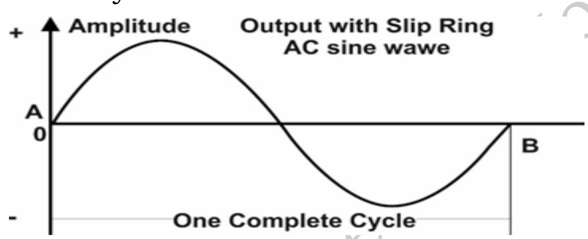


Fig. 2.14 Cycle of AC signal

Circuit Elements

All electronic devices are made up of components such as resistors, capacitors, power supplies, and circuit chips. If you were to open up your television or cell phone you'd see similar things inside. When you turn on your electronic gadget, electricity runs through it giving it the power to do everything you expect it to do.

An electric or electronic circuit forms the core part for functioning of any electrical or electronic home appliances. A circuit is built up using various components. These components can be classified into three types (1) active components, (2) passive components (3) electromechanical components.

1. **Active Components**

Active components depend on a source of energy to perform their functions. These components can amplify current and can produce a power gain. The examples of active components can be given as Diode, Light Emitting Diode (LED), Transistor and Integrated Circuit (IC). Figure 2.15 shows the various active components used in the circuit.

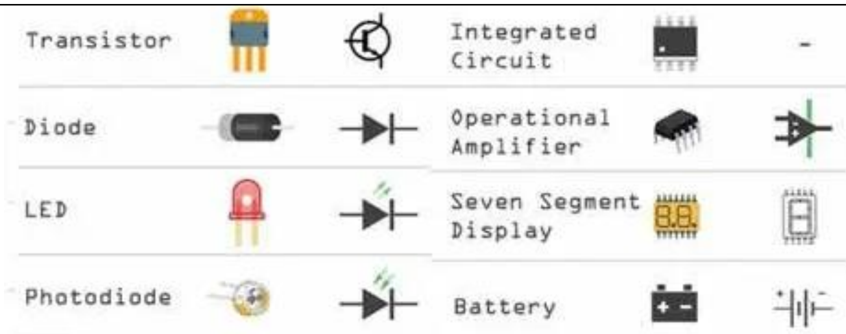


Fig. 2.15 Active components

2. Passive Components

Passive components are those components which can perform their specific functions without any power source. These components are incapable of controlling current. The examples of passive components can be given as Thermistor, Inductor, Capacitor, Resistor, Transformer. Figure 2.16 shows the various passive components used in the circuit.

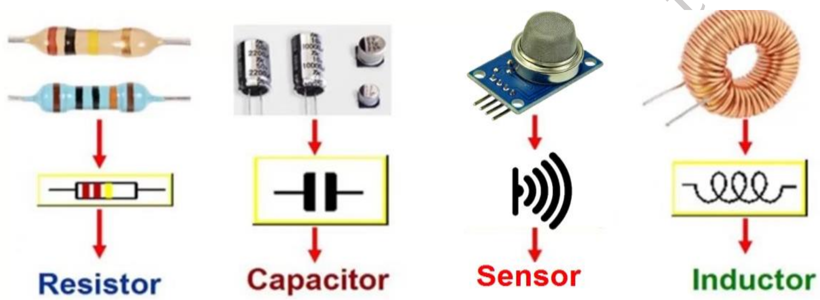
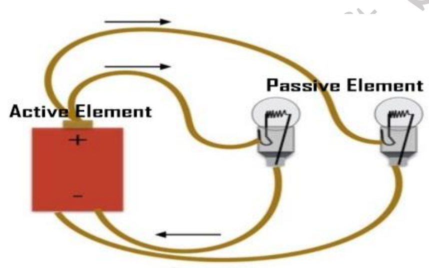


Fig. 2.16 Passive components

Important note

Active components are those that **deliver** or **produce energy** or power in the form of a voltage or current. Passive components are those that **utilize or store energy** in the form of voltage or current.



3. Electromechanical Components

Electromechanical components convert electric energy into mechanical energy (mechanical movement) or vice versa for carrying out electric operations. The examples of electromechanical components can be given as Timer, Starter, Connector. Figure 2.17 shows the various electromechanical components used in the circuit.

Fig 2.17 Electromechanical components

Digital Circuit – Logic Gates

Logic gates are fundamental building blocks in digital logic circuits. They are mathematical operations that operate on one or more binary inputs (0 or 1) and produce a binary output based on predefined logic rules. There are several types of Boolean gates, each with its specific behaviour. The basic boolean gates are of three types NOT gate, AND gate, and OR gate. Figure 9.6 illustrates the symbolic representation of these gates.

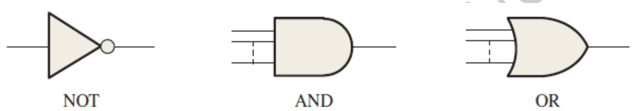


Fig. 2.18 The basic logic functions and symbols

NOT Gate – A NOT gate, also known as an inverter, is a fundamental Boolean gate that has a single input and produces an output that is the complement of the input. In other words, if the input is 1, the output is 0, and if the input is 0, the output is 1. Figure 2.19 illustrates that when the input is HIGH (1), the output is LOW (0). When the input is LOW, the output is HIGH. In either case, the output is not the same as the input. The NOT function is implemented by a logic circuit known as an inverter.

Fig. 2.19 The NOT gate

Table 2.4 illustrates the truth table of the NOT gate. When the input is low then the output is high and when the output is high then the input is low.

Table 2.4 The truth table of NOT gate

X	Output
0	1
1	0

AND Gate – An AND gate is a fundamental Boolean gate that takes two or more inputs and produces an output based on the logical AND operation. The output of an AND gate is 1 only if all of its input signals are 1; otherwise, the output is 0. The truth table of the AND gate is shown in Table 2.5.

Table 2.5 The truth table of AND gate

X	Y	Output
0	0	0
0	1	0
1	0	0
1	1	1

Figure 2.20 illustrates the AND gate and whenever both inputs are HIGH the output become HIGH

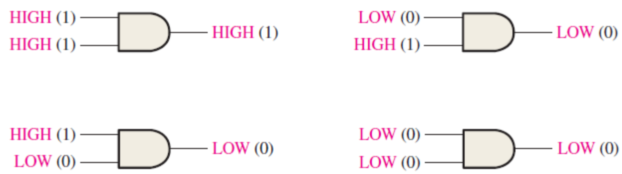


Fig. 2.20 The AND function

The Boolean expression for an AND gate is represented by the symbol "∧" or by the multiplication operator (*). For example:

OR Gate – An OR gate is another fundamental Boolean gate that takes two or more inputs and produces an output based on the logical OR operation. The output of an OR gate is 1 if at least one of its input signals is 1; otherwise, the output is 0. The truth table of the OR gate is shown in Table 2.6.

Table 2.6 The truth table of OR gate

X	Y	Output
0	0	0
0	1	1
1	0	1
1	1	1

Figure 2.21 illustrates the OR gate and whenever both inputs are LOW the output becomes LOW

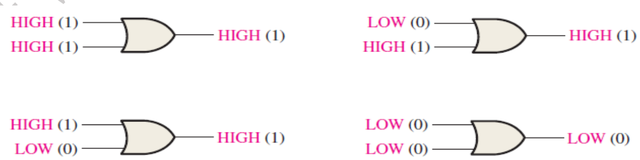


Fig. 2.21 The OR function

The OR gate is represented by the symbol "∨" or by the addition operator (+).

XOR Gate – The XOR gate, also known as the exclusive OR gate, has two inputs and produces a high output (logic 1) when the number of high inputs is odd. If the inputs are the same (both high or both low), the output is low (logic 0). The Boolean expression for an XOR gate is Y = A XOR B. The truth table of the XOR gate is shown in Table 2.7.

Table 2.7 The truth table of XOR gate

X	Y	Output
0	0	0

0	1	1
1	0	1
1	1	0

Figure 2.22 illustrates the XOR gate and whenever both inputs are different the output becomes HIGH

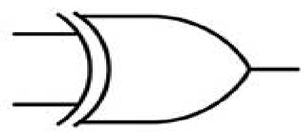


Fig. 2.22 The XOR function

XNOR Gate – The XNOR gate, also known as the exclusive NOR gate, is the complement of the XOR gate. It produces a high output (logic 1) when the number of high inputs is even. If the inputs are the same (both high or both low), the output is high (logic 1). The Boolean expression for an XNOR gate is Y = A XNOR B. The truth table of the XNOR gate is shown in Table 2.8.

Table 2.8 The truth table of XOR gate

X	Y	Output
0	0	1
0	1	0
1	0	0
1	1	1

Figure 2.23 illustrates the XOR gate and whenever both inputs are different the output becomes LOW

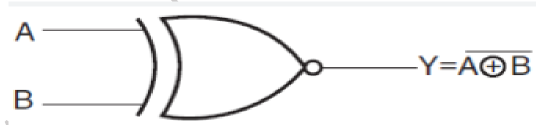


Fig. 2.23 The XNOR function

NAND Gate – The NAND gate is a combination of an AND gate followed by a NOT gate. It produces a low output (logic 0) only when all of its inputs are high (logic 1). Otherwise, the output is high (logic 1). The Boolean expression for a NAND gate is Y = NOT (A AND B). This is a universal gate, which means any gate can be prepared using the combination of NAND gates. The truth table of the NAND gate is shown in Table 2.9.

Table 2.9 The truth table of NAND gate

X	Y	Output
0	0	1
0	1	1
1	0	1
1	1	0

Figure 2.24 illustrates the NAND gate and the output of this gate is an inverted AND gate.

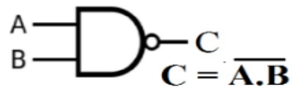


Fig. 2.24 The NAND function

NOR Gate – The NOR gate is a combination of an OR gate followed by a NOT gate. It produces a high output (logic 1) only when all of its inputs are low (logic 0). Otherwise, the output is low (logic 0). The Boolean expression for a NOR gate is Y = NOT (A OR B) This is a universal gate, which means any gate can be prepared using the combination of NOR gates. The truth table of the NOR gate is shown in Table 2.10.

Table 2.10 The truth table of NOR gate

X	Y	Output
0	0	1
0	1	0
1	0	0
1	1	0

Figure 2.25 illustrates the NOR gate and the output of this gate is an inverted OR gate.

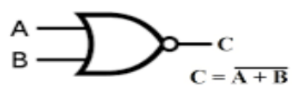


Fig. 2.25 The NAND function

Number system

The binary number system and digital codes are fundamental to computers and digital electronics in general. In this chapter, the binary number system and decimal number system are discussed. Binary numbers are covered to provide a basis for understanding how computers and many other types of digital systems work. Digital codes such as binary coded decimal (BCD), the Gray code, and the ASCII (American Standard Code for Information Interchange) are used in the system.

Decimal Number One is familiar with the decimal number system because one uses decimal numbers every day. In the decimal number system, each of the ten digits, 0 through 9, represents a certain quantity. As one knows, the ten symbols (digits) do not limit one to expressing only ten different quantities because one uses the various digits in appropriate positions within a number to indicate the magnitude of the quantity. One can express quantities up through nine before running out of digits; if one wishes to express a quantity greater than nine, then one can use two or more digits, and the position of each digit within the number tells the magnitude it represents. If, for example, one wishes to express the quantity twenty-three, one uses (by their respective positions in the number) the digit 2 to represent the quantity twenty and the digit 3 to represent the quantity three, as illustrated below.

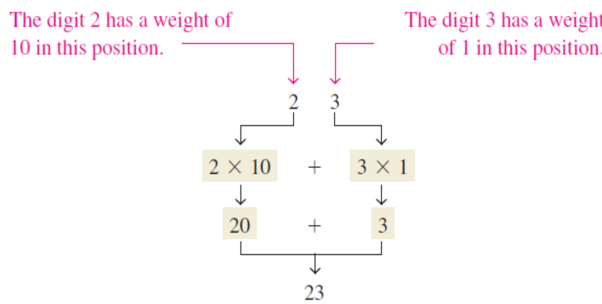


Fig. 2.26 Addition of decimal number system

The position of each digit in a decimal number indicates the magnitude of the quantity represented and can be assigned a weight. The weights for whole numbers are positive powers of ten that increase from right to left, beginning with $10^0 = 1$.

$\ldots 10^5\ 10^4\ 10^3\ 10^2\ 10^1\ 10^0$

For fractional numbers, the weights are negative powers of ten that decrease from left to right beginning with 10^{-1}**.** The value of a decimal number is the sum of the digits after each digit has been multiplied by its weight**.**

$$10^2\ 10^1\ 10^0.10^{-1}\ 10^{-2}\ 10^{-3}\ \ldots$$

Decimal point

Fig. 2.27 Decimal number system

Binary Number: The binary number system is another way to represent quantities. It is less complicated than the decimal system because the binary system has only two digits. The decimal system with its ten digits is a base-ten system; the binary system with its two digits is a base-two system. The two binary digits (bits) are 1 and 0. The position of a 1 or 0 in a binary number indicates its weight, or value within the number, just as the position of a decimal digit determines the value of that digit. The weights in a binary number are based on powers of two.

A binary count of zero through fifteen is shown in Table 2.2. Notice the patterns with which the 1s and 0s alternate in each column.

Table 2.11 Binary count of decimal digits

Decimal Number	**Binary Number**			
0	0	0	0	0
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
5	0	1	0	1
6	0	1	1	0
7	0	1	1	1

8	1	0	0	0
9	1	0	0	1
10	1	0	1	0
11	1	0	1	1
12	1	1	0	0
13	1	1	0	1
14	1	1	1	0
15	1	1	1	1

four bits are required to count from zero to 15. In general, with n bits, one can count up to a number equal to (2n – 1).

Largest decimal number = 2n - 1

For example, with five bits (n = 5) you can count from zero to thirty-one.

$2^5 - 1 = 32 - 1 = 31$

With six bits (n = 6) you can count from zero to sixty-three.

$2^6 - 1 = 64 - 1 = 63$

Application of binary number system – binary number system will help to understand how digital circuits can be used to count events. For example, counting tennis balls going into a box from a conveyor belt. Assume that nine balls are to go into each box. The counter in Figure 9.11 counts the pulses from a sensor that detects the passing of a ball and produces a sequence of logic levels (digital waveforms) on each of its four parallel outputs. Each set of logic levels represents a 4-bit binary number (HIGH = 1 and LOW = 0), as indicated. As the decoder receives these waveforms, it decodes each set of four bits and converts it to the corresponding decimal number in the 7-segment display. When the counter gets to the binary state of 1001, it has counted nine tennis balls, the display shows decimal 9, and a new box is moved under the conveyor belt. Then the counter goes back to its zero state (0000), and the process starts over. The number 9 was used only in the interest of single-digit simplicity. Figure 2.28 illustrates the counting of balls using Boolean logic

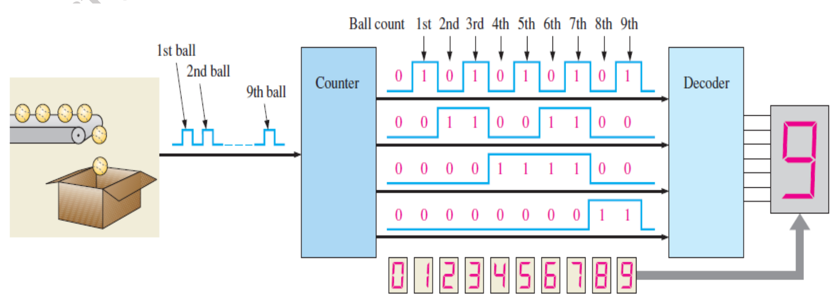


Fig. 2.28 Illustration of a simple binary counting application

Hexadecimal Number System

The hexadecimal number system, also known as the base-16 system, is commonly used in computer science and programming. It uses sixteen digits: 0-9 for the first ten digits and A-F (or a-f) for the additional six digits. Each hexadecimal digit represents a four-bit binary number. Hexadecimal numbers are often used to represent binary numbers in a more concise and human-readable format. The decimal to hexadecimal conversion is demonstrated in Table 2.12

Table 2.12 Hexadecimal of decimal digits

Decimal (Base 10)	**Hexadecimal (Base 16)**
1	**1**
2	**2**
3	**3**
4	**4**
5	**5**
6	**6**
7	**7**
8	**8**
9	**9**
10	**A**
11	**B**
12	**C**
13	**D**
14	**E**
15	**F**

For example, the hexadecimal number 2F is equivalent to the binary number 0010 1111, which is equal to the decimal number 49.

Octal number system

The octal number system, also known as the base-8 system, uses eight digits: 0-9. Octal numbers are used less frequently nowadays but were commonly used in early computer systems. Each octal digit represents a three-bit binary number. Octal numbers can be easily converted to and from binary by grouping binary digits into sets of three. For example, the octal number 27 is equivalent to the binary number 010 111, which is equal to the decimal number 23.

Microprocessor

Microprocessors are semiconductor single-chip devices that act as miniaturized computers but not as full-fledged computers. On a single chip, its CPU houses registers, an interrupts circuit, an arithmetic and logic unit (ALU), a program counter, a stack pointer, and a program counter. Typically, ROM and RAM, a memory decoder, an oscillator, and a number of serial and parallel ports must be added to create a complete microcomputer. Application of microprocessor includes Desktop PC's, Laptops, notepads etc.

Fig. 2.29: Microprocessor

Microcontroller

A microcontroller (or VLSI microcomputer) is a computing device integrated on a single chip. Unlike a microprocessor, a microcontroller has a CPU with RAM, ROM, and other necessary peripherals, all embedded on a single chip.

It is a kind of minicomputer in a circuit that allows IoT-based hardware to communicate effectively with other devices. Microcontrollers are the heart of any IoT device because they are small, require less power, and perform the necessary functions like any advanced microprocessor. In IoT applications, the microcontroller is cheap as most of the internal pins are user programmable and all components can be integrated on a single board, which reduces the size of the entire computing unit.

All microcontrollers are designed to perform specific tasks. Microcontrollers can be of 4-bits, 8-bit, 64-bit, or 128-bits configuration, depending on the functionality of the embedded system. The following image shows the microcontroller:

Fig. 2.30: Microcontroller

Applications of Microcontroller

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

Comparison of microprocessor and microcontroller: The following table lists the difference between a microprocessor and a microcontroller:

Basis for Comparison	Microprocessor	Microcontroller
Functional Units	ALU, registers, CU.	ALU, register, CU, IO port, RAM, ROM, ADC, DAC, timer and counters.
Data transfer instructions	It has large number of data transfer instructions.	Comparatively a smaller number of such instructions.
Cost	High	Comparatively low.
Size of PCB	Large	Small in comparison to

		microprocessor.
Weight	Bulky	Less bulky
Processing speed	1 GHz	8 to 50 MHz
Uses	Finds its use in general purpose computing systems.	Uses in systems that are manufactured for specific application.
Efficiency	Less efficient	More efficient
Power consumptions	High	Low in comparison to microcontroller
Reliability	Less reliable	More reliable
Example	8085, 8086 etc	8051, 8951 etc.

Table 2.13 Comparison of a microprocessor and a microcontroller

Practical activity 3.1: Identify microprocessors and microcontroller chips.
Step 1: Take the given chip and observe it carefully.
Step 2: Check properly the details of the chip.
Step 3: Match with the given description for identification.

POWER SUPPLY

Power supply is an electrical device which provides operating voltage to the computer. Power supply is used to provide power to PC. Power supply requires a minimum load of 7A at 5V and 6.5A at 12V. Modern PC requires power in range from 60 W to 250W. The electronic components inside the computer requires vary low DC voltage.

Types of Power supply

The various types of power supply are:

- AC power supply
- DC power supply
- Batteries
- Uninterrupted Power Supply
- Switched Mode Power supply (SMPS)

AC power supply

AC power supply is utilized to furnish alternating current (AC) power to a load, and it can accept power input in either AC or DC form. Frequently, power received from wall outlets (mains supply) and other power storage devices isn't directly compatible with the requirements of the load. In order to overcome this disparity, AC power supplies play a crucial role by transforming and adjusting the AC power from the electrical source to match the specific voltage, current, and frequency needs of the connected device. This transformation involves stepping up or stepping down the voltages, coupled with filtering processes. Consequently, the electrical power is delivered to the device in a precise and controlled manner.

AC power supplies possess the capability to regulate the voltage provided to the load and, in some cases, manage the current drawn by the load to ensure safe operating levels.

Fig. 2.31 AC Power supply

Nature of Alternating Current

Alternating current (AC) is a form of electricity in which the flow of electric current periodically reverses direction. As a result, the voltage also changes polarity with time. It is created by an AC generator through the principle of electromagnetic induction; an AC generator consists of a conductor which rotates over stationary magnetic poles.

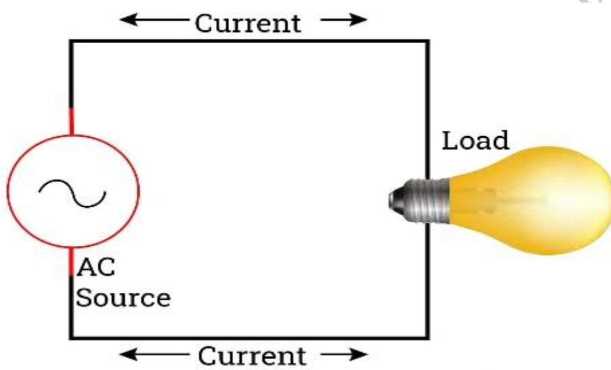


Fig. 2.32 AC current circuit

DC power supply

DC/DC power supply, also referred to as a DC/DC converter, operates by utilizing DC voltage as its input, in contrast to AC voltage. The primary objective of DC/DC power supplies is to generate a controlled and consistent voltage output suitable for electronic and electrical devices. Unlike AC voltage, which can be manipulated using transformers to step up or step down the voltage, DC voltage lacks this capability.

Fig. 2.33 DC Power supply

BATTERIES

Batteries are convenient sources of electricity that can be easily stored and utilized. Batteries are the hardware device which stores the energy in the form of chemical. When an external circuit is connected to the battery it converts the chemical energy into electrical energy.

Fig. 2.34 Battery used in UPS

Batteries can be broadly classified into two types: Primary and Secondary.

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)

A switched mode power supply (SMPS) is used to achieve good voltage regulation and good conversion of power. The SMPS functions in three states input rectifier where AC is converted to DC, inverter phase where again the DC is converted into inverted AC, output rectifier stage where the inverted AC is given to the high winding transformer.

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

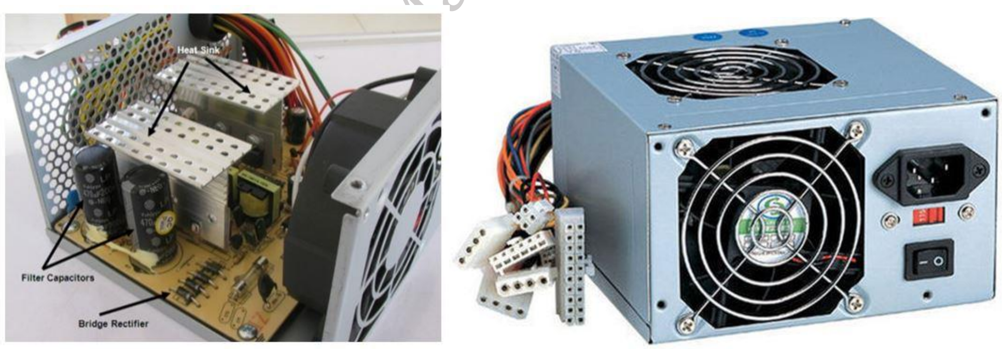


Fig. 2.35: SMPS and its internal parts

SMPS contain several colour of wires which carry the different voltage to the different parts of the computer. The table 2.14 shows the different colour cables and it carrying voltage.

Table 2.14

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 (Stand By)

UNINTERRUPTED POWER SUPPLY

The Uninterruptible Power Supply (UPS) is an electronic device which supplies power to a load when mains supply or input power source fails. Any UPS has a power storage element which stores energy in the form of chemical energy like 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.

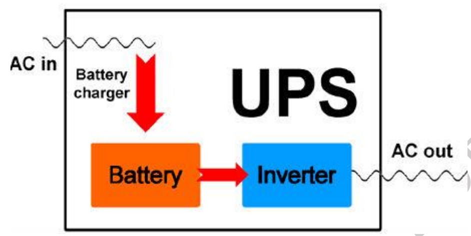


Fig. 2.36: Block representation of UPS

Classification of UPS

UPS plays a vital role to maintain the regularity of the electric power. There are vary of UPS are used in our 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 power cut there will be no momentary power breaks.

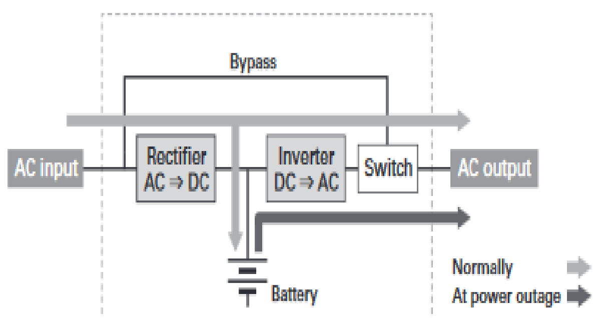


Fig. 2.37: Online UPS

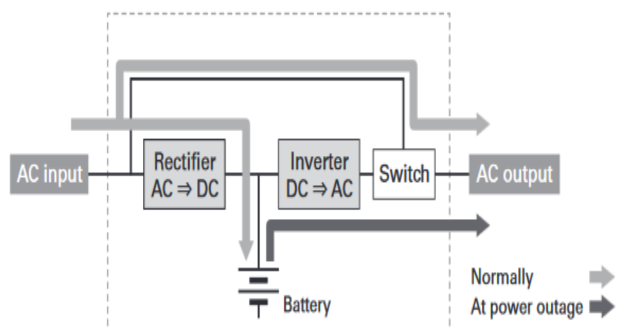


Fig. 2.38: Offline UPS

Standby/ Offline UPS: A system where, normally AC input (utility power) is output as 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 occur in AC output.

PRINTED CIRCUIT BOARD

A Printed Circuit Board (PCB) is used to electrically connect various components using tracks, pads etc. Internally all the components are connected which reduce the complexity of the circuit. PCB 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 PCB 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 consist of one layer of copper on a rigid base material.
- Double-layer PCB: Double sided consists of 2 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 particular glue.
- Flexible PCB: It consists of a single conductor layer on a dielectric film.

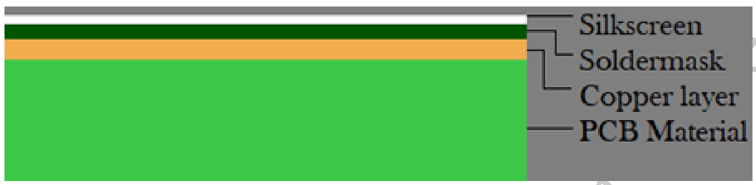


Fig. 2.39: Single-layer PCB

Fig. 2.40: Double-layer PCB

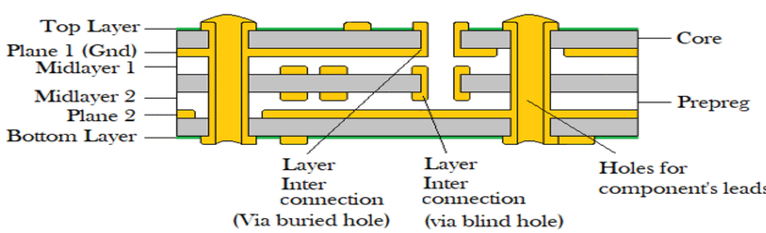


Fig. 2.41: Multi-layer PCB

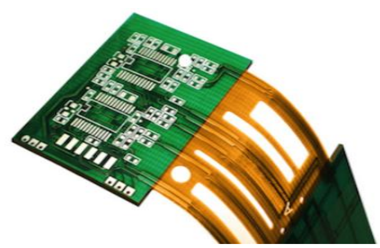


Fig. 2.42: Flexible PCB

Check Your Progress

A. Multiple Choice questions

1. Which of the following components stores energy in an electric field? (a) Inductor (b) Capacitor (c) Resistor (d) Diode

2. What is the main function of a resistor in a circuit? (a) Store electrical charge (b) Control the flow of current (c) Amplify the signal (d) Rectify alternating current

3. Which component is used to amplify electrical signals? (a) Diode (b) Resistor (c) Transistor (d) Capacitor

4. Which of the following is used to convert AC to DC? (a) Inductor (b) Transformer (c) Rectifier (d) Ca-

pacitor

5. What does an inductor do in an electronic circuit? (a) Stores energy in a magnetic field (b) Resists the flow of current (c) Converts AC to DC (d) Allows current to flow in one direction only

B. Fill in the blanks

1. A __________ stores energy in an electric field.
2. A __________ is used to resist the flow of current in an electronic circuit.
3. A __________ is a semiconductor device used to amplify or switch electronic signals.
4. A __________ converts alternating current (AC) to direct current (DC).
5. The unit of capacitance is the __________.

C. State true or False for the following

1.A transistor is a passive component.

2.The purpose of a rectifier is to convert AC to DC

3. An LED (Light Emitting Diode) converts electrical energy into light.

4. An inductor stores energy in an electric field.

5.A transformer is used to step up or step down the voltage in a circuit.

D. Short Answer Type Questions

1. What is the function of a capacitor in an electronic circuit?
2. Describe the role of a resistor in an electronic circuit?
3. What is a diode, and what is its primary function?
4. Explain what a transistor is and its main applications?
5. What is the function of a Zener diode?

Session 3. Functions of Electrical and Mechanical Parts in a Computer system

A computer system comprises various electrical and mechanical parts, each playing a vital role. The CPU processes data, while RAM stores active data temporarily. The motherboard connects all components, facilitating communication and distributing power from the Power Supply Unit (PSU). Voltage regulators stabilize power levels, and capacitors smooth voltage fluctuations. Fans and heat sinks cool the CPU and GPU, preventing overheating. Chassis houses and protects internal components, offering structural support and airflow management. Hinges in laptops provide screen mobility, while expansion card slots allow for hardware upgrades. Hard drive mounts secure storage devices, ensuring data integrity. Connectors and I/O ports facilitate external connections. The BIOS/UEFI chip initializes hardware during boot-up, while LEDs indicate system status. Together, these electrical and mechanical parts ensure the system operates efficiently, reliably, and safely.

3.1 Functions of Various Electrical Parts

The electrical parts and modules in a computer system play crucial roles in ensuring the system functions correctly. There are a breakdown of the key electrical components and their functions:

1. Central Processing Unit (CPU)

The CPU is responsible for executing instructions from programs. It processes data by performing arithmetic and logic operations, controlling other components, and handling input/output operations.

2. Power Supply Unit (PSU)

The PSU converts AC (alternating current) from the wall outlet into DC (direct current) used by the computer's internal components. It supplies the necessary voltages and current levels to the motherboard, CPU, GPU, drives, and other peripherals.

3. Motherboard

The motherboard is the main printed circuit board (PCB) that connects and allows communication between all components of the computer. It distributes power from the PSU to the CPU, RAM, and other hardware.

4. Random Access Memory (RAM)

RAM is the computer's short-term memory, where data is stored temporarily while being accessed or processed by the CPU. It requires constant power to retain data and enables quick read/write operations.

5. Voltage Regulators

These are electronic circuits on the motherboard that regulate the voltage supplied to the CPU, RAM, and other components, ensuring they receive the correct voltage levels for stable operation.

6. Capacitors

Capacitors store and release electrical energy, helping to smooth out voltage fluctuations and provide a stable power supply to the components. They are crucial for filtering and decoupling in the power distribution network on the motherboard.

7. Inductors

Inductors store energy in a magnetic field when current flows through them. They are used in conjunction with capacitors in power regulation circuits, such as voltage regulators, to filter out noise and stabilize voltage.

8. Resistors

Resistors limit the flow of electric current in circuits. They are used for controlling voltages, current levels, and signal strength in various parts of the computer system.

9. Diodes

Diodes allow current to flow in one direction only. They are used for rectification (converting AC to DC), protecting circuits from voltage spikes, and in logic circuits.

10. Transistors

Transistors are semiconductor devices that can act as amplifiers or switches. They are fundamental in building the logic gates and circuits in CPUs, memory modules, and other digital logic components.

11. Integrated Circuits (ICs)

ICs are compact assemblies of transistors, resistors, capacitors, and other components on a single chip. They perform a wide range of functions, from processing data (as in the CPU) to managing power distribution (as in voltage regulators).

3. Crystal Oscillator

The crystal oscillator provides the clock signal that synchronizes the operation of the CPU and other components. It generates a precise frequency signal that dictates the timing of all operations in the system.

13. Battery (CMOS Battery)

The CMOS battery powers the CMOS chip, which stores BIOS settings like system time, date, and hardware configuration. It allows the system to retain these settings when the computer is powered off.

14. Connectors and Ports

Electrical connectors and ports (like USB, HDMI, and power connectors) provide pathways for power and data to flow between the computer and external devices or between components within the system.

15. Heat Sinks and Fans (with Electrical Components)

Heat sinks and fans dissipate heat generated by electrical components like the CPU and GPU. Fans are powered by electrical motors that create airflow, while heat sinks may contain thermoelectric coolers that also use electrical power.

16. Sensors (Temperature, Voltage, etc.)

Sensors monitor various parameters like temperature, voltage, and fan speed. They send data to the motherboard, which uses this information to control cooling systems, adjust power levels, and prevent overheating or electrical faults.

17. LEDs

LEDs (Light Emitting Diodes) are used for indicators on the motherboard, PSU, and other peripherals. They signal power status, component activity (like hard drive access), and error conditions.

3.2 Functions of Various Mechanical Parts

The mechanical parts and modules in a computer system are crucial for the physical assembly, protection, cooling, and functionality of the hardware. Here's an overview of the functions of these mechanical components:

1. Chassis (Case)

The chassis, or computer case, houses all the internal components of the computer, providing structural support and protection from physical damage, dust, and electromagnetic interference. It also helps organize and manage cables and provides mounting points for components like the motherboard, power supply, drives, and cooling systems.

2. Fans

Fans are mechanical devices used to move air through the computer case to cool internal components. They help dissipate heat generated by the CPU, GPU, PSU, and other components by creating airflow that carries heat away from them, preventing overheating.

3. Heat Sinks

Heat sinks are passive cooling devices made of metal, usually aluminum or copper, with fins or ridges to increase surface area. They absorb and dissipate heat from components like the CPU, GPU, and voltage regulators by transferring heat away from these components and into the surrounding air, often assisted by fans.

4. Hard Drive/SSD Mounts and Trays

These are mechanical brackets or trays inside the chassis that securely hold hard drives (HDDs) or solid-state drives (SSDs) in place. They protect the drives from movement and vibration, ensuring reliable operation and data integrity.

5. Optical Drive Bays

Optical drive bays are compartments in the chassis designed to hold optical drives (such as CD, DVD, or Blu-ray drives). They provide easy access to the drives from the front of the case and ensure they are securely mounted.

6. Expansion Card Slots (PCIe, PCI, AGP)

These slots on the motherboard provide mounting and connection points for expansion cards, such as graphics cards, sound cards, network cards, and others. The mechanical design ensures that the cards are securely inserted and aligned for proper electrical connection.

7. I/O Shield

The I/O shield is a metal plate that fits into the back of the chassis, aligning with the motherboard's input/output ports. It provides a clean and secure interface for connecting peripherals while protecting the internal components from dust and debris.

8. Screws and Standoffs

Screws and standoffs are mechanical fasteners used to mount components like the motherboard, drives, and expansion cards securely to the chassis. Standoffs are used to elevate the motherboard off the case floor, preventing electrical shorts and allowing proper airflow.

9. Hinges (in Laptops)

Hinges in laptops connect the display to the main body of the laptop and allow the screen to be opened and closed smoothly. They are designed to hold the screen at various angles and ensure durability through repeated use.

10. Keyboard and Mouse Mechanisms

The mechanical components of a keyboard include the keys, switches, and supporting structures that provide tactile feedback and durability. In a mouse, mechanical parts include buttons, scroll wheel mechanisms, and the optical sensor's movement-tracking components.

11. Drive Eject Mechanism (Optical Drives)

This mechanism in optical drives allows the user to eject and retract discs using a motorized system. It involves gears, a tray, and a small motor that work together to move the disc in and out of the drive.

3. Cable Management Features

These include hooks, straps, and channels within the chassis designed to organize and route cables neatly. Good cable management improves airflow, reduces clutter, and makes it easier to upgrade or maintain the system.

13. Power Button and Reset Button

These buttons on the chassis allow the user to power on, power off, or reset the computer. They are connected to the motherboard and function by completing or breaking an electrical circuit when pressed.

14. Display Hinge Mechanism (in Laptops)

This is a specialized hinge system that allows the screen of a laptop to be rotated and positioned at various angles. It provides stability and durability, ensuring that the screen stays in place during use.

15. Vibration Dampening Components

These are rubber or silicone pads, mounts, or grommets used to reduce vibrations from mechanical components like hard drives and fans. This helps in reducing noise and protecting sensitive components from mechanical wear and tear.

16. Cooling Ducts and Airflow Channels

Cooling ducts and airflow channels are designed into the chassis to guide air efficiently over critical components like the CPU and GPU. This mechanical design enhances cooling performance by optimizing the path of airflow.

17. Laptop Trackpad Mechanisms

The mechanical components of a trackpad include the touch-sensitive surface and the underlying sensors that detect finger movement. It also includes physical buttons or pressure-sensitive areas for clicking.

18. Hinge and Latch Mechanisms (Laptop/Tablet)

These mechanisms allow the screen to close securely onto the laptop's body or enable a tablet to attach and detach from a keyboard or stand. They provide stability and ease of use in convertible devices.

3.3 Precautions of protect from electrical hazards

There are some precautions take to protect yourself from electrical hazards:

Check equipment

Before using any electrical equipment, inspect it for damage or wear and tear, including power cords, tools, and electrical fittings. If you find a fault, stop using the equipment.

Avoid overloading outlets

Overloaded outlets can create too much demand on a circuit, which can lead to shock or fire. To avoid this, spread out the number of things you plug into each outlet.

Ground electrical systems

Proper grounding provides a safe path for excess electricity to flow, which helps protect workers from shock. An improperly grounded system can cause electrical currents to flow through a person's body, which can lead to injury or death.

Unplug equipment when not in use

Unplugging appliances when they're not in use can prevent electrical hazards and save you money on your electricity bill. It can also prevent your appliances from overheating and being damaged if there's a power surge.

Use child-proof outlets

Child-proof outlets, also known as tamper-resistant outlets, restrict access to the part of the outlet that carries electricity. Look for the words "tamper resistant" or "TR" on the outlet to ensure it's safe for children.

Avoid contact with power lines

Power lines are not insulated and can be dangerous to touch. It's possible to get electrocuted if you touch a power line.

Follow lockout/tagout procedures

Lockout/tagout procedures can help prevent electrical hazards in the workplace, especially those that could result from unexpected electrical energy releases.

Use Insulated Tools

Always use tools with insulated handles when working with or near electricity to prevent electric shocks.

Avoid Water

Keep electrical devices away from water and ensure your hands are dry when using electrical equipment.

Don't Overload Outlets

Plugging too many devices into one outlet can cause overheating and fire hazards.

Turn Off Power

Before working on any electrical device or system, make sure to turn off the power source to prevent shocks.

Proper Handling of Cords

Do not pull on electrical cords to unplug devices, as this can damage the cord and create a shock hazard.

Wear Protective Gear

Use safety gear like rubber gloves and shoes with rubber soles when working with electricity.

Check Your Progress

A. Multiple Choice questions

1. What is the primary function of the CPU (Central Processing Unit)? (a) Store data (b) Execute instructions (c) Manage power supply (d) Control input and output devices

2. Which component is responsible for temporarily storing data and instructions that the CPU is currently using? (a) Hard Drive (b) RAM (Random Access Memory) (c) ROM (Read-Only Memory) (d) Motherboard

3. What is the role of the motherboard in a computer system? (a) Provide power to all components (b) Store files and programs (c) Connect and communicate between different components (d) Cool the CPU

4. What is the function of the graphics card in a computer? (a) Manage file storage (b) Process and render images and videos (c) Connect peripherals (d) Increase the speed of the CPU

5. Which component is used for long-term data storage in a computer? (a) RAM (b) CPU (c) Hard Disk Drive (HDD) (d) Motherboard

B. Fill in the blanks

1. The __________ (CPU) is known as the brain of the computer and is responsible for executing instructions.
2. __________ is a type of memory that temporarily stores data and instructions currently in use by the CPU.
3. The __________ connects all the components of a computer and allows communication between them.

4. A __________ converts alternating current (AC) from the wall outlet into direct current (DC) for the computer's components.
5. The __________ provides long-term data storage for files, programs, and the operating system.

C. State true or False for the following

1. The CPU is responsible for executing instructions and processing data.
2. RAM is a type of non-volatile memory that retains data when the computer is turned off.
3. The motherboard serves as the main circuit board that connects all computer components.
4. The power supply unit converts DC power to AC power for the computer's components.
5. A graphics card is responsible for handling audio output in a computer system.

D. Short Answer Type Questions

1. What is the main function of the CPU in a computer system?
2. Describe the role of RAM in a computer?
3. What is the function of the motherboard in a computer?
4. What is the purpose of a graphics card?
5. Define the purpose of ROM in a computer?

Session 4. Tools and Equipment and Measuring instruments

4.0 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, organized, 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.

4.1 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—

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.

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.

Fig. 4.1: Different types of electronic cutters

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.

Fig. 4.2: Precise screwdriver

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.

Fig. 4.3: Philips head screwdriver

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.

Fig. 4.4: Torx screwdriver

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.

Fig. 4.5: Hex Driver

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. 4.6: 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. 4.7: 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.

Fig. 4.8: Crimping tool for RJ 45 connector

Tweezers

These are used to manipulate small parts.

Fig. 4.9: 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.

Fig. 4.10: Punch down tool

4.2 TESTING TOOLS

Testing the appliance is very important as customer satisfaction is the highest priority of the factory manufacturers. After testing the appliance in all parameters such as temperature, pressure, and many more, if it is found to be okay, then only it is launched in the market. However, as time passes performance of the appliance starts reducing with time. To maintain the performance of the appliance, it should be tested on a regular basis. The various test equipment used by the technician for performance testing and repairing the appliance. These tools and equipment are used in monitoring, maintaining, and repairing the air conditioner and its parts. Test instruments are important tools used in assisting with the diagnosis of the various problems that arise with appliances.

Ammeter – An ammeter is a device used to measure the electrical current flowing in a circuit. It is typically a small, portable instrument that is connected in series with the circuit being measured. The ammeter measures the current in amperes (A), which is a unit of electrical current. It is a test instrument that is connected into a circuit to measure the current of the circuit without interrupting the electrical current; a typical ammeter is shown in Figure 4.11.

Ammeters can be analog or digital. Analog ammeters use a pointer on a scale to indicate the current, while digital ammeters display the current as a numeric value on a screen. Some ammeters are designed to measure very small currents, while others can handle very high currents.

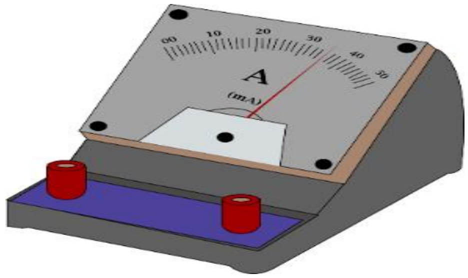


Fig. 4.11 Ammeter

Wattmeter – A wattmeter is a device used to measure the electrical power consumed by a circuit or an electrical device. It measures the product of voltage and current flowing in the circuit, which is expressed in watts (W). Wattmeters are commonly used in industrial, commercial, and residential settings to monitor and manage energy consumption. It is a test instrument used to check the total wattage drawn by an appliance, and a typical wattage is shown in Figure 4.12.

A wattmeter works by measuring both the voltage and current in a circuit and then multiplying them together to determine the power consumed by the circuit. This is typically achieved using a combination of current and potential transformers, which step down the voltage and current in the circuit to levels that can be safely measured by the wattmeter. A typical wattmeter is illustrated in

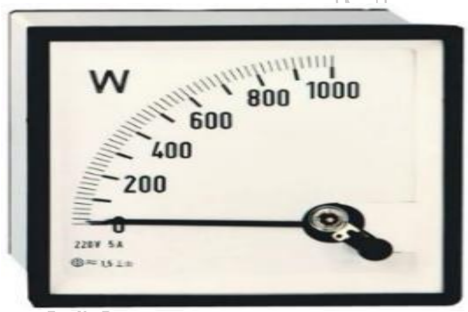


Fig. 4.12 Wattmeter

Temperature tester – A temperature tester is a device or tool used to measure the temperature of an object or substance. It can be either a digital or analog instrument that measures temperature through direct contact or infrared radiation. Temperature testers can be used to measure the temperature inside the washer tub. It can be used to check the inlet temperature of the inlet water supply; A typical temperature tester is shown in Figure 4.4.

Fig. 4.13 Temperature tester

Clamp Meter – It is a measuring instrument, used to measure the amount of current flowing in a wire. A clamp meter can directly measure the amount of current flowing in a wire. Its clamps are placed around the wire, and then automatically, it will measure the current value in a wire. A typical clamp meter is shown in Figure 4.14.

Fig. 4.14 Flexible charging line

Digital Multimeter – It is used to measure multiple parameters such as voltage, current, resistance, continuity testing and many more. It is available in two forms: manual and auto range multimeter. It displays the reading in numbers on an LCD screen. This type of meter is similar in operation to the analog meter. A typical multimeter is shown in Figure 4.15.

Fig. 4.15 Multimeter

Tachometer – It is used to measure the rotating speed of a motor. RPM of the wash motor and the spin motor is checked using this meter. A typical tachometer is shown in Figure 4.16.

Fig. 4.16 Tachometer

Practical activity 4.1 demonstrates the measurement of AC or DC current supply using a clamp meter in the air conditioner.

Practical Activity 4.1. To demonstrate the measurement of AC or DC current supply using a clamp meter in the air conditioner.

Material Required –

Clamp meter, Electric wire

Procedure

Step 1. Set the rotary selector on the clamp meter to the correct function and range, as shown in Figure 4.17.

Fig. 4.17 Setting the rotary selector on the clamp meter

Step 2. Set the clamp meter to the voltage symbol “V” to read the voltage on the conductor, as shown in Figure 4.18. Connect the black probe to the COM jack and the red probe to the V/O jack.

Fig. 4.18 Setting the clamp meter to voltage

Step 3. Push the trigger on the device to open the jaw. Clamp the device around the conductor and close it as shown in Figure 4.19, making sure that the electrical conductor is connected to a power source.

Fig. 4.19 Clamp the device around conductor

Step 4. Note the reading on the display of the clamp meter, as shown in Figure 4.20.

Fig. 4.20 Taking the reading on the clamp meter

Practical activity 4.2 demonstrates the use of a multimeter to measure various electrical quantities of the air conditioner.

Practical activity 4.2. Demonstrate the use of a multimeter to measure various electrical quantities of the air conditioner

Material required –

Digital multimeter, resistor, AC and DC power source, connecting cords.

Procedure

A. Measuring the resistance using a digital multimeter.

Step 1. Insert the black probe into the common terminal and the red probe into the terminal marked for measuring volts and ohms. Figure 1.70 illustrates that The Digital multimeter has two probes.

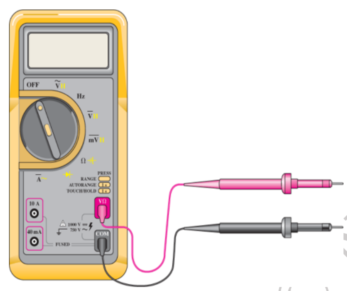


Fig. 4.21 Volt/ohm terminal and common terminal of multimeter

Step 2. Twist the selector knob to set the multimeter to measure resistance, as shown in Figure 1.71. This may be represented by the Greek letter Omega Ω, which stands for ohms, the unit for measurement of resistance.

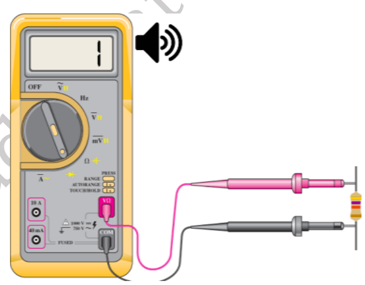


Fig. 4.22 Multimeter knob set measure the resistance value

Step 3. Touch the tips of the probes to sides of the resistor, as shown in Figure 4.23.

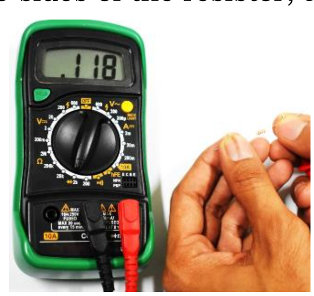


Fig. 4.23 Measuring the resistance of resistor by touching the resistor terminal to the red and black probes

Step 4. Read the display, as shown in Figure 4.24, taking care to note the units. A reading of 10 may indicate 10 ohms, 10 kilo-ohms or 10 mega-ohms.

Fig. 4.24 Resistance value in Kilo-ohm

B. Measuring AC and DC voltage using a digital multimeter.

Step 1. The Digital multimeter has two probes, as shown in Figure 4.25. Using these probes measurement of voltage can be done. Put the black probe in the common terminal and the red probe in the terminal marked for measuring volts and ohms.

Fig. 4.35 Connecting the red probe to the volt terminal and black probe to the common terminal

Step 2. Set the multimeter to measure the voltage, as shown in Figure 4.26. You can measure volts DC, millivolts DC or volts AC. If your multimeter has an auto-range function, it is not necessary to select the voltage you are measuring.

Fig. 4.26 (a) Turning the knob to measure the DC voltage

Fig. 4.26 (b) Turning the knob to measure the AC voltage

Step 3. Measure AC voltage by placing the probes across the component. In case of AC it is not necessary to observe polarity, as demonstrated in Figure 4.27

Fig. 4.27 Measuring AC voltage using multimeter

Step 4. Observe polarity when measuring DC voltage or millivolt. Place the black probe on the negative side of the DC source and the red probe on the positive side of the DC source, as demonstrated in Figure 4.28.

Fig. 4.28 Measuring DC voltage using multimeter

Step 5. Read the display, as shown in Figure 4.29. If you prefer, you can use the touch-hold feature to keep the reading on the display after removing the probes. The multimeter will beep each time a new voltage is detected.

Fig. 4.29 Holding the value in the display using hold button

4.2 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.

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.

4.3 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 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.

4.4 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.

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.

4.5 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.

4.6 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 of 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.

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. Multiple Choice questions

1. Which tool is commonly used for cutting wires and cables? (a) Pliers (b) Wire Cutter (c) Screwdriver (d) Hammer
2. What instrument is used to measure electrical voltage? (a) Ammeter (b) Voltmeter (c) Ohmmeter (d) Multimeter
3. Which tool is primarily used for tightening or loosening nuts and bolts? (a) Wrench (b) Hammer (c) Chisel (d) Level
4. What is the primary function of a multimeter? (a) Measure temperature (b) Measure electrical properties such as voltage, current, and resistance (c) Cut wires (d) Solder components
5. What type of tool is a soldering iron? (a) Measuring instrument (b) Cutting tool (c) Hand tool for joining components (d) Fastening tool

B. Fill in the blanks

1. A __________ is used to cut wires and cables cleanly.
2. The device that measures electrical voltage is called a __________.
3. A __________ is a versatile instrument that can measure voltage, current, and resistance in electrical circuits.
4. An __________ is used to measure the resistance of electrical components.
5. A __________ converts electrical energy into usable power for various components in a circuit.

C. State true or False for the following

1. A voltmeter is used to measure electrical current.
2. A soldering iron is used for joining electronic components together.

3. A multimeter can measure voltage, current, and resistance.
4. A hammer is used primarily for tightening screws.
5. A digital multimeter can display measurements in both analog and digital formats.

D. Short Answer Type Questions

1. What is the primary function of a voltmeter?
2. What is the use of a soldering iron in electronics?
3. What is the function of a power supply unit in a computer system?
4. What tool is commonly used to strip insulation from electrical wires?
5. Explain the use of pliers in electrical work.

Module 4	INSTALLATION OF DESKTOP COMPUTER AND PERIPHERALS

Module Overview

Properly handling tools is an indispensable aspect of computer assembly and maintenance. A computer installation technician must exercise caution to ensure both the tools and personal safety are prioritized. Adhering to safe working practices not only prevents injuries to individuals but also safeguards computer equipment from potential damage. A well-organized, clean, and adequately lit workspace is essential for a safe working environment. This unit emphasizes the significance of understanding and following safety procedures during tool handling and explores the various tools required for computer installation.

Computer assembly, a pivotal task for a computer installation technician, demands a logical and methodical approach when handling diverse components and peripherals. Proficiency in computer assembly skills is developed through consistent practice. This process involves fitting all internal components in a sequential manner to render the computer fully functional. In this unit provides insights into the systematic attachment of components such as the CPU, motherboard, drives, video and graphics cards, sound card, modem and adapter, connectors, and system panel connector. Additionally, it guides technicians through the step-by-step process of assembling a computer system, emphasizing the need for adequate system resources to ensure the efficient operation of both hardware and software in the customer's computing environment.

Learning Outcomes

After completing this module, you will be able to:

- Demonstrate the correct installation of the motherboard and CPU/processor in a desktop computer.
- Install RAM, graphics & sound cards, power supply, disk drives, and connect the monitor and peripherals to the motherboard.
- Assemble and dismantle a desktop computer, ensuring proper component handling and connection procedures.

Module Structure

Session 1. Install the Motherboard and CPU or Processor

Session 2. Install RAM Modules, Graphics & sound, Power Supply Unit, Disk Drive, Monitor and Peripherals on the Motherboard

Session 3. Assemble and Dismantle the Desktop Computer

Session 1. Install the Motherboard and CPU or Processor

Motherboard

The motherboard is a circuit board for the computer system, called a logic board or mainboard. In the computer system, the biggest component is the motherboard, which controls all the components of the computer system and establishes a link between all components. The motherboard connects components such as ROM, CPU, RAM, PCI slots, USB ports, and other peripherals. It also attaches devices like a DVD drive, hard drive, mouse, and keyboard to the controller. The computer system starts using the motherboard, and these components act as the backbone for starting the system as shown in Figure 1.1.

Fig. 1.1 Motherboard

Working of Motherboard

A motherboard acts as a computer's central nervous system, coordinating interactions between hardware components for seamless operation. It provides physical and electrical connections for critical components and facilitates data transfer. The central processing unit (CPU) is placed on the motherboard and acts as the computer's brain. The motherboard's CPU socket connects the CPU to the rest of the system, allowing it to execute instructions and perform calculations. Memory modules, such as RAM, are inserted into specific slots on the motherboard. These provide fast, temporary storage for data that the CPU needs for immediate tasks.

The motherboard manages data transfer between the CPU and RAM to ensure rapid access to information. Expansion slots on the motherboard allow additional components like graphics, sound, and network cards to be added to the system. These slots enable the CPU to communicate with these peripherals. The motherboard also provides power to various components through connectors, ensuring they receive the correct voltage and current. Input/output ports on the motherboard enable devices like USB drives, monitors, and keyboards to connect to the system. The motherboard functions as a critical communication hub, facilitating data transfer, power distribution, and interaction between the CPU, memory, and various peripherals, enabling the computer to function as a cohesive unit.

Connections of various Components on Motherboard

There are some of the important components of the motherboard are defined below:

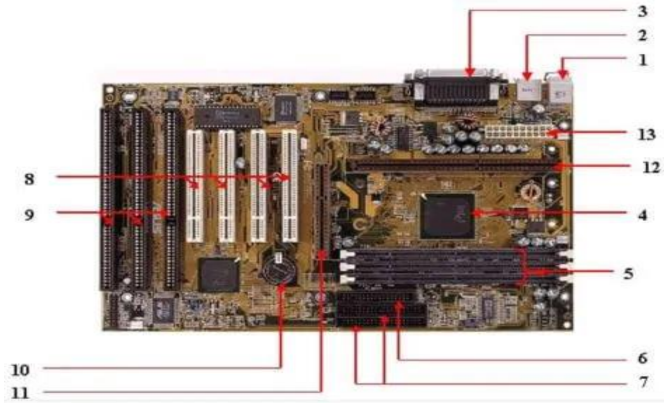


Fig. 1.2 Components of Motherboard

1. Keyboard and mouse

There are mainly two types of mouse and keyboard connectors. The first connector is known as PS/2 & the second connector is known as USB.

2. Universal Serial Bus (USB)

The USB port is used for connecting the computer system. Various devices are connected to the USB port in the computer system, like a keyboard, mouse, camera, scanner, printer, and other devices. The main use of a USB port is to connect the peripheral devices and computer motherboards. The peripheral device connected to the computer system can be inserted or removed without system restarts, which can be the main advantage of a USB port.

3. Parallel port

The old printers used in the past used the parallel port to connect with the computer system. In the parallel port, multiple wires send or receive various data bits simultaneously. On the other hand, serial ports use only one wire at a time. In the parallel port, 25 pins female DB-type connector is used.

4. CPU chip

The central processing unit is the processor that controls all computer system functions. The central processing unit controls the overall flow of tasks and functions. For the computer system, the central processing unit is called the brain of the computer system.

5. RAM slots

The RAM slots connect the RAM (memory) in the computer system. There are mainly two RAM slots in the general computer system, but sometimes, there can be four-plus slots in the motherboard to increase the computer system's memory.

6. Floppy Controller

The older motherboard chip contains a 34-pin ribbon cable connecting the computer system with a floppy drive. In this ribbon cable, one end is directly connected to the computer system, and one end is connected to the motherboard.

7. IDE controller

The integrated drive electronics, also known as ATA or Parallel ATA, represent the type of component responsible for hard drive control. In today's computer systems, there is no support for IDE controllers.

8. PCI slot

The full form of PCI is a peripheral component interface. The PCI slot primarily serves as the insertion point for a computer's expansion cards. It can also connect other PCI devices such as sound cards, network cards, video cards, modems, and other peripherals. In today's computer system, support for PCI expansion slots is not there.

9. ISA slot

Industry-standard architecture (ISA) defines a standard architecture for expansion buses. The ISA slot serves as a connection point for input devices and modems.

10. CMOS Battery

The CMOS battery stores the BIOS settings on the motherboard. The CMOS battery can also store the time and data in it.

11. AGP slot

The AGP (Accelerated Graphics slot) is a type of computer slot used to attach the video card to the system. This slot facilitates high-speed data transfer.

12. CPU slot

The CPU slot connects the central processing unit to the computer system's motherboard.

13. Power Connectors

These connectors supply power to the motherboard. The main power connector is typically a 24-pin ATX connector, and there may be additional connectors for CPU power.

1. Southbridge/northbridge

The Northbridge and Southbridge are chipsets on a motherboard. The Northbridge handles high-speed connections like RAM and graphics, while the Southbridge manages slower I/O functions like USB and SATA.

15. BIOS/UEFI Chip

The BIOS or UEFI chip stores firmware and settings for the motherboard. It initializes hardware during the boot process and manages system settings.

16. FDC (Floppy-Disk Controller)

FDC, or Floppy-Disk Controller, is a hardware component that manages data transfer to and from floppy disks in older computer systems.

17. Cooling Connectors

Headers for CPU and system fans and temperature sensors allow you to monitor and control the system's cooling.

18. Clock Generator

A clock generator is a hardware component that produces precise timing signals to synchronize and regulate the operation of various components within a computer or electronic device.

Types of Motherboard and From Factors

The main form factor for the motherboard is size and shape. The other factors are physical layout, mounting holes, and board organization. there are some from factors are as following:

1. ATX

In this type, developers defined standard locations for the mouse, keyboard, input/output devices, video connectors, and other devices. In 1990, they developed the ATX form factor. They relocated the expansion slot in this form factor, providing separate spaces to connect it with the motherboard.

2. Micro-ATX

The benefit obtained from the Micro-ATX is the same as the ATX form factor. The main difference lies in improving the system design to reduce the overall cost of the component as we reduce the motherboard size in this form factor. We achieve this reduction in size by decreasing the number of I/O slots on the motherboard.

Micro ATX, short for Micro Advanced Technology Extended, is a compact motherboard form factor commonly used in desktop computers. It measures 9.6 x 9.6 inches (24.4 x 24.4 cm) and is smaller than the standard ATX motherboard. Despite its reduced size, Micro ATX motherboards typically feature most of the same components and connectivity options, making them a popular choice for smaller PC builds with limited space. However, performance and expandability are still important.

3. Baby AT

Introduced in 1995, the Baby AT motherboard form factor, short for Advanced Technology Extended, represented an evolution of the earlier AT form factor. It aimed to accommodate more advanced hardware components and offered improved layout and compatibility. These motherboards, which were smaller in size, gained popularity in the mid-1990s. However, ATX motherboards eventually replaced them, providing even more advancements in terms of expansion and connectivity options.

4. DTX

A DTX motherboard is a compact motherboard form factor, smaller than ATX and microATX but larger than Mini-ITX. It typically measures 8.5 x 9.6 inches (21.6 x 24.4 cm) and is designed for small form factor (SFF) PC builds. DTX motherboards balance space-saving and expandability, accommodating a few expansion slots and components while fitting into smaller PC cases. They suit budget and mid-range gaming or general-purpose computing setups in compact builds.

5. NLX

NLX, New Low-Profile Extended, represents a compact and versatile form factor for computer motherboards. Designers conceived it to offer a smaller footprint while retaining compatibility with standard desktop components. NLX motherboards have low height and horizontal orientation, making them suitable for space-constrained environments. This form factor enjoyed popularity in the late 1990s and early 2000s but has since seen replacement by other form factors like ATX and Mini-ITX in modern computer systems.

6. Mini STX

Mini STX, for Mini Socket Technology Extended, represents a compact motherboard form factor for small form factor PCs. It measures 147 x 140 mm, making it smaller than Mini-ITX but larger than Intel's NUC. Mini STX motherboards typically support desktop-class CPUs, providing more power than NUCs. They offer limited expandability due to their size but are ideal for compact and efficient PC builds, particularly in scenarios where space is a premium.

7. Flex ATX

This form factor is designed for small form factor (SFF) and mini PCs and is a compact computer motherboard. It measures 9 x 7.5 inches (approximately 229 x 191 mm) and is smaller than standard ATX and microATX motherboards. Flex ATX motherboards have a reduced size and feature set, making them suitable for space-constrained environments while supporting basic computing needs. They typically have limited expansion slots and connectors compared to larger motherboard form factors.

8. Extended ATX

This form factor is larger and specifically designed for high-performance desktop computers and workstations. It measures 12 x 13 inches (30.5 x 33 cm) and offers more space for additional components, such as multiple graphics cards, RAM modules, and storage devices. E-ATX motherboards provide extra room for advanced cooling solutions and support for various CPU and memory configurations, making them suitable for demanding tasks like gaming, content creation, and professional applications.

9. Standard ATX

Many computer motherboards and power supplies widely use the Standard ATX (Advanced Technology Extended) form factor. It measures 12 x 9.6 inches (30.5 x 24.4 cm) and has defined specifications for component placement and connectors. ATX motherboards typically offer a range of features and expansion slots, making them suitable for various computing needs. The ATX power supply units provide stable power to the components. Overall, the ATX form factor has become a standard in the PC industry, ensuring users' compatibility and ease of assembly.

Functions of a Motherboard

The following are seven functions of a motherboard:

Fig. 1.3 Function of Motherboard

1. Manages data flow

The BIOS component of the motherboard ensures that the operating system interacts well with input and output devices, such as the keyboard and mouse, to process instructions. This ensures that the data sent to the computer moves as expected to perform the intended purpose. It also manages data flow through its USB ports, allowing for data transfer between devices. Additionally, it ensures the processor can access information from the RAM to boost efficiency.

2. Conserves resources

The motherboard saves consumers time, energy, and money by connecting all the computer connects. The motherboard provides a platform on which manufacturers can connect all the necessary components to ensure that the computer functions. Thus, saving consumers' time and energy as they do not have to assemble and connect different parts manually. Moreover, collecting the individual components can prove costly as consumers would be forced to incur additional transport and other miscellaneous costs.

3. Optimizes power distribution

The motherboard provides and distributes power optimally. Computers require electricity to function. The motherboard has a power connector plug that connects the computer to a power source and converts it into a form of electrical power that the computer can use. After that, the motherboard ensures that the electric current is distributed optimally to different system components.

The motherboard has an integrated circuit technology with pre-defined connections that ensure each element gets the necessary power. Moreover, the circuits ensure less energy is consumed to make the computer an energy-efficient machine.

4. Drives communication

The motherboard makes communication between different components easier. For a computer to process a particular set of instructions, sometimes it may require several components to communicate and work together to complete the task. In such scenarios, the motherboard relies on its circuit technology to enable communication between these components. The motherboard may also depend on some of its components, such as the CPU, BIOS, expansion ports, and USB ports, to interact with the computer's operating system.

5. Enhances performance

The motherboard boosts the capabilities of a computer. Motherboards often transform the capabilities of a computer. For instance, they have additional features and functionalities, such as built-in sound and video capabilities that can enhance the computer's output. Motherboards also allow users to connect peripheral devices such as printers, enabling computers to perform additional tasks such as printing documents. Additionally, users can expand and upgrade factory-made motherboard parts such as memory slots or hard disks to boost the capabilities of their computers.

6. Improves reliability

A good motherboard boosts the overall reliability of the computer. A high-quality motherboard provides a stable foundation for its components to operate on. A good motherboard has proper cooling, and its integrated circuit technology is set in place. These factors enable it to control the computer's hardware efficiently by ensuring that each element functions as expected and communicates with the other components. A reliable computer performs tasks efficiently and thus enhances the user experience.

7. Enables productivity

The motherboard reduces effort duplication and simplifies work for computer users. While traditional computers came pre-installed with BIOS, modern ones are pre-installed with EFI and UEFI. BIOS, EFI, and UEFI enable computers to boot without requiring users to reconfigure basic settings, time, and date. They also load the operating system into the memory. Therefore, these motherboard components allow users to focus on other productive tasks.

Slots and Sockets on Motherboard

Slots

A **slot** is a part of the motherboard that allows you to add extra components, like a **graphics card (GPU)**, **sound card**, or **network card**, to your computer. These components, also known as **expan-**

sion cards, help improve the computer's performance or add new features. The great thing about slots is that they let you upgrade your computer by adding or removing these cards without needing to change the entire motherboard. Different slots are designed for different types of cards, and they come in various **shapes** and **sizes**. For example, **PCIe slots** are commonly used for **graphics cards**, while older computers may have **PCI slots** for other expansion cards. Slots make it easy to customize or upgrade your computer, allowing you to add better graphics or sound without major changes.

Socket

A **socket** is a part of a computer's motherboard where the **CPU** (the computer's brain) is placed. Whether the CPU is from **Intel** (like Intel Core) or **AMD** (like Ryzen), it fits into this socket. The socket has tiny connectors that create a strong **mechanical** and **electrical** link between the CPU and the motherboard. This connection allows the CPU to talk to and control other hardware parts, such as memory (RAM), storage, and graphics cards. Different motherboards support different types of sockets, so it's important to make sure the CPU and motherboard are compatible. The socket plays a crucial role in ensuring that the CPU works efficiently with the entire system, allowing the computer to process data and run applications smoothly.

Procedure for installation of Motherboard

The motherboard is the backbone of your desktop computer. All of your components plug into the motherboard, so ensuring that you install it correctly is the first step towards building your own computer or upgrading an old one. Read on after the jump to get a new motherboard installed in your computer case in just a few minutes.

Motherboard Installation Overview & Basics

To start, open up your case and remove the metal I/O shield from the back of the case. Install standoffs (if they're not already installed) and place the motherboard on the standoffs. Secure the motherboard to the standoffs with the provided screws. Then, you can install your components and connect your power supply.

Step 1. Open your computer case

Then remove both side panels for easy access to the motherboard tray. The motherboard tray can be removed from the case, which will allow you to easily install the motherboard without having to work at weird angles. Not all cases have removable motherboard trays as shown in Figure 1.4.

- The motherboard tray is typically held in with two screws. Set these aside so that you don't lose them.
- Installing a motherboard typically means you are essentially building a new computer. You will need to reinstall your operating system if you are upgrading, and you will need to format any system drives. You cannot simply upgrade to a new motherboard without reinstalling everything on your computer.

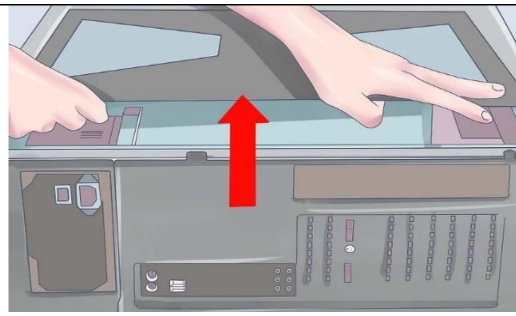


Fig. 1.4 Computer case

Step 2. Ground yourself

Before you begin working on the interior of your computer or handling the motherboard, make sure you discharge any electrostatic charge you may have. You can touch a water tap to discharge your electrostatic charge.

- Wear an antistatic wrist strap while working on the computer to prevent causing electrostatic damage.

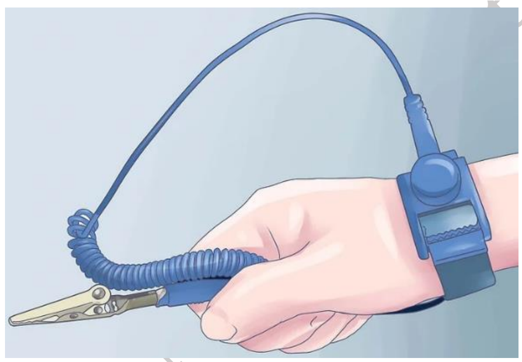


Fig. 1.5

Step 3. Replace the I/O panel shield

This is located at the rear of the case, where the connectors for the motherboard extend out for your monitor, USB devices, and other peripherals. Most cases have a default panel shield installed, which will need to be removed and replaced with the panel that came with your motherboard.

- Apply pressure to all four corners of the panel to secure it into the case. It should snap into place.
- Make sure that you are installing the panel in the correct direction. Compare it to the actual layout of the connectors on the motherboard to make sure it is going in the right way.

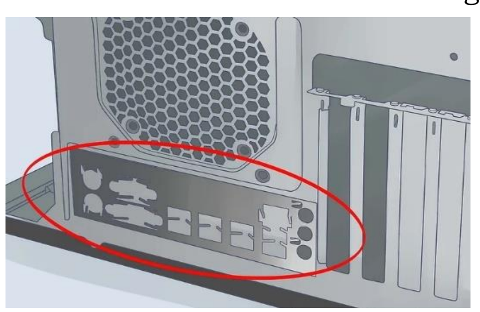


Fig. 1.6

Step 4. Find the standoffs

Standoffs keep the motherboard above the case. This prevents it from shorting out and helps cooling. Some cases will come with standoffs, while others do not. Your motherboard should come with its own standoffs as well that you can use.

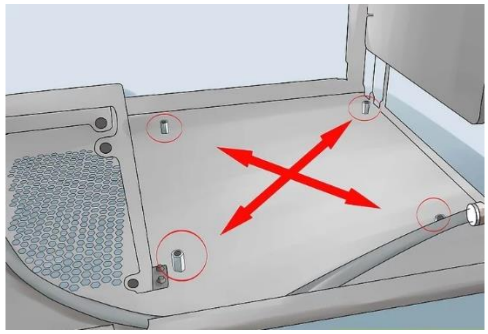


Fig. 1.7

Step 5. Install the standoffs

Match the holes on the motherboard with the available standoff locations on the motherboard tray. Every case and motherboard tray are different, and all will have different hole configurations. Line up the motherboard to see where you can use standoffs to secure it. Every hole possible on your motherboard should have a standoff installed.

- Most standoffs screw into their holes, but some are pushed in like pegs.
- Not all motherboards will be able to attach with all of the available holes. Connect as many standoffs as possible, but never use any extra standoffs. Standoffs should only be installed in locations with a corresponding motherboard hole.

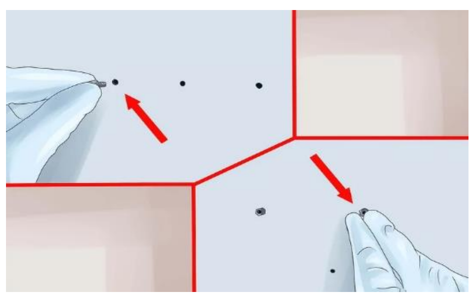


Fig. 1.8

Step 6. Place your motherboard on the standoffs

The holes and the standoffs should all line up. If your motherboard tray does not come out of the case, you may need to gently force the motherboard against the I/O panel on the back of the case to fit it. Start securing the motherboard with screws.

- Don't overtighten the screws. Make sure it is firm but not too tight. Do not use an electric screwdriver.
- Holes that don't have metal on them will need cardboard washers between the screw and the motherboard. It is best to avoid using non-metallic holes at all.

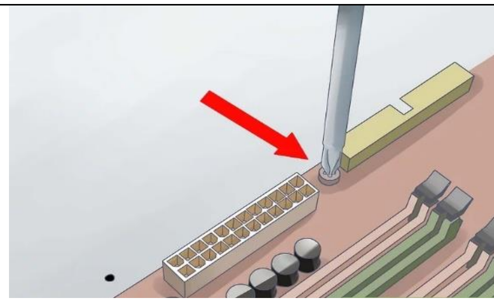


Fig. 1.9

Step 7. Install your components

Before reinserting the motherboard tray with the newly-fastened motherboard into the case, install your CPU, CPU cooler, and RAM. Doing this now will make it much easier to reach everything. If your motherboard is not on a removable tray, install your components after wiring.

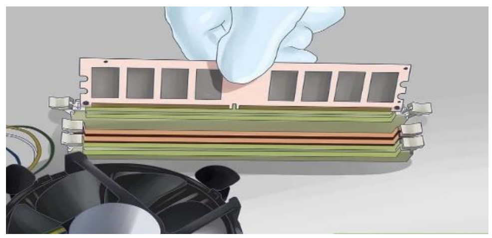


Fig. 1.10

Step 8. Connect the power supply

Once the motherboard is secured, you can start connecting your components to it. It is recommended that you connect the power supply first, as the plugs will be difficult to reach later. Make sure that both the 20/24-pin connector is attached as well as the 4/8-pin 12V connector.

- Refer to your power supply's documentation if you are unsure which cables to use.

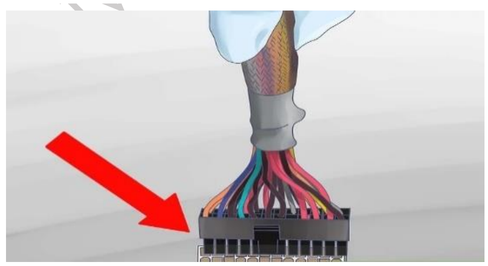


Fig. 1.11

Step 9. Connect your front panel

In order to turn on your computer with the front power button or see when the hard drive is being accessed, you will need to connect the front panel switches and indicators. Locate the following wires and connect them to the appropriate pins on the motherboard:

- Power switch
- Reset switch
- Power LED
- Hard drive (HDD) LED
- Speaker

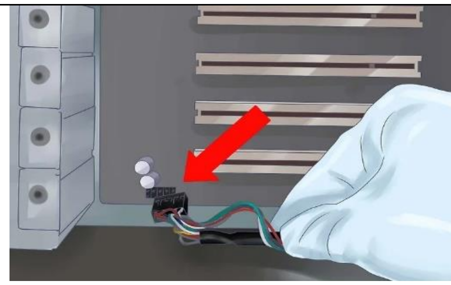


Fig. 1.12

Step 10. Connect the front USB ports

Connect any front USB ports to the appropriate connectors on the motherboard. These are typically labelled. Make sure the correct plugs are placed on the correct pins.

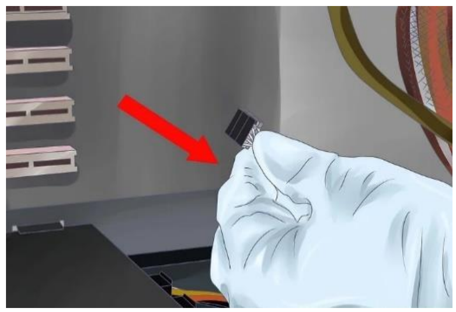


Fig. 1.13

Step 11. Connect the fans

Connect any case and CPU fans to the appropriate pins on the motherboard. There are typically several places to plug in chassis fans, as well as a two-pin connector near the CPU for the CPU fan.

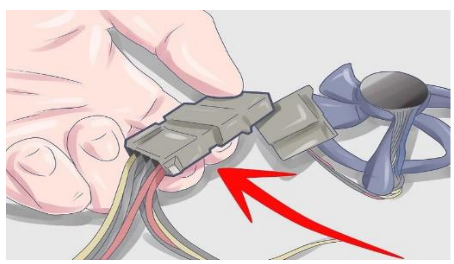


Fig. 1.14

Step 12. Install your drives

Once the motherboard is secure and connected, you can start attaching your drives to it. Make sure that you attach your SATA hard drives and optical drives to the correct SATA ports on your motherboard.

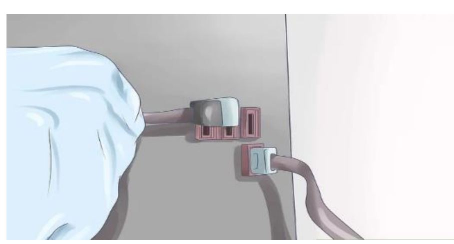


Fig. 1.15

Step 13. Install a video card

One of the last components you should install is the video card. The card will take up the most space, and will make reaching other areas difficult. Installing a video card may be optional, depending on your system and needs.

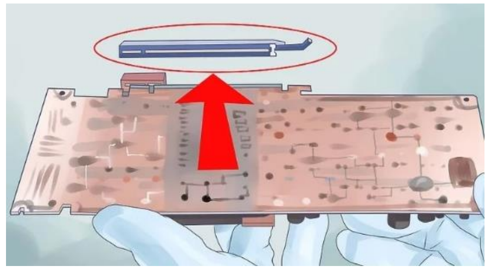


Fig. 1.16

Step 1. Adjust your wiring

Now that everything is connected to your motherboard, it's time to move that wiring around so that heat doesn't get trapped or wires don't get stuck in fans. Tuck excess cable into spare drive bays and use zip ties to bundle cables together. Make sure that all of your components have room to breathe.

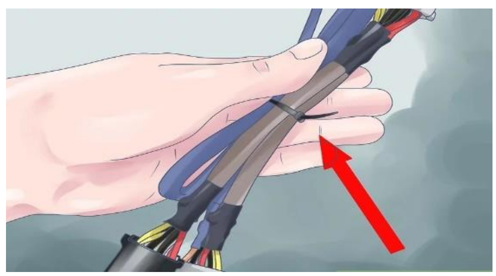


Fig. 1.17

Step 15. Close up the computer

Return the side panels of the case to their original positions and screw them back in. Plug your computer and components in. Turn your computer on and prepare for operating system installation.

Fig. 1.18

CMOS Battery

The CMOS battery is a small, round battery in a computer that powers the CMOS (Complementary Metal-Oxide-Semiconductor) chip, which stores important system settings. These settings include the date and time, hardware configurations, boot sequence, power management settings, and sometimes passwords. The CMOS battery is especially important for laptops, as they are often unplugged for long periods, unlike desktop PCs. When the laptop is plugged in, the battery recharges, and it drains when unplugged.

Most CMOS batteries last between 2 to 10 years. When the battery dies, you may notice signs like trouble starting your computer**,** disappearing drivers**,** or the wrong date and time on your system. If the battery dies, the settings stored on the CMOS chip may be lost or corrupted, which can lead to performance problems or prevent the computer from booting properly. Replacing the CMOS battery can fix these issues.

There are some important of CMOS battery in computer

- **System date and time**: Ensures that the computer maintains accurate time and date, even when powered off.
- **Hardware settings**: Retains information about the devices connected to the computer, such as the hard drive, memory, and peripheral devices.
- **Boot sequence settings**: Determines the order in which the system looks for bootable devices during startup.
- **Power management settings**: Manages the computer's energy usage and related configurations.
- **Password settings**: If enabled, stores BIOS password information.

Without the CMOS battery, these settings would be reset every time the computer is turned off or loses power, leading to boot issues, incorrect time, or the system failing to detect hardware components. The battery ensures that even when the computer is unplugged, this critical data is preserved.

In laptops, which are often disconnected from power, the CMOS battery's role is particularly vital. When the battery dies, signs like difficulty booting, incorrect date and time, and missing drivers may appear. Replacing the battery helps maintain system stability and prevents data corruption or configuration loss.

There are some Features and Specifications of CMOS Battery

Features of CMOS Battery:

1. **Non-Volatile Power Source**: The battery provides continuous power to the CMOS chip to retain critical system data, even when the computer is shut down or unplugged.
2. **Small and Compact**: Typically coin-shaped (most commonly CR2032), making it easy to fit into compact spaces like a motherboard.
3. **Long Lifespan**: Usually lasts between **2 to 10 years** depending on the system's usage and environment.
4. **Self-Sustaining**: Powers the CMOS chip without requiring an external power supply when the computer is off.
5. **Rechargeability (in laptops)**: In some laptops, the battery charges when the system is plugged into power and discharges when unplugged.

Specifications of CMOS Battery:

1. **Battery Type**: Usually a **CR2032** lithium coin cell battery, but other types like **CR2025** or **CR2016** may also be used.

2. **Voltage**: Typically provides a **3V** output, which is sufficient to power the CMOS chip and retain data.
3. **Size**: Standard size is around **20mm in diameter** and **3.2mm in thickness** for the CR2032 battery.
4. **Capacity**: Lithium coin batteries typically have a capacity of **220 mAh** (milliamp hours), which contributes to their long lifespan.
5. **Operating Temperature**: CMOS batteries function within a wide temperature range, usually between **-20°C to 60°C**, making them suitable for most computing environments.

Procedure for installation and un-installation of CMOS Battery on Motherboard

Installing and uninstalling a CMOS battery on a motherboard is a straightforward process, but it requires careful handling to avoid damaging the components. There is step-by-step both the installation and uninstallation of a CMOS battery.

Materials Required: Anti-static wrist strap**,** Small flathead screwdriver

Installation of CMOS Battery:

Step 1. Check Compatibility

Ensure that the new CMOS battery matches the specifications of the old one, typically a CR2032 (3V) lithium coin cell.

Step 2. Position the New Battery

Orient the new CMOS battery with the positive side (usually marked with a "+") facing up**.**

Step 3. Insert the New Battery

Carefully place the new battery into the slot, aligning it with the holder. Press down gently until it snaps into place. Make sure the metal clip or latch securely holds the battery.

Step 4. Reassemble the Computer

Reattach the side panel (for desktops) or the back cover (for laptops) using the screws you removed earlier.

Step 5. Reconnect Power and Test

Plug the computer back into the power source and turn it on. Enter the BIOS (usually by pressing a key like Delete or F2 during startup) to check if the system date and time are correct. If necessary, reset the date, time, and other BIOS settings.

Un-installation of CMOS Battery:

Step 1. Power Down the System

Turn off the computer and unplug the power cable**.** For laptops, also remove the battery if possible.

Step 2. Discharge Any Static Electricity

To avoid damaging the motherboard, either wear an anti-static wrist strap or touch a grounded metal object before handling any internal components.

Step 3. Open the Computer Case

Remove the screws holding the side panel of the desktop case. Slide the panel off to access the motherboard. For laptops, open the back cover according to the manufacturer's instructions.

Step 4. Locate the CMOS Battery

The CMOS battery is usually a small, silver, coin-shaped battery on the motherboard. Look for a round holder on the board.

Step 5. Remove the CMOS Battery

Gently press the small latch or metal clip holding the battery in place using your finger or a small flathead screwdriver**.** The battery will pop out easily once released.

Step 6. Handle the Battery Carefully:

Hold the battery by the edges to avoid touching the surface, as oils from your fingers can reduce the lifespan of the new battery.

CPU or Processor on the Motherboard

CPU or Processor Architecture

The **CPU architecture** refers to the design and structure of the central processing unit, which determines how it processes information. Modern CPU architectures are typically based on either **x86** (used by Intel and AMD) or **ARM** (used in mobile devices). These architectures define the **instruction set**—the commands a CPU can understand and execute. A CPU architecture consists of key components like the **control unit**, **ALU (Arithmetic Logic Unit)**, **registers**, and **cache**. Advanced architectures incorporate **multiple cores**, **hyper-threading**, and advanced technologies like **SIMD (Single Instruction Multiple Data)** for parallel processing, improving overall system efficiency and performance.

Features and Working of CPU

The CPU, often called the **brain of the computer**, is responsible for executing instructions from programs and controlling all the other hardware components. Key features include:

- **Multiple Cores**: Modern CPUs can have **dual-core**, **quad-core**, or more, allowing for simultaneous task execution.
- **Clock Speed**: Measured in **GHz**, this defines how many cycles per second the CPU can execute.
- **Cache Memory**: Provides quick access to frequently used data. The CPU works by fetching instructions from memory, decoding them, and executing them. It continuously performs this cycle to handle tasks like calculations, running applications, and managing data flow between other components like RAM and storage.

Generations and Types of CPU

CPUs have evolved over time, with different **generations** offering more power, efficiency, and advanced features. For example, Intel's CPUs range from the **1st generation Core i-series** to the latest **12th generation Alder Lake** processors, each generation improving on **core count**, **power efficiency**, and **performance**. AMD has similar advancements with its **Ryzen series**. There are also different types of CPUs, such as **desktop** CPUs for PCs, **mobile** CPUs for laptops, and **server** CPUs for handling high-end computing tasks in data centers. Each type is designed for specific performance needs and energy efficiency.

Specifications of CPU

CPU specifications define the processor's capabilities and performance. The key specifications include:

- **Clock Speed**: Measured in **GHz**, it shows how fast the CPU can process instructions.
- **Core Count**: Determines how many tasks the CPU can handle simultaneously. Modern CPUs have 2 to 64 cores.
- **Threads**: Virtual cores that enhance multitasking; some CPUs support **hyper-threading** for doubling the thread count.
- **Cache Size**: L1, L2, and L3 cache sizes vary and influence how quickly the CPU accesses data.
- **TDP (Thermal Design Power)**: The amount of heat the CPU generates, which determines cooling requirements. These specifications help determine the CPU's performance in various tasks, such as gaming, content creation, or multitasking.

Speed, Form Factor, and Performance of CPU

The **speed** of a CPU, measured in **GHz**, directly affects how quickly it processes instructions. Higher clock speeds generally mean faster performance. However, performance also depends on other factors like **core count**, **cache size**, and **instruction set efficiency**. The **form factor** of a CPU refers to its physical size and shape, affecting compatibility with motherboards and cooling solutions. CPUs come in different packages, such as **LGA** for Intel and **PGA** for AMD. CPU performance is influenced by a combination of clock speed, core count, and architecture, with improvements in each area resulting in more powerful processors that can handle complex tasks with ease.

CPU Fan

The **CPU fan** is a critical component for maintaining the processor's temperature and ensuring stable performance. It works by drawing heat away from the CPU and dispersing it into the surrounding air. Most CPUs come with a **stock fan** that is sufficient for general use, but high-performance systems often require more powerful **aftermarket cooling solutions** like **air coolers** or **liquid cooling systems**. Proper cooling ensures that the CPU operates within its **thermal limits** (TDP) and prevents issues like **thermal throttling**, where the CPU slows down to avoid overheating. A well-functioning CPU fan is essential for maximizing the processor's lifespan and maintaining consistent performance.

Procedure for Installation of CPU and CPU Fan

Install a CPU

A CPU is the brains of your computer, but don't worry installing a CPU isn't brain surgery. There are steps by steps install a CPU today with these simple steps.

Step 1. All motherboards should come with a plastic cover that protects the CPU socket. This cover has to be re-moved to free up the socket for your CPU. To begin your CPU installation, push the socket lever down and slide it to the right.

Fig. 1.19

Step 2. Lift up the socket lever and the load plate will pop up (as shown in Figure 1.20 You can now remove the CPU socket cover. Be sure to keep this cover - You'll need it when selling your motherboard or sending it back for repairs.

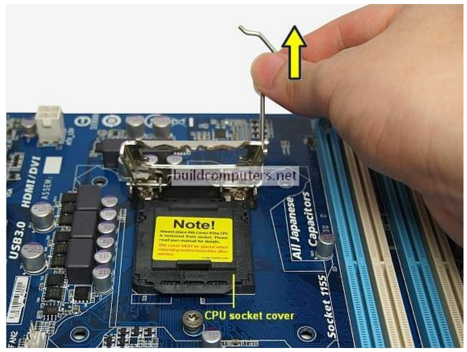


Fig. 1.20

Step 3. Remove the CPU from its plastic tab and insert it into the motherboard's CPU socket. When installing a new CPU, be sure to hold it by the sides and avoid touching the golden pins at the bottom. It is shown in Figure 1.21 for the correct way to hold a CPU:

Fig. 1.21

Step 4. Gently align the two CPU notches as shown in Figure 1.22 circled in yellow above with the two protruding socket keys. Gently set the CPU onto the socket.

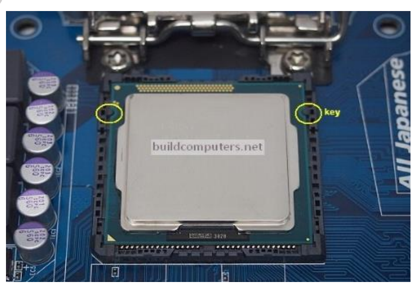


Fig. 1.22

Step 5. To confirm that the CPU has been correctly seated, lightly rest your finger on top of the CPU and gently move it around. The CPU should not budge at all if it has been correctly inserted into the socket.

Step 6. Now lower the load plate and slide it under the shoulder screw. Once this is done, lower the socket lever under it touches the motherboard and slide it left to lock it into place. as shown in Figure 1.23

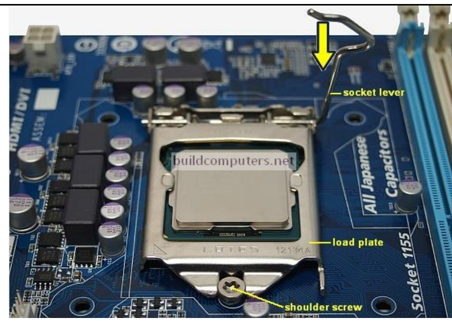


Fig. 1.23

Install a CPU Fan

Installing a CPU fan correctly is important for keeping your computer cool and quiet. There are step by step install a CPU fan in a few quick steps.

Step 1. Before installing a CPU fan and heatsink, you'll first have to determine whether you need to apply thermal paste to the CPU.

Step 2. As we have explained in our "What is CPU thermal paste" article, it is essential to have thermal paste between the CPU and heat sink. Without it, your CPU will run about 20 to 30°C hotter under load. Even if your CPU doesn't overheat and shut down immediately, its lifespan is going to be shortened considerably.

Step 3. If you're installing the default Intel or AMD heat sink fan for the first time, then there is no need to apply any thermal compound. The reason is simple - The standard CPU fan (called a stock cooler) that comes with every boxed Intel and AMD CPU has thermal paste pre-applied to its base. You can see the three grey stripes of pre-applied thermal paste in the Figure.1.24 below:

Fig. 1.24

Step 4. If you're installing a stock cooler than has been used before or an aftermarket heatsink fan, then it's a must to apply thermal compound to the CPU before proceeding - Click here to learn how to apply CPU thermal grease.

Begin CPU fan installation by making sure that all four push pins are facing the correct direction. The grooves on the push pins should be facing the center of the CPU fan as shwon in Figure 1.25

Fig. 1.25

Step 5. To install a CPU fan and heat sink, you will need to align the four push pins of the heat sink circled in yellow above with the four pin holes on the motherboard circled in yellow below:

Fig. 1.26

Step 6. Once everything is aligned, place your thumbs on the two diagonally opposite push pins and press down on both pins at the same time until you hear a "click" sound. as shown in Figure 1.27.

Fig. 1.27

Step 7. Once you have pushed down all four pins, take a look at the bottom of the motherboard. If you have installed the CPU cooler correctly, the pins should protrude fully as shown in Figure 1.28.

Fig. 1.28

Step 8. Now we are down to the final step of installing a CPU fan: Plug the CPU fan power connector into the 4-pin CPU fan header on the motherboard. On most motherboards, this header will be located near the CPU socket as shown in Figure 1.29.

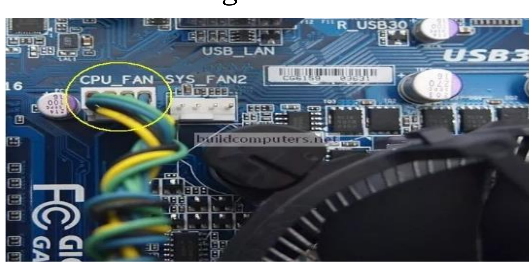


Fig. 1.29

Check Your Progress

A. Multiple Choice questions

1. Which of the following components is essential for a motherboard to function? (a) RAM (b) Graphics Card (c) Power Supply Unit (d) All of the above
2. What is the first step in installing a motherboard? (a) Connect the power supply (b) Secure the motherboard in the case (c) Install the CPU (d) Attach the I/O shield
3. Which tool is commonly used to install a motherboard in a case? (a) Screwdriver (b) Hammer (c) Pliers (d) Wrench
4. What is the purpose of the thermal paste when installing a CPU? (a) To enhance electrical conductivity (b) To improve heat dissipation between the CPU and cooler (c) To lubricate moving parts (d) To prevent dust accumulation
5. What component is typically mounted on the motherboard to allow the CPU to communicate with other components? (a) RAM (b) Chipset (c) Power Supply (d) GPU

B. Fill in the blanks

1. The first step in installing a motherboard is to attach the __________ to the case.
2. Before handling the CPU, it is important to __________ yourself to avoid static discharge.
3. The CPU must be aligned with the __________ on the motherboard during installation.
4. The __________ connects the CPU to other components and allows communication within the computer.
5. A __________ is used to lock the CPU in place within the socket after installation.

C. State true or False for the following

1. The I/O shield must be installed before the motherboard is placed in the case.
2. It is safe to handle the CPU without grounding yourself.
3. The CPU can be installed in any orientation in the socket.
4. It is unnecessary to check all cable connections before powering on the computer.
5. The locking mechanism for the CPU socket is used to hold the CPU in place after installation.

D. Short Answer Type Questions

1. What is the first step to take when installing a motherboard?
2. Why is it important to ground yourself before handling the CPU?
3. What should be aligned correctly when installing a CPU into the motherboard?
4. What role does thermal paste play in CPU installation?
5. After installing the CPU, what is the next component you should typically install?

Session 2. Installing Process External and Internal Peripherals on the Motherboard

Random Access Memory (RAM) is a key component in computers that provides temporary storage for the operating system (OS), software programs, and any data currently in use. (Figure 2.1) This allows the processor to access this information quickly, which helps the computer run smoothly. Because of this, RAM is often called a computer's main memory, as it is different from other types of memory, like the processor cache.

RAM is considered part of a computer's primary memory. It is much faster to read from and write to compared to secondary storage devices like hard disk drives (HDDs), solid-state drives (SSDs), or optical drives. However, one important thing to note about RAM is that it is volatile, meaning it only keeps data while the computer is powered on. If the power goes out, all the data in RAM is lost. When you restart your computer, the operating system and other files need to be reloaded into RAM, usually from the HDD or SSD.

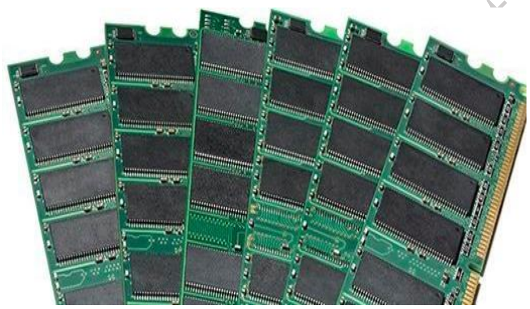


Fig. 2.1 Random Access Memory (RAM)

Importance of RAM in Computer

Random Access Memory (RAM) is a crucial component of computer systems, serving as the primary memory that stores data and instructions temporarily while a computer is running. It allows for fast read and write operations, enabling quick access to the data that the CPU needs for processing. The performance of a computer significantly depends on the amount and speed of RAM; more RAM can improve multitasking capabilities and overall system performance. Applications such as gaming, video editing, and graphic design require substantial amounts of RAM to function smoothly. Insufficient RAM can lead to slowdowns and lag, as the system struggles to manage tasks efficiently. Overall, RAM is vital for enabling a responsive and efficient computing experience, allowing users to run multiple applications simultaneously without significant performance degradation.

Features, Types, and Specifications of RAM Modules

RAM modules come with various features and specifications that cater to different computing needs. Key features include speed (measured in megahertz or gigahertz), capacity (measured in gigabytes), and latency (measured in nanoseconds). Common types of RAM include:

1. **DRAM (Dynamic RAM):** Used in most computers, it is slower but cheaper and consumes less power.
2. **SRAM (Static RAM):** Faster and more expensive than DRAM, typically used in cache memory.

3. **SDRAM (Synchronous DRAM):** Synchronized with the system clock, enhancing performance.
4. **DDR SDRAM (Double Data Rate Synchronous DRAM):** Offers higher bandwidth, with various generations (DDR, DDR2, DDR3, DDR4, DDR5) improving speed and efficiency with each iteration.

Specifications to consider when choosing RAM modules include capacity, speed (frequency), latency, and the number of channels (single, dual, or quad-channel).

Examples of RAM Modules

- **DDR4-2400**: A common RAM module used in mainstream PCs, featuring a clock speed of 2400 MHz. It balances cost, speed, and power consumption.
- **DDR5-4800**: Offers much higher data transfer rates and efficiency than its predecessor, making it ideal for modern, high-performance computing applications like gaming and content creation.
- **ECC RAM (Error-Correcting Code RAM)**: Used mainly in servers, ECC RAM detects and corrects data corruption, ensuring system stability in critical environments.
- **LPDDR (Low-Power DDR)**: Common in mobile devices and laptops, it offers energy efficiency without sacrificing speed, prolonging battery life in portable devices.

Procedure for installation of RAM Modules on Motherboard in Desktop and Laptop

Sometimes, the device starts working slowly or a new software that is installed in the device is not working properly. So, there may be some problem present in the RAM. Installing RAM can be a solution for that. So, how to upgrade the memory (RAM) of your PC or laptop.

Boost your computer's speed by installing RAM in your PC or laptop. Upgrade your system for better performance

Random Access Memory (RAM) is the key element in computers or laptops that helps to increase computer speed when necessary. Multiple data lines like 8-bit, 16-bit, 32-bit, and 64-bit are present in RAM which helps to improve the speed of the device.

lets first know Why should you Upgrade my RAM.

a) Improved Performance: Upgrading your RAM can boost system speed, allowing for faster multitasking, smoother application performance, and quicker data access.
b) Software Compatibility: Increasing RAM can help your computer handle newer software and OS updates, extending its usability.
c) Cost-Effective: RAM upgrades are often more affordable than purchasing a new computer.
d) Enhanced Productivity: Better RAM capacity enables efficient work and creativity.
e) Gaming Experience: Upgraded RAM supports high-quality gaming with minimal lag.

How to upgrade RAM: Quick Overview

a) Check Compatibility: Ensure the RAM module matches your computer's specifications.
b) Shut Down & Unplug: Turn off your computer and disconnect the power source.
c) Ground Yourself: Prevent static discharge by touching a grounded object.
d) Open the Case: Access your computer's RAM slots.
e) Remove Old RAM (if any): Carefully release the latches and pull out old modules.
f) Insert New RAM: Align the notches, gently push it in until it clicks.

g) Close the Case: Secure the computer's case and plug it back in.

h) Power On & Test: Start your computer and verify the new RAM is recognized.

Things to Remember Before RAM Installation

1. Choosing Right RAM:

- Check your motherboard's manual or online for RAM compatibility.
- Find out the type and generation of RAM your motherboard supports (e.g., DDR3, DDR4).
- Consider how much RAM you need (8-16GB for basic tasks, more for gaming or heavy work).
- Make sure the RAM speed matches your motherboard.

2. Check the Device Capability:

- Not all devices can get more RAM, especially laptops.
- Some laptops use SSD cards instead of adding RAM.
- Check online to see if your device can get more RAM.

3. Be Cautions For RAM:

- Inserting or removing RAM isn't too hard, but you should be careful of:
- Hold the RAM on its two corners, avoid touching other parts.
- Don't touch the golden part; fingerprints can cause issues.
- Keep RAM clean for it to work correctly. Be cautious.

4. Danger from Static Electricity:

Static electricity can be a big problem during installation, Mistakes can damage computer parts and give you a shock. After disconnecting power, static electricity stays, to avoid this, touch the metal cabinet or use an ESD wrist strap.

Installing RAM on Computer

After getting all the general information & disclaimer, we will move for the installation process. First, we will do the insertion in Desktop & Laptop.

Install RAM on Desktop

Step 1: At first, Shut Down the computer by moving to the Start Menu as shown in Figure 2.2. And then, click on the Shut Down option to close all the programs.

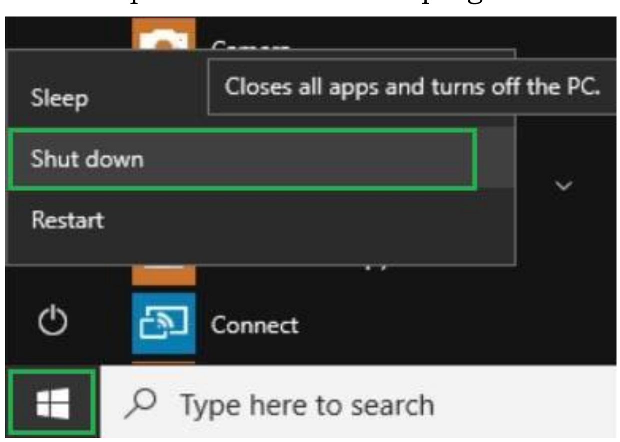


Fig. 2.2

Step 2: Switch Off the power connection & remove all the connections from the plug point. Now, press the Power Button to present there for at least 5 seconds. (Figure 2.3) It will remove the remaining electricity from the device.

Fig. 2.3

Step 3: Now, open the cabinet using a screwdriver & place it on the ground. It will also help to ground yourself. Touch any metal unpaired body, like the CPU Cabinet Body. (Figure 2.4) The place is marked in the image below. And Try to locate the RAM slot.

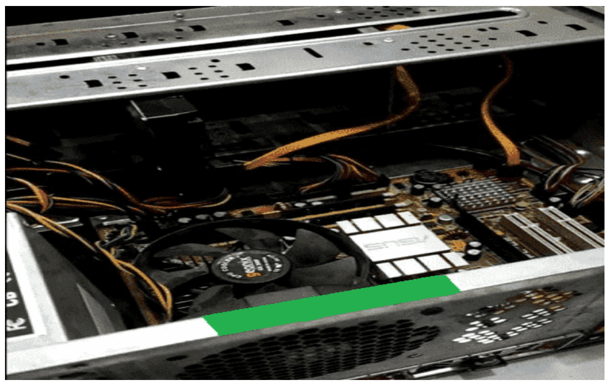


Fig. 2.4

Step 4: In the RAM slot, you will find some of the Clips. Pressing the clips will open the RAM from the motherboard. Now, you can easily insert or remove RAM from the slot. (Figure 2.5) At last, again press the clip to close the slot.

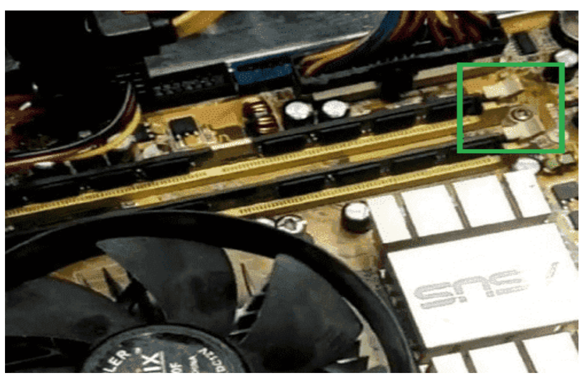


Fig. 2.5

Install RAM on Laptop

Step 1: In this case also, the device Shut Down will be the first priority. (Figure 2.6) Let all the applications completely close down. And wait for a few minutes to Cool Down the inner components, because in a laptop the space to reduce heat is very less.

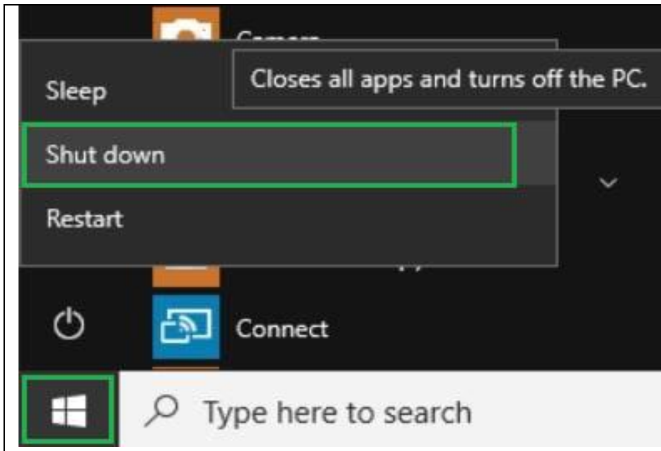


Fig. 2.6

Step 2: Remove all the power connections from the device along with the battery connection. (Figure 2.7) Now, press the Power Button for a while to remove the additional electrical charge present there. it will reduce to get any electrical shock.

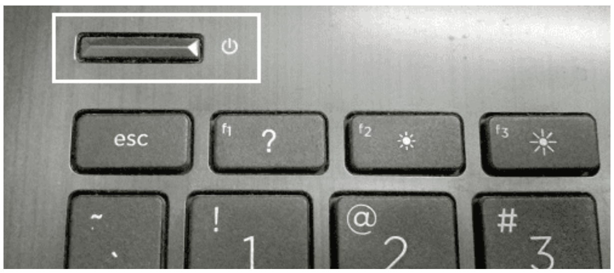


Fig. 2.7

Step 3: Open the backside of the laptop & find out the RAM slot. (Figure 2.8) There is also no such clip concept present in the RAM slot. In the RAM slot, first place the RAM in the tilted position & hold it in a soft hand. The RAM is now inserted.

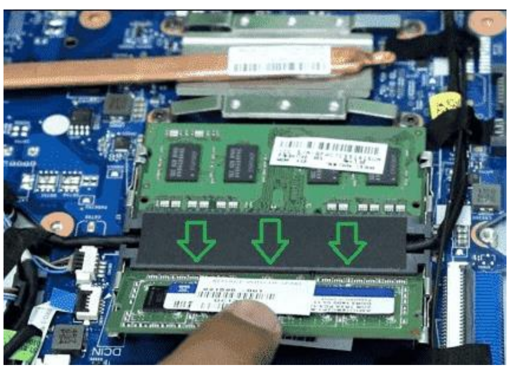


Fig. 2.8

Step 4: Now, press the RAM softly into the lower direction. (Figure 2.9) There are some hands present on the sides of the RAM slot. While pressing, they will activate & hold the RAM in the RAM slot.

Fig. 2.9

Install the Graphics Card and Sound Card on the Motherboard

Graphics Card

Graphics card is a hardware which is used to increase the video memory of a computer, and make its display quality more high-definition. It makes the computer more powerful and gives it the capacity to do more high-level works. The quality of the image depends on the quality of the graphics card. It is very much important for gaming and video editing on a computer. Every game needs a graphics memory to start and it depends on the type of the game, and the requirements are mentioned on the game box.

Fig. 2.10

Example

Acer predator – Nvidia GTX 1050 4GB Graphics Card.

Alienware 17 – Nvidia Geforce GTX 1070 8GB Graphics Card.

Types of Graphics Card

Integrated – The graphics which are built into the motherboard are known as Integrated, are generally used in most laptops, the cannot be easily upgraded.

Discrete – It is an external graphics card which is a hardware and added on a motherboard as an extra component.

Components of Graphics Card

- **GPU:** Basically, like a CPU, the GPU is a real piece of hardware in a system.
- **Memory:** It also referred to as VRAM, the graphics card has memory allocated specifically to support the initial operations.

- **Interface:** PCI Express, located at the card's bottom as per requirement, is used by the majority of GPUs in the system.
- **Heat Sink:** To aid in the initial dissipating heat accumulation during use, every GPU has a heat sink and fans as well.
- **Power Connectors:** Six- or eight-pin power connectors are very much necessary for modern GPUs to process; sometimes in the special cases, two or three are needed.
- **Outputs:** A variety of useful video outputs are available in the system, frequently including HDMI, DisplayPort, DVI, or VGA as per requirement.
- **BIOS:** The graphics card when the user turn off the system or computer, the BIOS saves the required data on voltages, memory, and other components. It also contains the initial basic setup and program information to process well.

Features of Graphics Card

- **Memory:** Graphics card carries its own memory. Memory range could be from 128MB to 2GB of memory. We should buy a card with more memory. More RAM equals higher resolutions, more colors on the screen, and the best special effects.
- **Multiple Screen support:** Most new video cards have the ability to connect two monitors to one card. This feature is very important for video editing and hardcore gamer craves that extra real estate as well. You can either see two separate Desktops or make the two monitors into one Desktop.
- **Gaming and Video Editing:** The discrete graphics card is not only for a gamer but those who use high-end video editing software also get help as a high-quality graphics card to reduce the rendering time of an image also give a high-def environment.
- **Connection:** The graphic card is connected to the monitor using many different ports put the port must be present on both monitor and Graphics card. These are some common ports used to connect graphics card with a monitor. VGA, HDMI, DVI
- Some motherboards have more than 1 expansion slot so we can add more than one graphic card to make performance better. Many laptops nowadays come with an integrated graphics card in them.

Importance of Graphics Card in a Computer

A graphics card, or GPU (Graphics Processing Unit), is essential for rendering images, videos, and animations in a computer. While integrated graphics can handle basic tasks, a dedicated graphics card is crucial for high-performance activities like gaming, video editing, 3D rendering, and running design software. The GPU offloads the visual processing tasks from the CPU, enhancing overall system performance. With a powerful graphics card, users experience smoother frame rates in games, faster rendering times in creative software, and better support for higher resolution displays like 4K. For professionals in animation, video production, or gaming, a good GPU is indispensable.

Install Graphics Card

We will start with the Hardware Installation & later move to the Software Installation.

Section 1: Install Graphics Card Hardware

Step 1: Remove all the connections from the **CPU Cabinet** & leave the cabinet for a few minutes.

This will flow all the currents stored in several parts of the computer.

Step 2: Press the **Power Button** of the cabinet to remove existing static electricity from the device. Then, open the cabinet.

Fig. 2.10

Step 3: Now, hold the metal part of the cabinet like the **Cabinet Body** to ground yourself along with the computer cabinet. The portion is marked with a green color.

Fig. 2.11

Step 4: Now, you will find some **Doors** present in the cabinet that are marked as **Plus**. You have to remove the **Vertical Door** to remove the **Plus Doors**. Remove any one of the **Plus Doors**.

Fig. 2.12

Step 5: You will get the **Graphics Card Slot** on the button of the Motherboard. Remove the **Clips** by pressing them gently to open the slots.

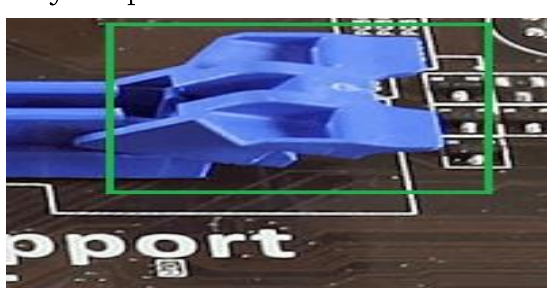


Fig. 2.13

Step 6: Get the **Notch** present on the slots & put the graphics card in the slot. Make sure that the Notch gets placed in the Graphics Card gap smoothly.

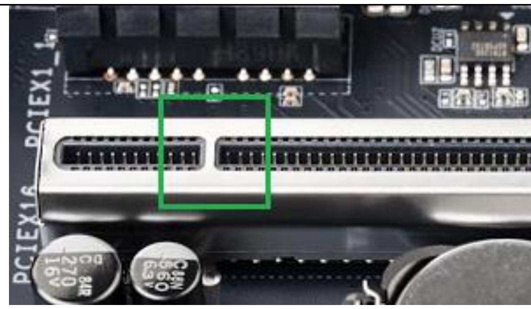


Fig. 2.14

Section 2: Install Graphics Card Software

Step 1: Now, execute the CD driver that you have received with the Graphics Card. If it is not there downloading the executable file from the internet by using the Graphics Card brand. Now, execute the file and click on the **Driver Installation** option.

Fig. 2.15

Step 2: Select the **Operating System** that you are having. Click **OK**.

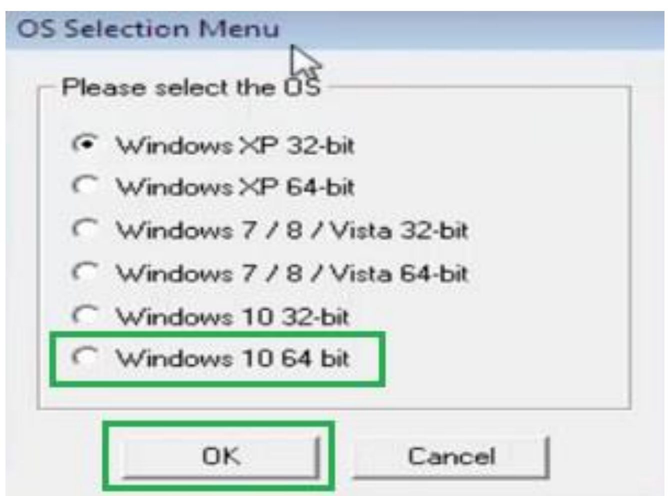


Fig. 2.16

Step 3: Select **Custom** Option & click **Next**.

Fig. 2.17

Step 4: Leave all the things as it is & click on **Next**.

Fig. 2.18

Step 5: Click on the **Restart Now** button.

Fig. 2.19

Sound Card

The sound card is a part of a computer that produces and records sound. Users may use it to connect analogue microphones, speakers, and headphones to their computers. A sound card is often integrated into the motherboard of a contemporary computer. Since computers are digital technologies and sound is inherently analogue, creating audio on them may be difficult. The human ear is also extremely sensitive to even the smallest variations in sound.

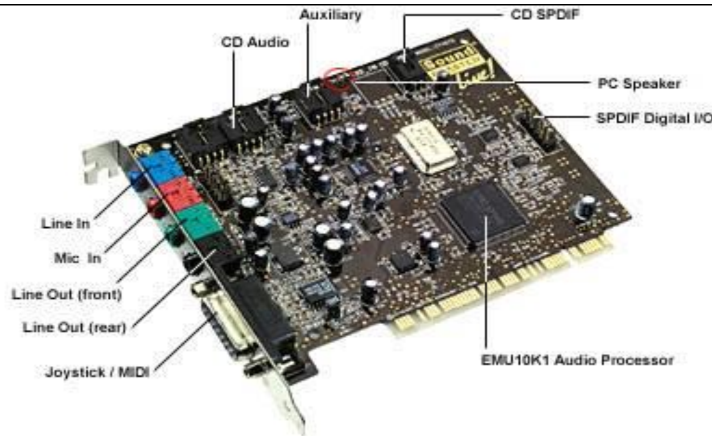


Fig. 2.20

Working of Sound Card

- A sound card employs specialized chips to reduce the CPU load and functions via an analog-digital converter (ADC) and a digital-analog converter (DAC).
- In the past, sound cards were expansion cards that frequently had PCI or ISA ports for early computers.
- The latest cards are PCIe. However, it became customary to integrate basic sound card capabilities into the motherboard as audio recording and playback grew more widespread and component costs dropped.
- Usually connected via USB, external sound cards are also known as audio interfaces.
- An audio interface with several separate audio inputs and outputs is necessary for advanced sound creation and recording.
- The headphones and microphone are now combined into a single 3.5mm connection on all current smartphones. sophisticated sound cards

Types of Sound Card

a) **External Sound Adapters**

The features of an external sound adapter are identical to those of a regular sound card. Rather of using an internal expansion slot, this little box connects to a computer via a USB or FireWire interface. Occasionally, it has features like physical volume control knobs and other inputs and outputs that aren't found on a normal sound card.

b) **Motherboard Sound Chips**

When the sound cards were initially released, they were expensive add-on cards. The cost amounted to several hundred dollars. As miniaturization technology advanced and made computer sound technology more inexpensive, computer hardware manufacturers were able to integrate sound into a single chip.

c) **Standard Sound Cards**

A conventional sound card plugs into one of the slots within the computer. One advantage of using a sound card over a motherboard sound chip is that the latter has its own CPU chips.

Features of Sound Card

- **Digital Signal Processor (DSP):** A processor that can handle the majority of the processing is incorporated into certain sophisticated sound cards. This is comparable to how graphic cards have a graphics processor.

- **Audio quality:** An evaluation of an electronic device's audio output's precision, fidelity, or comprehensibility is commonly referred to as sound quality.
- **Analog sound:** An analogue sound, such as that from a microphone or audio cassette, can be received by the sound card, which can then transform it into digital data that can be saved in an audio file.
- **Firmware ROM:** Card drivers, which are necessary for controlling the card, and other fundamental data are stored in the firmware RAM. During the first boot, it also aids in the sound card's initialization.

Uses of Sound Card

- **Sound for gaming:** Users may also utilize an external sound card to enhance surround sound and positional audio for the greatest gaming experiences.
- **Production of music:** Recording studios can enhance their output by utilizing external sound cards. Those who wish to begin producing their own music can also utilize it. They may be utilized for both amateur and expert music creation.
- **Audio recording:** The card has a microphone input port that may be used to record sounds such as voices, instruments, and other noises.
- **Voice recognition systems:** Users with visual impairments should be able to utilize speech recognition systems with the assistance of an auditory interface.

Importance of Sound Card in a Computer

A sound card, though not as critical as a GPU, plays an important role in enhancing a computer's audio capabilities. It converts digital audio signals into analog, making them audible through speakers or headphones. Integrated sound processors are sufficient for basic tasks like web browsing or video playback, but for audiophiles, gamers, or sound professionals, a dedicated sound card ensures superior audio quality, including higher bitrates, richer soundscapes, and immersive experiences. In audio production, sound cards allow for multiple input/output connections, reducing latency and offering better sound clarity, making them crucial for recording and mixing tasks.

Installing sound Card

Step 1. Turn Off the Computer: Make sure your computer is completely turned off and unplugged from the power source for safety.

Step 2. Open the Computer Case: Use a screwdriver to remove the side panel of your computer. This gives you access to the inside of the computer.

Step 3. Find an Empty PCIe Slot: Look for an empty PCIe slot on the motherboard. It's usually near the bottom of the motherboard and looks like a small, open slot where you'll place the sound card.

Step 4. Insert the Sound Card: Gently line up the sound card with the empty PCIe slot and push it in until it clicks into place. Be firm but gentle.

Step 5. Secure the Sound Card: Use a screw (from your computer case) to hold the sound card in place by fastening it to the metal bracket at the back of the case.

Step 6. Close the Computer Case: Put the side panel back on the computer and screw it closed.

Step 7. Reconnect the Power and Devices: Plug the computer back into the power socket and reconnect any other devices like the monitor, mouse, and keyboard.

Step 8. Turn on the Computer: Turn your computer back on. Your system should recognize the new sound card.

Step 9. Install the Drivers: Insert the driver CD that came with the sound card or download the drivers from the manufacturer's website. Follow the instructions to install them.

Step 10. Set Up Sound: Go to your computer's sound settings and choose your new sound card as the default sound device.

Install the Power Supply Unit (PSU)

Power supply unit is a hardware component of every computer system its main function is to convert external electrical power into the specific voltage and current required by various components within the computer, in short, it is the heart of the system responsible for stable and reliable power delivery which is important for the seamless operation of the entire computing infrastructure.

Need and Requirement of PSU in a Computer

The Power Supply Unit (PSU) is essential for powering a computer. It converts the electricity from a wall outlet (AC power) into the DC power needed by the computer's internal components, such as the motherboard, CPU, graphics card, and drives. Without a PSU, the computer would not function, as it wouldn't receive the necessary voltage and current to operate. A suitable PSU ensures that the system runs efficiently and safely, preventing issues like overheating or component failure due to incorrect power delivery. The PSU's wattage rating is crucial in meeting the power demands of the system, especially when running high-performance components like GPUs.

Working and Operation of PSU

A PSU works by converting high-voltage alternating current (AC) from the wall outlet into lower-voltage direct current (DC) used by the computer. Inside the PSU, components such as transformers, rectifiers, and regulators are responsible for converting and stabilizing the current. The process starts with the transformer reducing the high-voltage AC to a lower, safer voltage. Then, rectifiers convert the AC into DC. Finally, voltage regulators ensure that the output voltages (typically 12V, 5V, and 3.3V) remain stable to protect sensitive components. Most PSUs also have built-in protection mechanisms to prevent issues like overvoltage, overheating, or short circuits.

Features and Specifications of PSU

The primary features of a PSU include wattage rating, efficiency, and modularity. The wattage rating, typically ranging from 400W to 1000W or higher, determines how much power the PSU can supply to the computer. 80 PLUS certification indicates its efficiency level, with ratings like Bronze, Silver, Gold, and Platinum, meaning the PSU delivers power efficiently, reducing heat and saving electricity. Modular PSUs offer detachable cables, allowing users to only connect the necessary cables, which improves airflow inside the case. Other specifications include rail configuration (single or multi-rail), form factor (ATX, SFX), and protections like OVP (Over Voltage Protection), UVP (Under Voltage Protection), and SCP (Short Circuit Protection).

Connection of PSU

Connecting a PSU involves attaching the appropriate power cables to the various components of the computer. The main power connections are:

- **24-pin ATX connector**: This power the motherboard.
- **8-pin CPU power connector**: Supplies power to the processor.
- **PCIe power connectors (6 or 8-pin)**: Used for graphics cards that require additional power.
- **SATA power connectors**: Provide power to storage devices like SSDs and HDDs.
- **Molex connectors**: Used for older components like fans or drives. When installing, ensure the PSU is mounted securely in the case, typically at the bottom or top, and all necessary cables are properly connected to their respective components.

Install a Power Supply Unit (PSU) in a Computer

Step 1. Turn Off and Unplug the Computer

Before you start, make sure the computer is completely turned off and unplugged from the power outlet to avoid any electrical issues.

Step 2. Open the Computer Case

Use a screwdriver to remove the side panel of the computer case. This will give you access to the inside of the computer where the PSU will be installed.

Step 3. Find the PSU Mounting Area

Locate the PSU mounting spot in the case. It's usually at the bottom or top of the case, near the back. You'll see a space where the PSU fits and where its fan will face outward through a vent.

Step 4. Insert the PSU into the Case

Slide the PSU into its designated spot with the fan facing either downwards (for bottom-mounted PSUs) or towards the vent (for top-mounted PSUs). Align it with the screw holes at the back of the case.

Step 5. Secure the PSU with Screws

Use the screws provided with the PSU or case to securely fasten it in place. There should be four screw holes on the back of the case that line up with the PSU.

Step 6. Connect Power Cables to Components

- **Motherboard:** Connect the large 24-pin ATX cable from the PSU to the motherboard.
- **CPU:** Attach the 8-pin CPU power cable to the CPU power slot on the motherboard.
- **Graphics Card:** If your graphics card requires extra power, connect the 6-pin or 8-pin PCIe power cable to the card.
- **Storage Devices:** Connect SATA power cables to the hard drives and SSDs.
- **Other Components:** If you have fans or other components that need power, use Molex or additional connectors from the PSU.

Step 7. Close the Case

Once all the cables are connected, tidy them up to improve airflow. After that, replace the side panel of the computer case and screw it back into place.

Step 8. Plug in the Computer and Test

Finally, plug the computer back into the power outlet and turn it on. Check that everything is working properly.

Install the Disk Drive

Floppy Disk Drive (FDD): An older type of storage device that reads and writes data to floppy disks. It was once popular for saving small files but is now largely obsolete due to its limited capacity (1.44 MB) and slow speed.

Fig. 2.21

CD/DVD Drive: These drives read and write data to optical discs, such as CDs (700 MB) and DVDs (4.7 GB to 8.5 GB). CD/DVD drives are still used for media playback, software installation, and data storage, although they have been replaced in many systems by faster alternatives.

Fig. 2.22

Hard Disk Drive (HDD): A common storage device in computers, HDDs use magnetic disks (platters) to store large amounts of data. HDDs come in various sizes, from hundreds of gigabytes to several terabytes, and they are used to store everything from the operating system to personal files.

Fig. 2.23

Working and Operation of Disk Drives

Floppy Disk Drive: A floppy disk is inserted into the drive, where a magnetic read/write head accesses the disk's magnetic coating to store or retrieve data. The disk spins inside the drive, and the head moves to the correct position to read or write data.

CD/DVD Drive: Optical drives use lasers to read and write data. For reading, a laser beam scans the surface of the CD or DVD, detecting the reflective pits and lands on the disc, which represent the binary data. For writing, a higher-powered laser burns data onto writable discs.

Hard Disk Drive: Inside an HDD, multiple spinning platters coated with magnetic material store data. A read/write head moves across the platters' surface to magnetize or demagnetize tiny spots, representing binary data (1s and 0s). The platters spin at high speeds (e.g., 5400 RPM or 7200 RPM), allowing the drive to read or write data quickly.

Features, Speed, and Specifications of Disk Drives

Floppy Disk Drive: Limited capacity (1.44 MB), slow read/write speeds (around 125 KB/s), and low durability. FDDs were phased out in favour of more modern storage solutions.

CD/DVD Drive: CD drives read at speeds of up to 52x, and DVD drives can reach 16x speeds. A DVD can hold 4.7 GB on a single layer or 8.5 GB on a dual layer, while CDs hold 700 MB. Optical drives are slower than modern alternatives like HDDs and SSDs.

Hard Disk Drive (HDD): HDDs offer high capacities, ranging from 500 GB to several terabytes. Speeds depend on the platter rotation speed: 5400 RPM is common for laptops, while 7200 RPM is standard for desktop computers. Data transfer speeds are around 100–150 MB/s, slower than SSDs but faster than optical drives.

Connectors of Disk Drives

Floppy Disk Drive: FDDs used a 34-pin ribbon cable to connect to the motherboard and a Molex power connector for power. These connectors are no longer common in modern computers.

CD/DVD Drive: Optical drives typically use SATA connectors for data transfer, which has replaced the older IDE (PATA) connectors**.** They also use a 15-pin SATA power connector for power.

Hard Disk Drive (HDD): Modern HDDs use SATA connectors for both data and power, similar to CD/DVD drives. Older models used IDE (PATA) connectors, but these have largely been replaced by SATA. High-performance drives, like enterprise HDDs**,** may use SAS (Serial Attached SCSI) connectors.

Procedure for installation of Disk Drives in Computer.

Step 1. Turn Off and Unplug the Computer

Before starting, make sure the computer is completely powered off and unplugged from the electrical outlet for safety.

Step 2. Open the Computer Case

Use a screwdriver to remove the side panel of the computer case. This gives you access to the inside of the computer.

Step 3. Locate the Drive Bays

- For CD/DVD Drive: Find the 5.25-inch drive bay, typically located near the top front of the case.
- For Hard Disk Drive (HDD): Find the 3.5-inch drive bay, located either at the front or bottom of the case.

Step 4. Insert the Disk Drive

- CD/DVD Drive: Slide the CD/DVD drive into the 5.25-inch bay from the front of the case until it aligns with the screw holes.
- Hard Disk Drive (HDD): Slide the HDD into the 3.5-inch bay, making sure it fits snugly into place.

Step 5. Secure the Drive with Screws

Once the drive is in place, use screws to fasten it securely to the drive bay. Some modern cases may have tool-free mounting systems, where you simply snap the drive in place.

Step 6. Connect the Data Cable

For Both CD/DVD and HDD: Connect a SATA data cable to the drive. One end of the SATA cable goes into the drive, and the other end connects to a SATA port on the motherboard. If using an older IDE drive, connect the wide IDE ribbon cable instead.

Step 7. Connect the Power Cable

For Both CD/DVD and HDD: Locate a SATA power connector from the power supply and connect it to the back of the drive. If you're installing an older drive, you may need to use a Molex power connector.

Step 8. Check the Connections

Double-check that all connections (data and power) are secure and that the drive is firmly mounted in the bay.

Step 9. Close the Computer Case

Once everything is connected, put the side panel back on the case and secure it with screws.

Step 10. Plug in and Power On

Plug the computer back into the power outlet and turn it on. Your system should automatically detect the new drive.

Step 11. Test the Disk Drive

- For CD/DVD Drive: Insert a disc to ensure the drive is functioning properly.
- For HDD: Check your system's BIOS or disk management tool to confirm that the drive is recognized.

Install Monitor

Computer Monitor

A **computer monitor** is the screen that displays the output from a computer. It shows everything you do on the computer, from typing to watching videos, playing games, or browsing the internet. It connects to the computer through various cables like HDMI, VGA, or DisplayPort, and allows you to interact with the system visually.

Types of Monitor

1. CRT (Cathode Ray Tube) Monitors: These are older, bulky monitors that use a cathode ray tube to display images. They are no longer in common use due to their large size and heavy wig

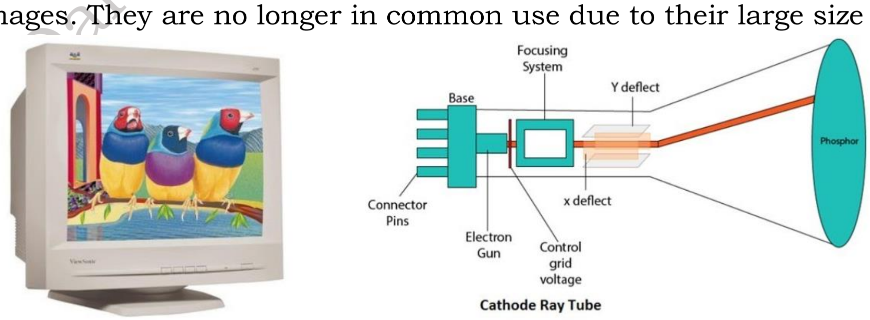


Fig. 2.24

2. LCD (Liquid Crystal Display) Monitors: These are thin and lightweight monitors that use liquid crystals to produce images. They are energy-efficient and widely used today.

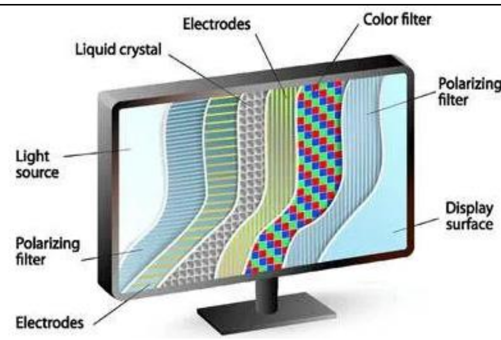


Fig. 2.25

3. LED (Light Emitting Diode) Monitors: A type of LCD monitor that uses LEDs for backlighting. These are more energy-efficient and provide better picture quality compared to standard LCD monitors.

Fig. 2.26

4. OLED (Organic Light Emitting Diode) Monitors: These monitors use organic compounds that emit light when electric current is applied. OLED monitors offer superior contrast, color accuracy, and are thinner than LED or LCD screens.

Fig. 2.27

5. Touchscreen Monitors: These monitors allow users to interact with the computer directly by touching the screen. They are common in tablets, smartphones, and certain desktop computers.

Fig. 2.28

Specifications of Monitor

Screen Size: Measured diagonally, common sizes range from **21 inches to 32 inches**, but there are larger monitors for specialized use.

Resolution: The number of pixels that make up the display. Common resolutions include:

- **1080p (Full HD)**: 1920x1080 pixels
- **1440p (Quad HD)**: 2560x1440 pixels
- **4K (Ultra HD)**: 3840x2160 pixels

Aspect Ratio: The proportion of width to height. Standard aspect ratios are **16:9** for widescreen monitors and **21:9** for ultrawide monitors.

Refresh Rate: The number of times the screen updates per second, measured in hertz (Hz). Typical refresh rates include **60Hz, 120Hz, 144Hz,** and even **240Hz** for gaming monitors.

Response Time: The time it takes for a pixel to change color, usually measured in milliseconds (ms). Lower response times, like **1ms** or **5ms**, are better for fast-moving images like in video games.

Panel Type:

- **TN (Twisted Nematic)**: Fast response times, good for gaming.
- **IPS (In-Plane Switching)**: Better color accuracy and viewing angles, great for design and media.
- **VA (Vertical Alignment)**: High contrast, suitable for general use and media.

Power Requirement for Monitor

The power requirements for monitors vary based on their type, size, and features.

- **CRT Monitors**: These older monitors consume a lot of power, typically around **80–150 watts**.
- **LCD Monitors**: Modern LCD monitors are much more energy-efficient, consuming around **20–40 watts** for smaller models, and **40–60 watts** for larger ones.
- **LED Monitors**: Even more energy-efficient, using around **15–30 watts** depending on the size.
- **OLED Monitors**: Power consumption varies with usage, typically around **40–60 watts**, but this can change based on brightness and the amount of content displayed.

Monitors typically use a **standard AC power input** (100-240V), and many come with energy-saving features like **auto power-off** and **sleep mode**, which reduce power consumption when the monitor is not in use.

Install a Computer Monitor

Required materials: Computer monitors, Power cable, Video cable

Step 1. Choose a Suitable Location

Find a flat, stable surface for your monitor, such as a desk or table. Ensure that the area has access to a power outlet and enough space for your computer and other peripherals.

Step 2. Connect the Monitor to the Computer

- **Locate the Video Ports**: Check the back of the monitor and the computer for available video ports.

- **Choose the Right Cable**: Depending on your monitor and computer, use an HDMI, VGA, or DisplayPort cable.
- **Connect One End to the Monitor**: Plug one end of the video cable into the corresponding port on the monitor.
- **Connect the Other End to the Computer**: Plug the other end of the video cable into the matching port on the back of the computer.

Step 3. Connect the Power Cable

Plug the power cable into the monitor's power input port (usually located at the back). Connect the other end of the power cable to an electrical outlet.

Step 4. Turn on the Monitor

Locate the power button on the monitor. It is usually located on the front or bottom edge. Press the power button to turn on the monitor.

Step 5. Turn on the Computer

Press the power button on your computer to start it up. The monitor should detect the signal and display your computer's desktop.

Step 6. Adjust Display Settings

- Once your monitor is on and connected, you may need to adjust the display settings for optimal viewing.
- On Windows, right-click on the desktop, select **Display settings**, and adjust resolution and orientation as needed.
- On macOS, go to **System Preferences > Displays** to adjust settings.

Step 7. Secure the Cables

To keep your workspace tidy, use cable ties or clips to secure any loose cables, preventing them from tangling or becoming a tripping hazard.

Install the Peripherals

Computer Peripherals: Computer peripherals are external devices that connect to a computer to expand its functionality. They are essential for completing various tasks, such as printing documents, scanning images, and playing sound.

Printer

A printer is a device that accepts text and graphics output from a computer, and it transfers this information to paper, sheets. Printers can print any information that has been passed to it, whether it be Text, Numbers or Images. It depends on the type of printer that what quality or color the printed matter would be.

Fig. 2.29

Types of Printers:

- **Inkjet Printers:** Use liquid ink to produce high-quality images and text. Good for photos and color documents.
- **Laser Printers:** Use toner powder and a laser to print documents quickly and efficiently. Ideal for text-heavy documents and high-volume printing.
- **Dot Matrix Printers:** Use a print head that strikes an ink ribbon to produce characters. Often used for multi-part forms.
- **Thermal Printers:** Use heat to print on special paper. Commonly used for receipts and labels.

Specifications:

- **Print Resolution:** Measured in DPI (dots per inch); higher DPI means better print quality.
- **Print Speed:** Measured in pages per minute (PPM); indicates how fast a printer can produce documents.
- **Connectivity:** Options may include USB, Wi-Fi, or Ethernet for network printing.
- **Paper Handling:** Includes paper size support, capacity of trays, and duplex printing (automatic double-sided printing).

Power Requirement for Printers

Most printers consume between 30-100 watts during operation. Inkjet printers usually use less power compared to laser printers. Some printers also have energy-saving modes that reduce power consumption when idle.

Connectors and Slots for Printers

- USB ports for direct connection to computers.
- Ethernet ports for network connections.
- Wi-Fi for wireless printing.

Scanner

A Scanner is an electronic device that is used to read and convert documents such as photographs, magazines, posters, and images into digital copies for display, editing, and archiving. The digital copies can be further modified by using different software tools. Most scanners are connected to computers using cords that plug into a port that is readily accessible. Some modern scanners also come equipped with Bluetooth and wireless features which offer greater accessibility and flexibility. Scanners work in conjunction with software applications. By installing scanning plug-ins, the images can be directly imported into the software applications. For example, by installing a plug-in for Adobe Photoshop the users can create new images directly from the linked scanner.

Types of Scanners:

Flatbed Scanners: Have a flat glass surface where documents are placed. Ideal for scanning books and photos.

Fig. 2.30

Sheet-fed Scanners: Automatically feed multiple pages through the scanner. Efficient for bulk document scanning.

Fig. 2.31

Handheld Scanners: Portable devices that allow users to scan documents on the go.

Fig. 2.32

Specifications:

- **Optical Resolution:** Measured in DPI; indicates the detail the scanner can capture.
- **Scan Speed:** Measured in pages per minute (PPM) for document scanners.
- **Color Depth:** Determines the range of colors captured; measured in bits (e.g., 24-bit color).

Power Requirement for Scanners

Scanners typically consume around 15-40 watts during operation. Some models may have energy-saving features that reduce power usage when idle.

Connectors and Slots for Scanners

- USB ports for direct connection to computers.
- Wi-Fi for wireless scanning.
- Network connections for use in office environments.

Speakers

Speakers are the type of transducers by use electromagnetic waves that convert electromagnetic waves into sound waves. It is used to connect to a computer system which creates a sound that is considered an output part of computer systems. here the user may give an audio input to the systems which is either in analog or digital form to create analog electromagnetic waves (analog speaker) to give sound waves as an output.

Fig. 2.33

Types of Speakers:

- **Stereo Speakers:** Two speakers for basic sound output.
- **5.1 Surround Sound Speakers:** Five speakers and one subwoofer for a surround sound experience, commonly used in home theaters.
- **Bluetooth Speakers:** Wireless speakers that connect via Bluetooth for portability.
- **USB Speakers:** Plug directly into a computer's USB port for easy connection.

Specifications:

- **Power Output:** Measured in watts; indicates the volume level and sound quality.
- **Frequency Response:** Indicates the range of frequencies the speakers can produce (e.g., 20Hz to 20kHz).
- **Impedance:** Measured in ohms; affects compatibility with audio devices.

Power Requirement for Speakers

Speaker power requirements can vary, typically ranging from 5-100 watts depending on the type and power output. Some active speakers may require an external power source, while passive speakers need a separate amplifier.

Connectors and Slots for Speakers

- 3.5mm audio jack for standard audio devices.
- USB ports for powered speakers.
- Bluetooth for wireless connectivity.

Install Computer Peripherals – Printer, Scanner, and Speakers

1. Installing a Printer

Step 1. Unpack the Printer: Remove the printer from the box and take off all protective tapes and packaging materials.

Step 2. Connect the Printer to Power: Plug the printer's power cable into an electrical outlet and turn on the printer using the power button.

Step 3. Connect the Printer to the Computer: Connect the printer to the computer using a USB cable. Plug one end into the printer and the other end into a USB port on your computer. Wireless Connection, if your printer supports Wi-Fi, connect it to your home network using the printer's control panel. Refer to the printer's manual for Wi-Fi setup steps.

Step 4. Install Printer Drivers: If prompted, insert the CD that came with the printer to install the required drivers.

Alternatively, download the latest drivers from the manufacturer's website.

Step 5. Configure the Printer: On your computer, go to Settings > Devices > Printers & Scanners. Click Add a Printer and follow the on-screen instructions.

Step 6. Test the Printer: Print a test page to ensure the printer is working properly.

2. Installing a Scanner

Step 1. Unpack the Scanner: Remove the scanner from the packaging and place it on a flat surface near your computer.

Step 2. Connect the Scanner to Power: Plug the scanner's power cable into an outlet and turn it on using the power button.

Step 3. Connect the Scanner to the Computer: Use a USB cable to connect the scanner to the computer. For wireless scanners, connect the scanner to your Wi-Fi network by following the instructions in the user manual.

Step 4. Install Scanner Drivers: Install the scanner's drivers using the CD provided or download them from the manufacturer's website.

Step 5. Configure the Scanner: On your computer, go to Settings > Devices > Printers & Scanners. Click Add a Scanner and follow the instructions to set it up.

Step 6. Test the Scanner: Use the scanning software provided by the manufacturer to scan a document or image to ensure the scanner is working correctly.

3. Installing Speakers

Step 1. Unpack the Speakers: Take the speakers out of the packaging and place them near your computer, ensuring there's space for proper sound distribution.

Step 2. Connect the Speakers to Power: For powered speakers, plug the power cable into an outlet.

Step 3. Connect the Speakers to the Computer: 3.5mm Audio Jack, if your speakers use a 3.5mm audio cable, plug it into the headphone/speaker output port (usually green) on your computer. USB Speakers, if your speakers use USB for both power and sound, simply plug them into a USB port on your computer. Bluetooth Speakers, turn on Bluetooth on your computer and pair it with your speakers by following the speaker's Bluetooth pairing process.

Step 4. Configure Sound Settings: On your computer, go to Settings > System > Sound and select the speakers as the default playback device.

Step 5. Test the Speakers: Play some audio (music, video, etc.) to ensure the sound is coming through the speakers and adjust the volume as needed.

Check Your Progress

A. Multiple Choice questions

1. What is the first step in installing RAM modules on the motherboard? (a) Push the RAM into the slots (b) Power on the computer (c) Open the RAM slots by pressing the clips (d) Close the case
2. Which slot is typically used for installing a graphics card? (a) DIMM slot (b) PCIe slot (c) SATA slot (d) AGP slot
3. What is the primary function of a power supply unit (PSU) in a computer? (a) To connect peripherals (b) To provide power to all components (c) To manage data transfer (d) To store files
4. Which type of cable connects a disk drive to the motherboard? (a) USB cable (b) SATA cable (c) HDMI cable (d) Ethernet cable
5. What is the purpose of installing sound cards in a computer? (a) To increase processing power (b) To improve audio output and sound quality (c) To connect to the internet (d) To enhance visual graphics

B. Fill in the blanks

1. Before installing RAM modules, you should first ensure that the motherboard is __________.
2. The slots for installing RAM on the motherboard are called __________ slots.
4. To install a graphics card, you need to insert it into the __________ slot on the motherboard.
5. The __________ connector provides power to the disk drive from the power supply.
6. Peripherals like keyboards and mice are typically connected to the motherboard via __________ ports.

C. State true or False for the following

1. RAM modules should be installed with the computer powered on.
2. The graphics card is installed into a PCIe slot on the motherboard.
3. SATA cables are used to connect disk drives to the power supply.
4. The monitor is typically connected to the graphics card via a USB cable.
5. A power supply unit converts AC power from the wall into DC power for the computer components.

D. Short Answer Type Questions

1. What is the purpose of RAM in a computer?
3. What type of slot is used to install a graphics card on the motherboard?
3. What is the primary function of the power supply unit (PSU)?
4. What cable is typically used to connect a disk drive to the motherboard?
5. Which type of connector is used to connect a monitor to the graphics card?

Session 3. Assemble and Dismantle the Desktop Computer

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 system. It also covers the need for adequate system resources to efficiently run the customer's hardware and software.

3.1 Computer Assembly

As we know, computer assembly is a systematic process. First, arrange all the computer parts. The sequence for assembly and working of the computer is as below:

- 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.

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

Procedure

Step 1: Open the case

- The first step in assembling a computer is to open the computer case. There are different methods for opening cases, as shown in Figure 3.1.

Fig. 3.1: Unscrew cabinet **Fig. 3.2: Pull cabinet side cover**

- 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, as shown

in Figure 3.3.

Fig. 3.3: Unscrew bolts

Step 2: Install the power supply

The next step is to install a power supply. 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. As shown in Figure 3.4.

Fig. 3.4: 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.

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.

3.1.1 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 as shown in Figure 3.5.

Fig. 3.5: Installing CPU on the motherboard

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 as shown in Figure3.6.

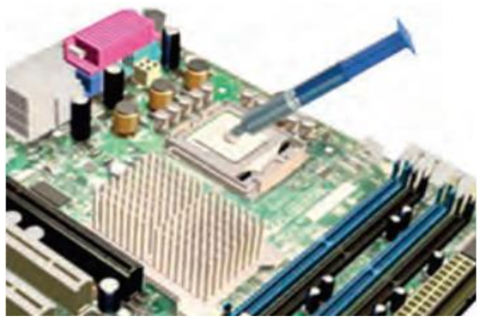


Fig. 3.6: Applying thermal compound on CPU

3.1.2 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/4pin 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 as shown in Figure 3.6.
- Place the Heat sink/Fan gently and tighten the screw properly as shown in Figure 3.7 and 3.3.

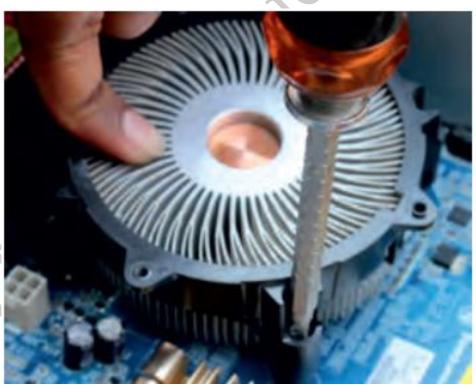


Fig. 3.7: Screw the heat sink

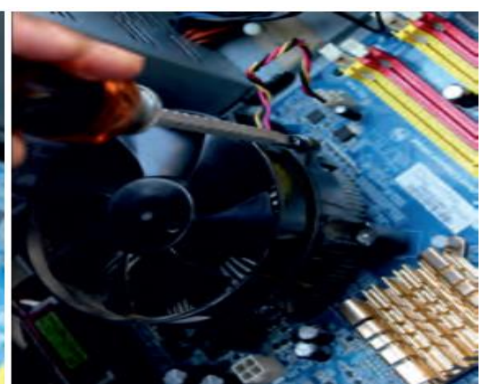


Fig. 3.8 Screw the heat sink fan assembly

3.1.3 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/DDR4 is mentioned on the motherboard, then DDR3/DDR4 RAM may be fixed in the memory slot. To install RAM, follow these steps.

- Press down the side locks of the memory slot as shown in Figure 3.9. 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.

Fig. 3.9: Memory slot

- 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 3.10. Plastic and metal standoffs are used to mount the motherboard and to prevent it from touching the metal portions of the case.

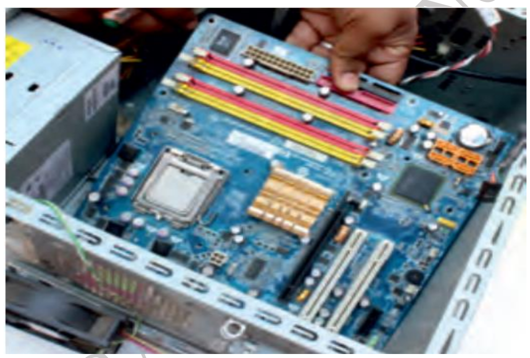


Fig. 3.10: Lay the motherboard over the standoffs

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 4-pin ATX power connector from the power supply to the motherboard.

Fig. 3.11: Tighten all the motherboards screws

Step 5. Install internal drives

3.1.4 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 as shown in Figure 3.3.

Fig. 3.12: Insert hard disk

- Secure the HDD to the case using proper screws as shown in Figure 3.13.

Fig. 3.13: Tighten screw of HDD

3.1.5 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 as shown in Figure 3.3.

Fig. 3.14: Insert optical drive

- Secure the optical drive to the case using the proper screws as shown in Figure 3.15.

Fig. 3.15: Tighten screws of optical drive

- 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.

Fig. 3.16: Connect cable IN to HDD

Fig. 3.17: Press cable socket for proper connection

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 as shown in Figure 3.13.

Fig. 3.18: Plug-in 20-pin ATX power connector to motherboard

- 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 as shown in Figure 3.19.

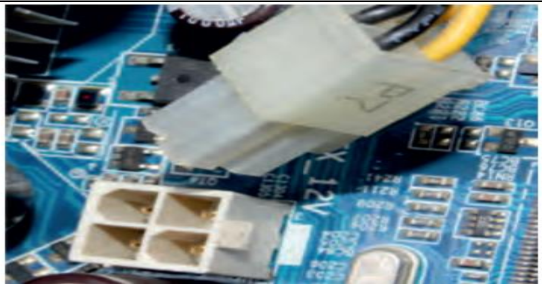


Fig. 3.19: Plug-in 4-pin AUX power connector to motherboard

3.1.6 SATA power connectors

SATA power connectors use a 15-pin connector as shown in Figure3.20. 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.

Fig. 3.20: Plug-in 15-pin connector to HDD

Step 7a. Connecting Front Panel connectors

To connect front panel connections, take care about all the wires which you can see in cabinet depends on the manufacturer. In most of the cabinets, you will find Power SW, Reset SW, Speaker, Power LED, HDD LED, Front USB connector etc, as shown in Figure 3.21 and 3.22. Few motherboards have built in speaker separately. Now a days one single combined connector is also available which have all in one to connect for front panel.

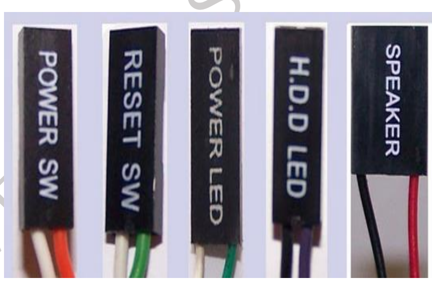


Fig. 3.21. Front Panel Connectors

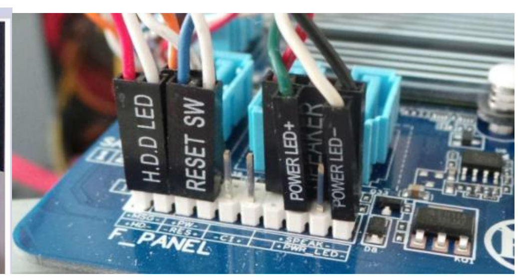


Fig. 3.22 Connecting Front Panel Connectors

Step 3. 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:

3.1.7 Locate the monitor cable

Locate the two-power cable and one VGA cable or monitor cable as shown in Figure 3.23. 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. 3.23: Display cable and ports

3.1.8 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 3.24 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.

Fig. 3.24: Connecting VGA or monitor cable to the port on back panel of computer

3.1.9 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 3.25 and 3.26 shows connecting keyboard in PS/2 connector and USB connector.

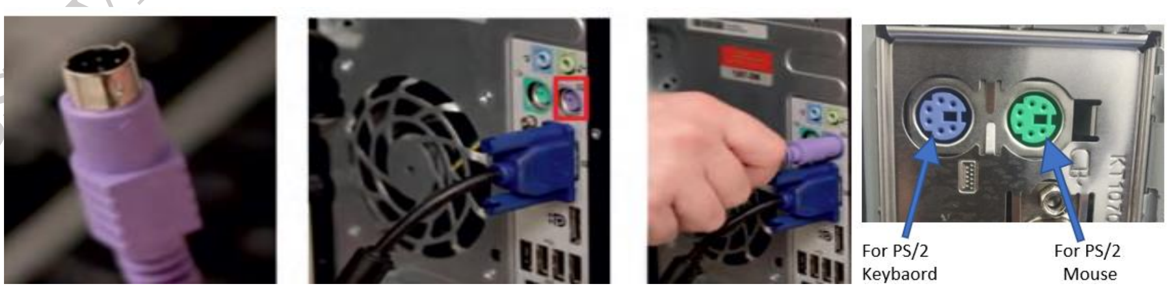


Fig. 3.25: Connecting keyboard in PS/2 port

Fig. 3.26: Connecting keyboards in USB port

3.1.10 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.

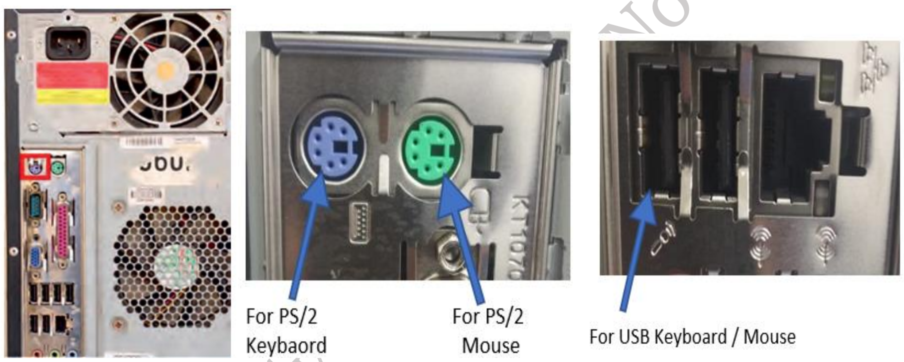


Fig. 3.27: (a) Connecting mouse in PS/2 port (b) Connecting mouse in USB port

3.1.11 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. 3.28: Connecting in Back panel **Fig. 3.29: Connecting in Front panel**

3.1.12 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. 3.30: 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 and turn it on when you are ready.

Fig. 3.31: Plug the surge protector into a wall outlet

3.1.13 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. Now a days almost all such devices are USB based and you can easily plug these in USB port. Correctly plugging in will recognize the peripherals as they are plug and play devices.

It may be required to install their software drivers for them to function properly. Most of the time the respected driver gets automatically installed as you plug in the device. 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.

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 monitors. Because the monitor consumes more electricity when powered on. An operating system or system software like Window or Linux will start loading as shown in Figure 3.32, 3.33, and 3.34 and the home window will appear as shown in Figure 3.35, 3.36, and 3.37. Now your computer is ready to use.

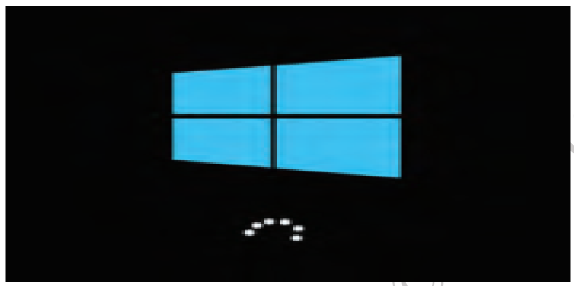


Fig. 3.32: Starting window of Windows 10

Fig. 3.33: Starting window of Windows 7

Fig. 3.34: Starting window of Ubuntu

Fig. 3.35: Home windows of windows 10

Fig. 3.36: Home window of windows 7

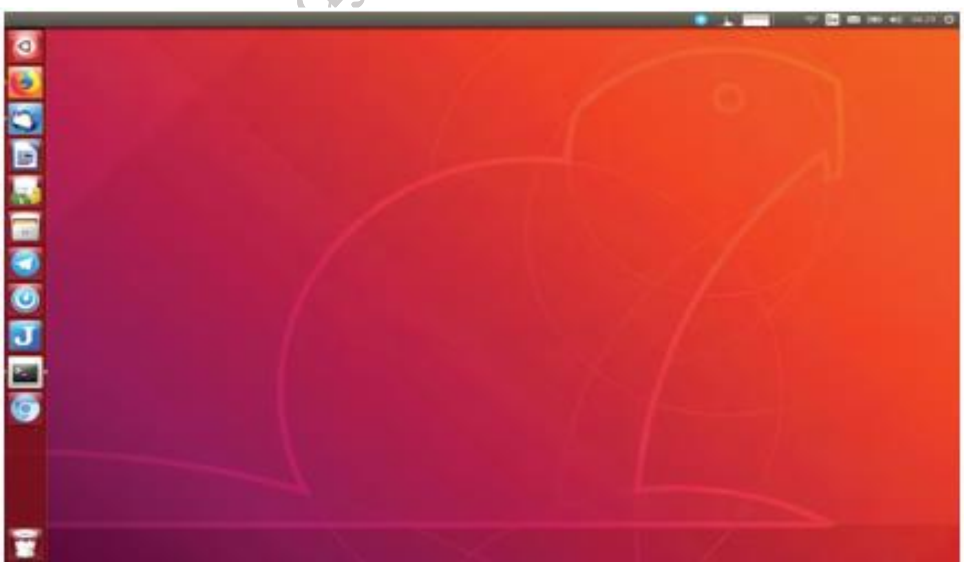


Fig. 3.37: Home windows of Ubuntu

3.2 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.

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

Fig. 3.38: CPU

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. 3.39: Unscrew cabinet

Fig. 3.40: 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. 20 or 24 Pin, 4 Pin connectors from Motherboard etc.

Fig. 3.41: Unplug 15-pin connector from HDD

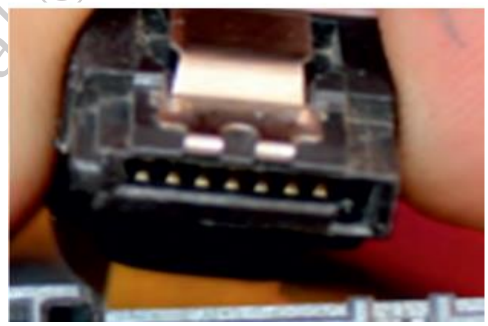


Fig. 3.42: Unplug 7-pin connector from HDD

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.

Fig. 3.43: Unscrew fan

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 as shown in Figure 3.44.

Fig. 3.44: Remove the system fan

To remove the CPU fan from the heat sink, first, disconnect its connector from the motherboard. Then remove the four screws securing it as shown in Figure 3.45.

Fig. 3.45: 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 as shown in Figure 3.43.

Fig. 3.46: Unplug 20-pin ATX **Fig. 3.47: unplug 4-pins AUX power**

connector from power connector from motherboard

Fig. 3.48: Unplug SATA cables from motherboard

- Disconnect the power cable of the hard disk and optical drive which connects to the SMPS as shown in Figure 3.49.

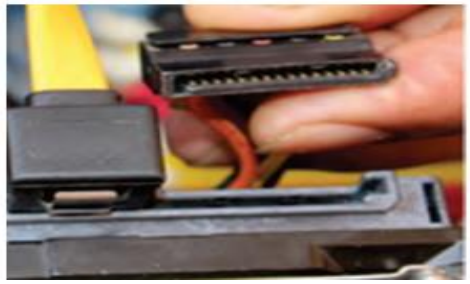


Fig. 3.49: Unplug power cable from optical drive and HDD

- Remove the screws that secure the power supply unit to the chassis as shown in Figure 3.50.

Fig. 3.50: Remove the screws

- Carefully lift the power supply out of the chassis as shown in Figure 3.51.

Fig. 3.51: Unscrew the SMPS and remove it from cabinet

Step 6. Removing HDD and optical drive

- Remove the SATA cable connecting to the HDD and motherboard.
- Then unscrew the four screws securing it in place and pull out the HDD as shown in Figure 3.52.

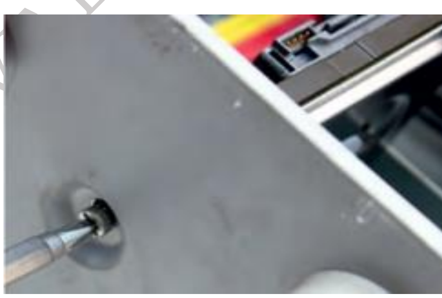


Fig. 13.52: Unscrewing of HDD

Fig. 3.53: Remove HDD

Step 7. Remove RAM (random access memory) modules

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.

Fig. 3.54: Unplug the RAM from slot

Step 3. 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 3.55, 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. 3.55: 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, as shown in Figure 3.56.

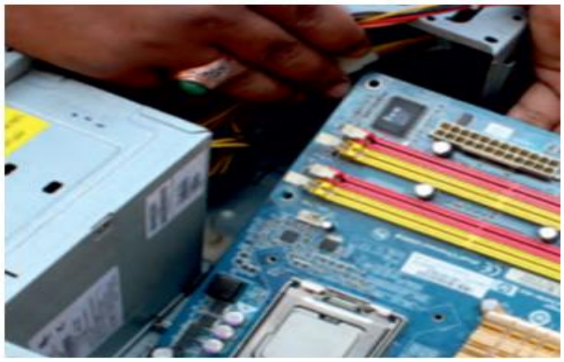


Fig. 3.56: Removing the motherboard

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.

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.

3.3 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 organized and keep track of all the screws. We have to figure out how to remove the back panel.

Fig. 3.57: Back panel of a laptop

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 as shown in Figure 3.58 and 3.59.

Fig. 3.58: Unscrew the socket

Fig. 3.59: 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.

3.4 Disassembly of laptop

Procedure

Step 1. Removal of battery

Start the disassembly process by removing the battery as shown in Figure 3.65. 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. 3.60: Remove battery and optical drive

Step 2. Separation of palm rest

Using a plastic case opener, separate the palm rest from the bottom case as shown in Figure 3.61.

Fig. 3.61: Separate plan rest from bottom case

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. 3.62: Remove screw from the hard drive and disconnect it

Fig. 3.63: 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.

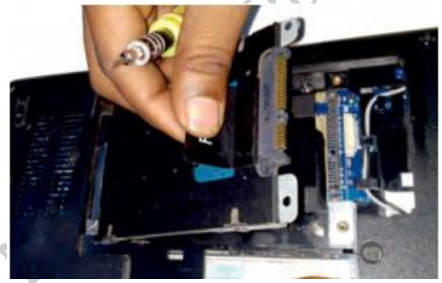


Fig. 3.64: Remove hard drive assembly **Fig. 3.65: Disconnect SATA cable**

Step 6. Removal of RAM

A notebook PC motherboard has two memory slots. Remove both RAM modules if necessary.

Fig. 3.66: 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 3. Removal of USB LED status board

Remove the USB LED status board.

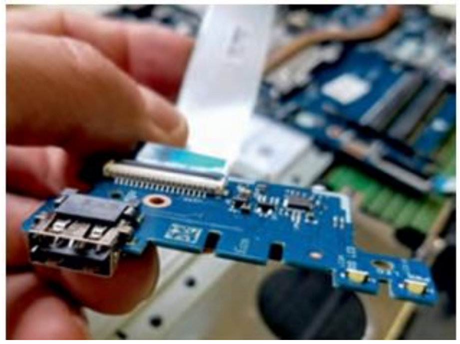


Fig. 3.67: Remove USB LED status board

Fig. 3.68: Remove optical CD DVD drive connector board

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 as shown in Figure 3.70.

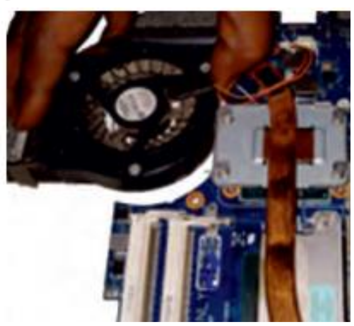


Fig. 3.69: Remove cooling fan

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.

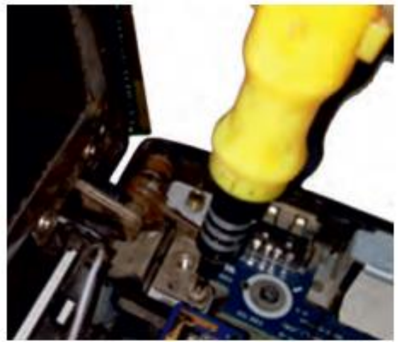


Fig. 3.70: Remove screws fastening display hinge

Fig. 3.71: Open the hinge and remove DC power jack

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.

Fig. 3.72: DC power jack mounted under display hinge

Fig. 3.73: Disconnect Wi-Fi Module

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 3.74.

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. 3.74: Disconnect cable from motherboard and remove screws

Fig. 3.75: Remove the motherboard from notebook case

Fig. 3.76: Keyboard permanently attached to top case

3.4.1 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.

Fig. 3.77: Notebook PC LCD screen removal

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 (as shown in Figure 3.73.

Fig. 3.78: Remove the four screws securing LCD screen

Fig. 3.79: Remove screen bezel

Step 5. Separate LCD screen from the back cover and place it the front side down on the keyboard.

Fig. 3.80: Separate LCD screen from back cover

Step 6. Now you can access the video cable connector as shown in Figure 3.81.

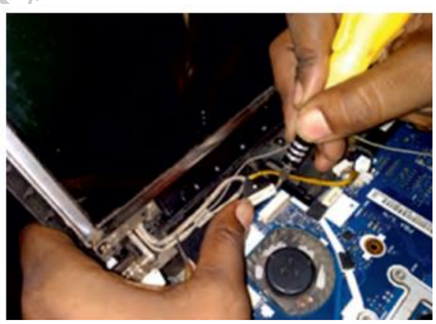


Fig. 3.81: Disconnect video cable from screen

Step 7. Peel off the grounding tape from the screen.

Step 3. Peel off the clear tape securing the connection and unplug the video cable from the screen.

Step 9. Remove the LCD screen completely and replace if necessary as shown in Figure 3.82.

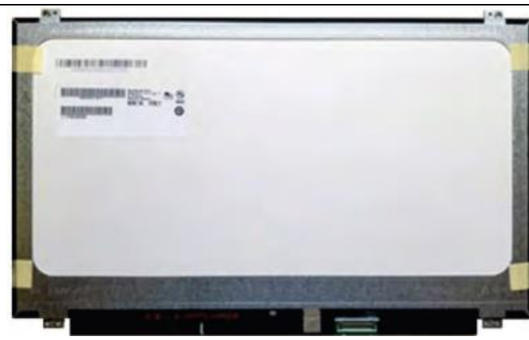


Fig. 3.82: Remove and replace LCD screen

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. Which tool is essential for assembling a desktop computer? (a) Hammer (b) Screwdriver (c) Wrench (d) Pliers
2. What should you do before starting to disassemble a desktop computer? (a) Remove all peripherals (b) Disconnect the power supply (c) Format the hard drive (d) Open all panels
3. Which component is typically the first to be installed in a desktop computer? (a) Power supply (b) Hard drive (c) RAM (d) Motherboard
4. What type of connector is used to attach the power supply to the motherboard? (a) SATA (b) Molex (c) 24-pin ATX connector (d) PCIe
5. During disassembly, which component should be removed last? (a) RAM (b) Hard drive (c) CPU (d) Power supply

B. Fill in the blanks

1. Before starting the assembly of a desktop computer, ensure that you have a clean and __________ workspace.
2. The __________ is the main component that houses the CPU, RAM, and other essential hardware.
3. When installing RAM, align the notch on the RAM stick with the __________ in the DIMM slot.
4. The __________ unit is responsible for providing power to all components in the computer.
5. During disassembly, it is important to __________ the power supply before removing any components.

C. State true or False for the following

1.The motherboard should be installed before the power supply unit.

2.The power supply unit converts AC power to DC power for the computer components.

3. Cable management is not necessary as long as all components are connected properly.

4.The graphics card is typically installed in a PCIe slot on the motherboard.

5.The operating system should be installed after assembling all the hardware components.

D. Short Answer Type Questions

1. What are the first steps to take before assembling a desktop computer?
2. What is the purpose of the power supply unit in a desktop computer?
3. How do you install RAM modules into the motherboard?
4. What type of connector is used to attach a hard drive to the motherboard?
5. What is the last component typically installed during the assembly of a desktop computer?

Answer Key

Module 1. Fundamental of Computer and Its Peripherals

Session 1. Role and responsibilities of a Field Technician Compu-ting and Peripherals

A. 1. (b) 2. (c) 3. (a) 4. (d) 5. (b)

B. 1. Electronic components 2. Semiconductor 3. Telecommunications 4. Economic growth 5. Troubleshooting

C. 1. (F) 2. (T) 3. (F) 4. (F) 5. (T)

Session 2. Basic Functionality of Computer System

A. 1. (b) 2. (c) 3. (b) 4. (c) 5. (a)

B. 1. High 2. First 3. Instructions 4. Software 5. Motherboard

C. 1. (F) 2. (F) 3. (T) 4. (F) 5. (T)

Session 3. Input and Output Devices

A. 1. (b) 2. (a) 3. (a) 4. (b) 5. (b)

B. 1. Keyboard 2. Pointing 3. Webcam 4. RFID 5. Soft copy

C. 1. (T) 2. (F) 3. (T) 4. (F) 5. (F)

Session 4. Storage and Peripheral Device

A. 1. (c) 2. (b) 3. (b) 4. (b) 5. (c)

B. 1. Primary, Secondary, and cache 2. Read Only Memory (ROM) 3. Bytes, Kilobytes (KB), Megabytes (MB) 4. Hard Disk 5. CDs and DVDs

C. 1. (T) 2. (F) 3. (F) 4. (T) 5. (F)

Module 2. Installation and Configuration of Operating Systems

Session 1. The Functions of Operating System

A. 1. (b) 2. (b) 3. (a) 4. (b) 5. (c)

B. 1. Booting 2. Process 3. Multi-user 4. Kernel 5. Memory

C. 1. (F) 2. (T) 3. (F) 4. (T) 5. (T)

Session 2. Install Windows Operating System

A. 1. (b) 2. (c) 3. (a) 4. (c) 5. (c)

B. 1. 32 GB 2. 2GB 3. USB drive 4. Media Creation Tools

C. 1. (F) 2. (T) 3. (F) 4. (T) 5. (T)

Session 3. Configure Windows operating system

A. 1. (b) 2. (c) 3. (d) 4. (b) 5. (b)

B. 1. Ctrl + Alt + Del 2. File Explorer 3. Time & Language 4. Installation media 5. Antivirus

C. 1. (T) 2. (F) 3. (T) 4. (F) 5. (T)

Session 4. Install Linux operating system

A. 1. (b) 2. (a) 3. (d) 4. (c) 5. (c)

B. 1. open-source nature 2. ISO 3. apt-get update 4. virtualizing 5. reboot

C. 1. (T) 2. (F) 3. (T) 4. (F) 5. (F)

Session 5. Post installation and Configure Peripheral devices in Linux operating system

A. 1. (b) 2. (b) 3. (b) 4. (b) 5. (a)

B. 1. chmod 2. ifconfig 3. / 4. mkdir 5. File system structure

C. 1. (F) 2. (T) 3. (F) 4. (T) 5. (F)

Module 3. BASIC OF ELECTRONICS, TOOLS AND EQUIPMENT

Session 1. Basic concepts of Electronics

A. 1. (c) 2. (a) 3. (b) 4. (d) 5. (c)

B. 1. Ohm 2. Capacitor 3. Current 4. Conductor 5. Rectifier

C. 1. (F) 2. (T) 3. (F) 4. (T) 5. (F)

Session 2. Electronic Circuit Components

A. 1. (b) 2. (b) 3. (c) 4. (c) 5. (a)

B. 1. Capacitor 2. Resistor 3. Transistor 4. Rectifier 5. Farad

C. 1. (F) 2. (T) 3. (T) 4. (F) 5. (T)

Session 3. Functions of Various Electrical and Mechanical Parts and modules in a Computer system

A. 1. (b) 2. (b) 3. (c) 4. (b) 5. (c)

B. 1. Central Processing Unit 2. RAM 3. Motherboard 4. Power supply 5. Hard disk drive

C. 1. (T) 2. (F) 3. (T) 4. (F) 5. (F)

Session 4. Tools and Equipment and Measuring instruments

A. 1. (b) 2. (b) 3. (a) 4. (b) 5. (c)

B. 1. Wire cutter 2. Voltmeter 3. Multi meter 4. Ohmmeter 5. Power Supply

C. 1. (F) 2. (T) 3. (T) 4. (F) 5. (F)

Module 4. Installation of Desktop Computer and Peripherals

Session 1. Install the Motherboard and CPU or Processor

A. 1. (a) 2. (d) 3. (a) 4. (b) 5. (b)

B. 1. I/O shield 2. Ground 3. Socket 4. Chipset 5. Retention arm

C. 1. (T) 2. (F) 3. (F) 4. (F) 5. (T)

Session 2. Installing Process External and Internal Peripherals on the Motherboard

A. 1. (c) 2. (b) 3. (b) 4. (b) 5. (b)

B. 1. Power off 2. DIMM 3. PCIe 4. SATA Power 5. USB

C. 1. (F) 2. (T) 3. (F) 4. (F) 5. (T)

Session 3. Assemble and Dismantle the Desktop Computer

A. 1. (b) 2. (b) 3. (c) 4. (c) 5. (d)

B. 1. Organized 2. Motherboard 3. Key 4. Power supply 5. Disconnect

C. 1. (T) 2. (T) 3. (F) 4. (T) 5. (T)