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Computer Hardware, Electronics Repair and Maintenance

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Technical and Vocational Stream
Learning Resource Materials

Computer Hardware, Electronics Repair and Maintenance

(Grade 10)

Computer Engineering

Government of Nepal
Ministry of Education, Science and Technology
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Preface

The curriculum and curricular materials have been developed and revised on a regular basis with the aim of making education objective-oriented, practical, relevant and job oriented. It is necessary to instill the feelings of nationalism, national integrity and democratic spirit in students and equip them with morality, discipline, self-reliance, creativity and thoughtfulness. It is essential to develop linguistic and mathematical skills, knowledge of science, information and communication technology, environment, health and population and life skills in students. It is also necessary to bring the feeling of preserving and promoting arts and aesthetics, humanistic norms, values and ideals. It has become the need of the present time to make them aware of respect for ethnicity, gender, disabilities, languages, religions, cultures, regional diversity, human rights and social values to make them capable of playing the role of responsible citizens with applied technical and vocational knowledge and skills. This learning resource material for computer engineering has been developed in line with the Secondary Level computer engineering Curriculum with an aim to facilitate the students in their study and learning on the subject by incorporating the recommendations and feedback obtained from various schools, workshops, seminars and interaction programs attended by teachers, students and parents.

In bringing out the learning resource material in this form, the contribution of the Director General of CDC Mr. Yubaraj Paudel and members of the subject committee Dr. Baburam Dawadi, Dr. Sarbim Sayami, Mrs. Bibha Sthapit, Mrs. Trimandir Prajapati is highly acknowledged. The learning resource material is written by Mr. Bimal Thapa, Mr, Rajendra Rokaya, Suresh Maharjan the subject matter of the materials, was edited by Mr. Badrinath Timsina and Mr. Khilanath Dhamala and language was edited by Mr. Nabin Kumar Khadka. CDC extends sincere thanks to all those who have contributed to developing this material in this form.

This learning resource material contains a wide coverage of subject matters and sample exercises which will help the learners to achieve the competencies and learning outcomes set in the curriculum. Each chapter in the material clearly and concisely deals with the subject matters required for the accomplishment of the learning outcomes. The Curriculum Development Centre always welcomes constructive feedback for the betterment of the material.

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Guidelines to Teachers

The goal of this course is to combine the theoretical and practical aspects of the contents needed for the subject. The nature of contents included in this course demands the use of practical or learner focused facilitation processes. Therefore, the practical side of the facilitation process has been focused much. The instructor is expected to design and conduct a variety of practical methods, strategies or techniques which encourage students engage in the process of reflection, sharing, collaboration, exploration and innovation new ideas or learning. For this, the following teaching methods, strategies or techniques are suggested to adopt as per the course content nature and context.

Brainstorming

Brainstorming is a technique of teaching which is creative thinking process. In this technique, students freely speak or share their ideas on a given topic. The instructor does not judge students' ideas as being right or wrong, but rather encourages them to think and speak creatively and innovatively. In brainstorming time, the instructor expects students to generate their tentative and rough ideas on a given topic which are not judgmental. It is, therefore, brainstorming is free-wheeling, non-judgmental and unstructured in nature. Students or participants are encouraged to freely express their ideas throughout the brainstorming time. Whiteboard and other visual aids can be used to help organize the ideas as they are developed. Following the brainstorming session, concepts are examined and ranked in order of importance, opening the door for more development and execution. Brainstorming is an effective technique for problem-solving, invention, and decision-making because it taps into the group's combined knowledge and creative ideas.

Demonstration

Demonstration is a practical method of teaching in which the instructor shows or demonstrates the actions, materials, or processes. While demonstrating something the students in the class see, observe, discuss and share ideas on a given topic. Most importantly, abstract and complicated concepts can be presented into visible form through demonstration. Visualization bridges the gap between abstract ideas and concrete manifestations by utilizing the innate human ability to think visually. This enables students to make better decisions, develop their creative potential, and obtain deeper insights across a variety of subject areas.

Peer Discussion

Peer conversation is a cooperative process where students converse with their peers to exchange viewpoints, share ideas, and jointly investigate subjects that are relevant or of mutual interest. Peer discussion is an effective teaching strategy used in the classroom to encourage critical thinking, active learning, and knowledge development. Peer discussions encourage students to express their ideas clearly, listen to opposing points of view, and participate in debate or dialogue, all of which contribute to a deeper comprehension and memory of the course material. Peer discussions also help participants develop critical communication and teamwork skills by teaching them how to effectively articulate their views, persuasively defend their positions, and constructively respond to criticism.

Peer conversation is essential for professional growth and community building outside of the classroom because it allows practitioners to share best practices, work together, and solve problems as a group. In addition to expanding their knowledge horizon and deepening their understanding, peer discussions help students build lasting relationships and a feeling of community within their peer networks.

Group Work

Group work is a technique of teaching where more than two students or participants work together to complete a task, solve a problem or discuss on a given topic collaboratively. Group work is also a cooperative working process where students join and share their perspectives, abilities, and knowledge to take on challenging job or project. Group work in academic contexts promotes active learning, peer teaching, and the development of collaboration and communication skills. Group work helps individuals to do more together than they might individually do or achieve.

Gallery Walk

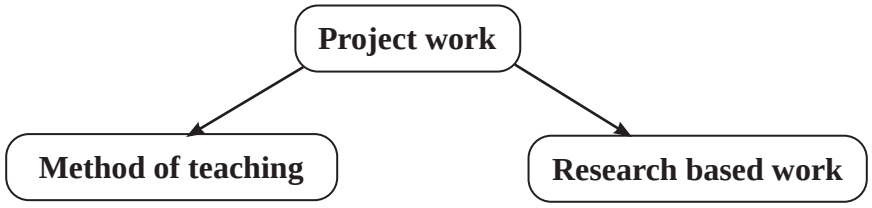
Gallery walk is a critical thinking strategy. It creates interactive learning environment in the classroom. It offers participants or students a structured way to observe exhibition or presentation and also provides opportunity to share ideas. It promotes peer-to-peer or group-to-group engagement by encouraging participants to observe, evaluate and comment on each other's work or ideas. Students who engage in this process improve their communication and critical thinking abilities in addition to their comprehension of the subject matter, which leads to a deeper and more sophisticated investigation of the subjects at hand.

Interaction

The dynamic sharing of ideas, knowledge, and experiences between people or things is referred to as interaction, and it frequently takes place in social, academic, or professional settings. It includes a broad range of activities such as dialogue, collaboration or team work, negotiation, problem solving, etc. Mutual understanding, knowledge sharing, and interpersonal relationships are all facilitated by effective interaction. Interaction is essential for building relationships, encouraging learning, and stimulating creativity in both in-person and virtual contexts. Students can broaden their viewpoints, hone their abilities, and jointly achieve solutions to difficult problems by actively interacting with others.

Project Work

Project work is a special kind of work that consists of a problematic situation which requires systematic investigation to explore innovative ideas and solutions. Project work can be used in two senses. First, it is a method of teaching in regular class. The next is: it is a research work that requires planned investigation to explore something new. This concept can be presented in the following figure.



Project work entails individuals or teams working together to achieve particular educational objectives. It consists of a number of organized tasks, activities, and deliverables. The end product is important for project work. Generally, project work will be carried out in three stages. They are:

- Planning
- Investigation
- Reporting

B. Instructional Materials

Instructional materials are the tools and resources that teachers use to help students. These resources/materials engage students, strengthen learning, and improve conceptual comprehension while supporting the educational goals of a course or program. Different learning styles and preferences can be accommodated by the variety of instructional

resources available. Here are a few examples of typical educational resource types:

- Daily used materials
- Related Pictures
- Reference books
- **Slides and Presentation:** PowerPoint slides, keynote presentations, or other visual aids that help convey information in a visually appealing and organized manner.
- **Audiovisual Materials:** Videos, animations, podcasts, and other multimedia resources that bring concepts to life and cater to auditory and visual learners.
- **Online Resources:** Websites, online articles, e-books, and other web-based materials that can be accessed for further reading and research.

Maps, Charts, and Graphs: Visual representations that help learners understand relationships, patterns, and trends in different subjects.

Real-life Examples and Case Studies: Stories, examples, or case studies that illustrate the practical application of theoretical concepts and principles.

C. Assessment

Formative Test

Classroom Discussions: Engage students in discussions to assess their understanding of concepts.
Quizzes and Polls: Use short quizzes or polls to check comprehension during or after a lesson.
Homework Exercises: Assign tasks that provide ongoing feedback on individual progress.
Peer review: Have students review and provide feedback on each other's work.

Summative Test

Exams: Conduct comprehensive exams at the end of a unit or semester.
Final Projects: Assign projects that demonstrate overall understanding of the subject.

Peer Assessment

Group projects: Evaluate individual contributions within a group project.
Peer feedback forms: Provide structured forms for students to assess their peers.
Classroom Presentations: Have students assess each other's presentations.

Objective Test

Multiple-choice Tests: Use multiple-choice questions to assess knowledge.
True/False Questions: Assess factual understanding with true/false questions.
Matching Exercises: Evaluate associations between concepts or terms.

Portfolio Assessment

Compilation of Work: Collect and assess a variety of student work samples.
Reflection Statements: Ask students to write reflective statements about their work.
Showcase Events: Organize events where students present their portfolios to peers or instructors.

Observational Assessment

Classroom observations: Observe students' behavior and engagement during class.
Performance observations: Assess practical skills through direct observation.
Field Trips: Evaluate students' ability to apply knowledge in real-world settings.

Abbreviation

AC: Alternating Current

ALU: Arithmetic Logic Unit

BIOS: Basic Input/Output System

BMR: Bare Metal Recovery

BSOD: Blue Screen of Death

CHKDSK: Check Disk

CLI: Command Line Interface

CMOS: Complementary Metal-Oxide Semiconductor

CPU: Central Processing Unit

CU: Control Unit

DC: Direct Current

ESD: Electrostatic Discharge

GPU: Graphics Processing Unit

GUI: Graphical User Interface

HDD: Hard Disk Drive

HDMI: High-Definition Multimedia Interface

I/O: Input/Output

ISO: International Organization for Standardization (used for disk images)

LCD: Liquid Crystal Display

LED: Light Emitting Diode

NAS: Network Attached Storage

NTFS: New Technology File System

OS: Operating System

PCB: Printed Circuit Board

POST: Power-On Self-Test

PSU: Power Supply Unit

RAID: Redundant Array of Independent Disks

RAM: Random Access Memory

RMA: Return Merchandise Authorization

ROM: Read-Only Memory

RPM: Revolutions Per Minute (for hard drives)

SFC: System File Checker

SSD: Solid State Drive

UPS: Uninterruptible Power Supply

USB: Universal Serial Bus

VGA: Video Graphics Array

Introduction to Electronic Devices

Unit 1

Electronic devices are crucial in our modern society, playing an important role in our daily lives. They are electronic circuit-controlled devices that process information, communicate, and perform various other duties. These devices can be found in various products, including smartphones and computers, household appliances, medical equipment, and industrial field. The main devices used in computers are registers, microprocessor chip and voltage.

Register: A register is a small, high-speed storage area within a computer's CPU (Central Processing Unit) that briefly holds data during processing. It enables easy retrieval and storage of instructions, addresses, or data.

Microprocessor: A microprocessor is the brain of the computer system—a compact chip that performs all the arithmetic, logic, and control functions necessary for running programs. It processes data and oversees tasks to execute program instructions.

Voltage: Voltage is the electrical pressure or force that drives electric current through a circuit. It is measured in volts (V) and is essential for powering electronic components such as microprocessors and registers.

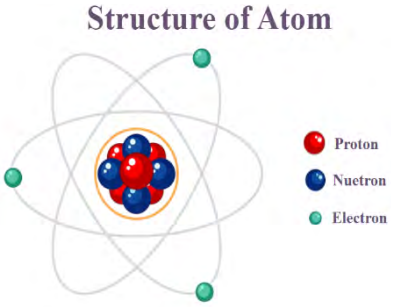
1.1 Define Matter, Molecule, and Atom

Matter

Matter refers to everything that fills space and has mass. It is the physical world's material, and it can take many different forms such as solids, liquids, gasses, and even plasma. Atoms and molecules are very small particles that make up all matter.

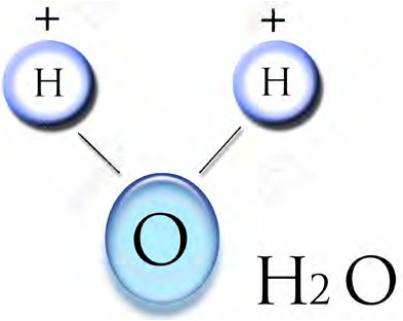
Atom

An atom is the smallest unit of an element that nevertheless retains its chemical properties. Atoms are the fundamental building blocks of matter, with a nucleus at the core containing protons and neutrons, and a cloud of electrons orbiting the nucleus. Each element on the periodic table is distinguished by its specific type of atom.



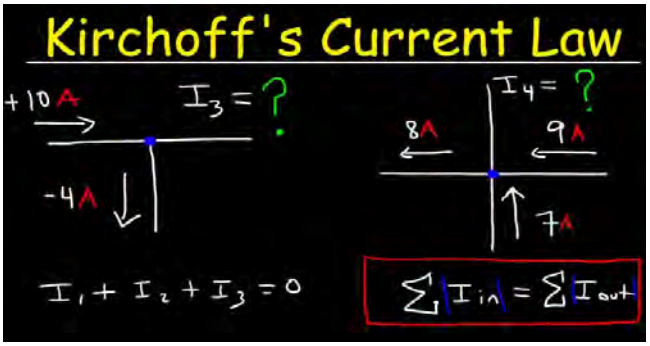
Molecule

A molecule is a collection of two or more atoms that are chemically connected. These atoms can be of the same element, forming a molecule such as oxygen gas (O_2), in which two oxygen atoms are joined, or of different elements, such as water (H_2O), in which two hydrogen atoms are bonded to one oxygen atom. Molecules can have chemical properties that differ from their constituent atoms.



1.2 Introduction to KCL, KVL

Kirchhoff's Current Law (KCL) is a fundamental idea in electronics and electrical circuits. It is named after the German physicist Gustav Kirchhoff and is one of two major rules governing the behavior of currents and voltages in electrical circuits, the other being Kirchhoff's Voltage Law (KVL).

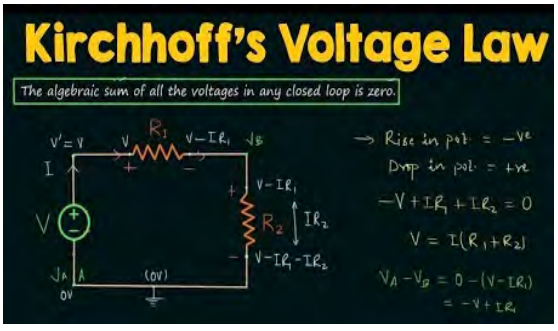


Kirchhoff's Current Law (KCL) states that the total current entering a junction or node in an electrical circuit is equal to the total current leaving that junction. In simpler terms, it is a statement of the conservation of electric charge. KCL's significance in electronic devices are:

- KCL conserves electric charge, ensuring that the total current flowing into a junction equals the total current flowing out of that junction.
- KCL conserves electric charge, ensuring that the total current flowing into a junction equals the total current flowing out of that junction.
- KCL is crucial for analyzing and designing electronic circuits and devices by ensuring proper current distribution and preventing charge accumulation or loss at any point.
- KCL is utilized by engineers and circuit designers to calculate unknown currents at junctions or nodes within a circuit, generating equations that describe the circuit's behavior.

Kirchhoff's Voltage Law (KVL)

Kirchhoff's Voltage Law (KVL) is a fundamental principle governing electronic devices and electrical circuits. It is named after the German physicist Gustav Kirchhoff and is one of two major rules governing the behavior of currents and voltages in electrical circuits, the other being Kirchhoff's Current Law (KCL).



Kirchhoff's Voltage Law (KVL) asserts that the sum of voltages in any closed loop or mesh in an electrical circuit equals zero. In other words, it expresses the conservation of energy inside an electrical circuit. KVL's significance in electronic devices:

- KVL, a law in electrical circuits, ensures that the sum of voltage rises equals the sum of voltage drops, based on the principle of conservation of energy.

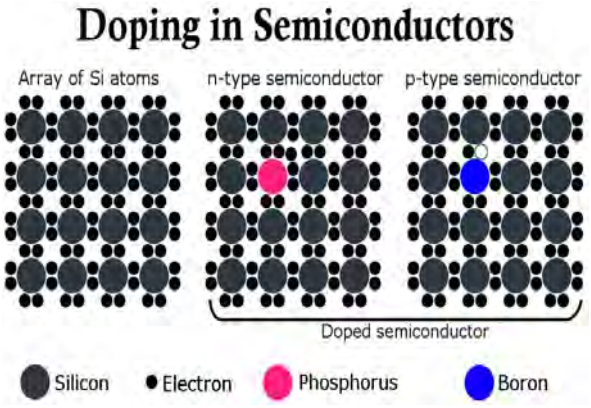
- KVL is calculated by dividing the sum of all voltage rises within a closed loop by the sum of all voltage drops across resistors and other components.
- KVL is crucial for analyzing and designing electronic circuits, ensuring energy conservation and consistent voltage distribution within a circuit, thereby enhancing device performance.
- KVL is frequently utilized by engineers and circuit designers for loop analysis, enabling the development of equations to describe circuit behavior and solve for unknown voltages or currents.

1.3 Introduction to Semiconductor Material (Doping, P-type, N-type, Majority and Minority charge carrier)

Semiconductor materials are the foundation of contemporary electronics and technology, and their electrical properties can be drastically altered through a process known as doping. Here are will discuss semiconductor material like doping, P-type and N-type semiconductors, and the concepts of majority and minority charge carriers:

Doping

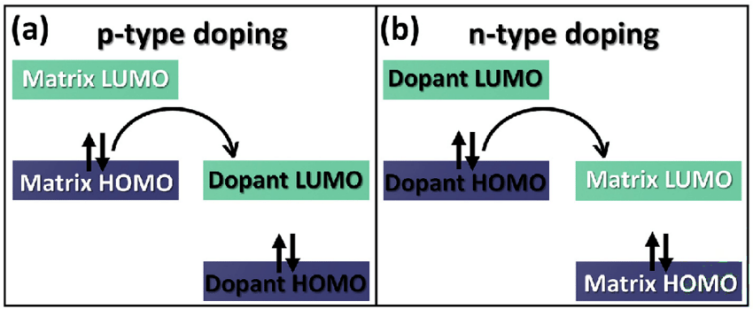
Doping is the deliberate introduction of certain impurity atoms into a semiconductor crystal lattice to modify its electrical characteristics. Engineers can alter the conductivity and behavior of semiconductor materials by introducing carefully selected impurities. Doping has various essential applications, depending on the desired outcome and the substance being doped.



Dopants

Dopants are the specific impurity atoms or molecules deliberately introduced into the host material. These dopants can be of two primary types:

- **N-type Dopants:** N-type dopants add electrons to the host material's crystal lattice. As a result, the material becomes more electron-rich and has higher electron conductivity. Phosphorus and arsenic are two commonly used n-type dopants.
- **P-type Dopants:** P-type dopants form "holes" or electron vacancies in the host material's crystal lattice. This makes the material more electron-deficient, which improves hole conductivity. Boron and aluminum are two commonly used p-type dopants.



Concentration

The concentration of dopant atoms in the host material is an important characteristic. It has a direct impact on the material's properties, and engineers carefully manage the dopant concentration to get the desired results.

Applications

Doping is applied across a wide range of industries and applications:

- In semiconductor electronics, doping is essential for producing transistors, diodes, and integrated circuits. It enables precise control over electrical conductivity in semiconductor materials such as silicon.
- Doped semiconductors are utilized in LEDs, lasers, and photo detectors.
- Doping in photovoltaic materials creates P-N junctions, which convert sunshine into electricity.
- Materials Engineering: Doping can improve the characteristics of steel, ceramics, and polymers, making them more appropriate for specific applications.
- Doping is used in contrast agents for medical imaging and medicine delivery systems.

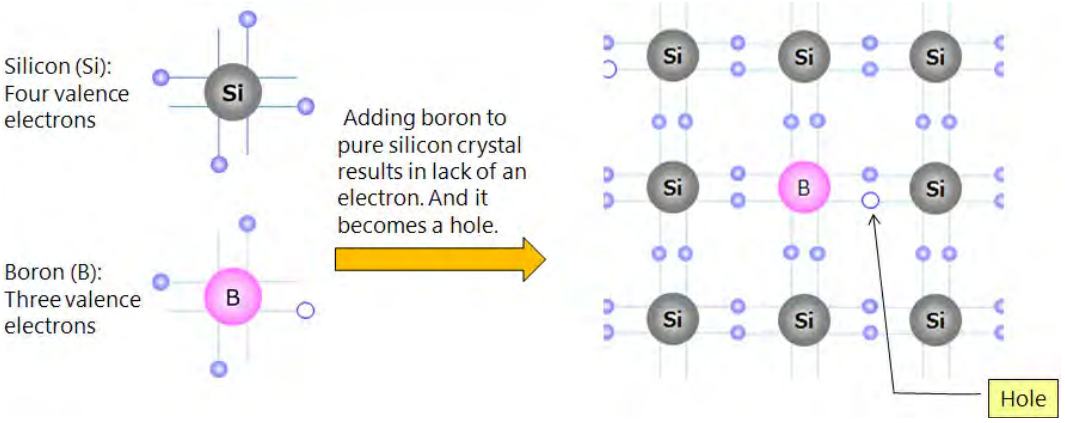
P-type Semiconductor

A P-type semiconductor is a semiconductor material that has been deliberately doped with certain impurities to produce an excess of "holes," or electron deficits, in its crystal lattice.

This surplus of holes becomes the dominating charge carrier in the material, resulting in a certain set of electrical properties. P-type semiconductors are essential components in the design of electronic devices, particularly diodes and transistors. Here's an introduction to P-type semiconductors:

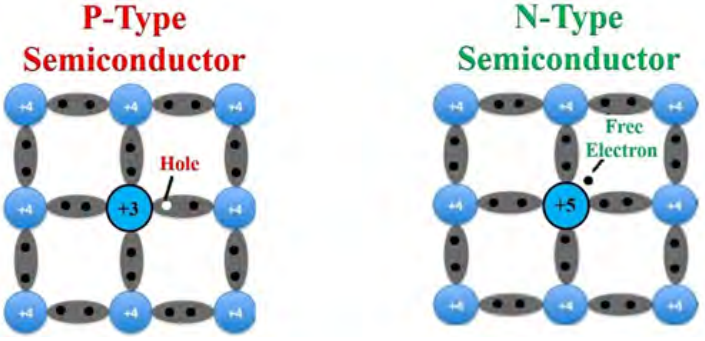
Doping Process

The creation of a P-type semiconductor involves the intentional introduction of certain impurity atoms into the crystal structure of a pure semiconductor material, such as silicon (Si) or germanium (Ge). These impurity atoms are typically referred to as acceptors because they readily accept electrons from the host material's crystal lattice.



N-type Semiconductor

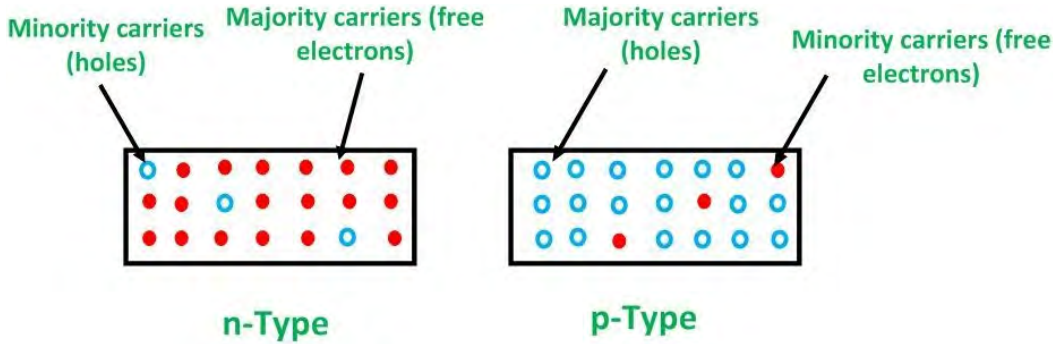
N-type semiconductor is a type of semiconductor material that has been intentionally doped with specific impurities to create an excess of free electrons as the dominant charge carriers. This surplus of electrons makes the material more conductive and imparts unique electrical properties.



N-type semiconductors are integral components in the design of various electronic devices, especially in the creation of diodes, transistors, and integrated circuits.

Majority and Minority Charge Carriers

The majority of charge carriers are the dominant type of charge carriers in a semiconductor material, and they are the primary carriers responsible for electrical conduction. In semiconductor physics, there are two main types of charge carriers: majority charge carriers and minority charge carriers.



Let's focus on majority charge carriers and understand their significance in semiconductor materials:

Majority Charge Carriers

a. N-type Semiconductors

In N-type semiconductors, the behavior of electrons plays a crucial role in the electrical conductivity of the material. N-type semiconductors are doped with a specific type of impurity, typically phosphorus or arsenic, which introduces extra electrons into the semiconductor crystal lattice. These extra electrons are referred to as "donor electrons" because they act as donors of electrons to the crystal structure.

b. P-type Semiconductors

In P-type semiconductors, the majority of charge carriers are positively charged "holes." Holes are not actual physical particles but rather represent the absence of electrons in the crystal lattice. They are mobile charge carriers that can move through the semiconductor material and are responsible for carrying electric current. Holes effectively behave as positive charges and contribute to the flow of electric current in P-type semiconductors.

Minority Charge Carriers

Minority charge carriers are the less abundant type of charge carriers in a semiconductor material. In semiconductor physics, there are two primary types of charge carriers: majority charge carriers and minority charge carriers. Minority charge carriers play a crucial role in

the behavior of semiconductor materials and electronic devices. Let's explore the concept of minority charge carriers and their significance:

Minority Charge Carriers

a. Electron-Hole Pairs

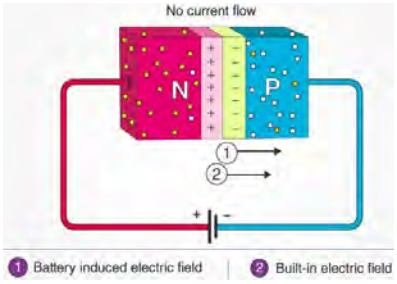
Electron-hole pairs typically represent the minority charge carriers in a semiconductor. Let's clarify:

- **N-Type Semiconductor:** In N-type semiconductors, where the majority charge carriers are electrons, electron-hole pairs represent the minority charge carriers. When an electron-hole pair is created in an N-type semiconductor, the electron (negatively charged) is the majority carrier, and the hole (positively charged) is the minority carrier.
- **P-Type Semiconductor:** In P-type semiconductors, where the majority charge carriers are holes, electron-hole pairs also represent the minority charge carriers. In this case, when an electron-hole pair is created, the hole (positively charged) is the majority carrier, and the electron (negatively charged) is the minority carrier.

In both cases, an electron transitioning from the valence band to the conduction band creates an electron-hole pair. The hole left behind is effectively a positively charged site in the valence band, and the electron in the conduction band carries a negative charge. These electron-hole pairs are essential for understanding the conductivity and electrical behavior of semiconductors.

1.4 PN Junction Formation, Forward biased & Reverse Biased

PN junction is a fundamental semiconductor structure formed by bringing together two differently doped regions of semiconductor material, typically silicon (Si) or germanium (Ge). These regions are the P-type (positive-type) and N-type (negative-type) regions. The PN junction plays a crucial role in the operation of various semiconductor devices, such as diodes, transistors, and photovoltaic cells.



Formation of a PN Junction

The doping process creates two neighboring zones within the semiconductor material: P-type and N-type. The P-N junction forms at the boundary of these zones.

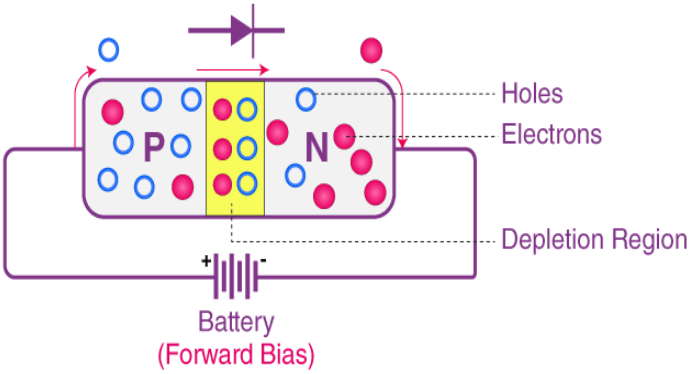
PN Junction Characteristics

The PN junction exhibits several key characteristics:

- **Depletion Region:** The P-N junction creates a "depletion region" zone. Due to electron-hole pair recombination, the depletion zone has no free charge carriers (electrons or holes) and only stationary ions.
- **Built-In Electric Field:** The development of the P-N junction generates a built-in electric field over the depletion zone. When a voltage is placed across the electric field it causes minority charge carriers (electrons and holes) to diffuse.
- **Forward Bias and Reverse Bias:** When a forward bias voltage (positive to P, negative to N) is given to the P-N junction, the breadth of the depletion region is reduced, and charge carriers can flow through. When a reverse bias voltage (negative to P, positive to N) is supplied, the depletion area deepens, preventing charge carriers from flowing.

Forward-Biased PN Junction

When a PN junction is forward-biased, an external voltage is applied in such a way that it encourages the flow of electric current through the junction. This condition allows charge carriers (electrons and holes) to move more freely across the junction.



Here's what happens when a PN junction is forward-biased:

i. Setup

a. The PN junction consists of a P-type semiconductor region (which has an excess of holes) and an N-type semiconductor region (which has an excess of electrons).

b. A power supply is connected to the junction, with the positive terminal (anode) connected to the P-type side and the negative terminal (cathode) connected to the N-type side.

ii. Effect on the Depletion Region

In an unbiased or equilibrium state, there is a built-in electric field across the depletion region at the junction, which prevents the majority of charge carriers (holes in the P-region and electrons in the N-region) from crossing the junction.

iii. Forward Bias Voltage Applied

a. When an external voltage (forward bias voltage) is applied, it opposes the built-in electric field in the depletion region.

b. For example, in a silicon PN junction, if the anode is made more positive than the cathode, the external electric field will be in the same direction as the built-in field but with a reduced magnitude.

iv. Reduction of Depletion Region

a. The forward bias voltage effectively reduces the width of the depletion region at the junction.

b. This reduction in the depletion region's width allows for the free movement of charge carriers (electrons and holes) across the junction.

v. Current Flow

a. Electrons from the N-side move toward the P-side, and holes from the P-side move toward the N-side.

b. As a result, electric current can flow through the PN junction, from the P-type region to the N-type region.

vi. Conducting State

a. In the forward-biased state, the PN junction behaves as a conductor, allowing a significant flow of electric current.

b. The PN junction has a low resistance, and it offers minimal opposition to the movement of charge carriers.

vii. Applications

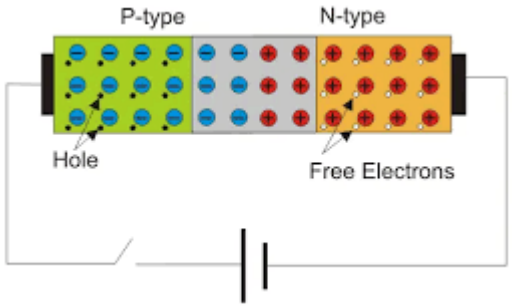
a. Forward-biased PN junctions are commonly used in semiconductor devices like

diodes and bipolar junction transistors (BJTs).

b. In a diode, forward bias allows current to flow from the anode (P-side) to the cathode (N-side), making it conductive and allowing it to rectify AC signals into DC signals.

Reverse-Biased PN Junction

When a PN junction is reverse-biased, an external voltage is applied across the junction in such a way that it opposes the flow of electric current through the junction. In this condition, the built-in electric field within the depletion region at the junction is strengthened, making it more challenging for charge carriers to cross the junction.



Here's what happens when a PN junction is reverse-biased:

i. **Setup:** The PN junction consists of a P-type semiconductor region (which has an excess of holes) and an N-type semiconductor region (which has an excess of electrons). A power supply is connected to the junction, with the positive terminal (anode) connected to the N-type side, and the negative terminal (cathode) connected to the P-type side.

ii. **Effect on the Depletion Region:** In an unbiased or equilibrium state, there is a built-in electric field across the depletion region at the junction, which prevents the majority of charge carriers (holes in the P-region and electrons in the N-region) from crossing the junction.

iii. **Reverse Bias Voltage Applied:** When an external voltage (reverse bias voltage) is applied, it reinforces the built-in electric field in the depletion region. For example, in a silicon PN junction, if the anode is made more negative than the cathode, the external electric field opposes the built-in field, making it stronger.

iv. **Widening of Depletion Region:** The reverse bias voltage causes the depletion

region at the junction to widen significantly. The strong electric field created by the reverse bias prevents the majority of charge carriers (holes and electrons) from crossing the junction.

v. **Lack of Current Flow:** Due to the widened depletion region and the strengthened electric field, there is very little movement of charge carriers across the junction. As a result, the PN junction is essentially non-conductive in the reverse-biased state, and there is minimal or no electric current flow.

vi. **Insulating State:** In the reverse-biased state, the PN junction behaves as an insulator. The PN junction has a high resistance, and it effectively blocks the flow of electric current.

vii. **Applications**

a. Reverse-biased PN junctions are often used in semiconductor devices like diodes and transistors to control the flow of electric current.

b. In diodes, reverse bias blocks current flows and allows them to function as rectifiers, permitting current in one direction while blocking it in the reverse direction.

Exercise

Choose the correct answer from the given alternatives.

1. In a semiconductor, when a P-type material is joined to an N-type material, it forms:

   a. A capacitor b. A resistor c. A p-n junction d. A transistor

2. Which semiconductor device allows current to flow in one direction and blocks it in the other?

   a. Diode b. Transistor c. Capacitor d. Resistor

3. The majority charge carriers in an N-type semiconductor are:

   a. Electrons b. Holes c. Protons d. Positrons

4. What happens when an electron moves from the valence band to the conduction band in a semiconductor?

   a. It creates a hole b. It emits light

   c. It forms a diode d. It generates a magnetic field

5. Which semiconductor device is commonly used as an amplifier in electronic circuits?

   a. Capacitor b. Resistor c. Transistor d. Diode

Write short answer to the following questions.

1. What is the fundamental function of an electronic device?
2. Define a semiconductor.
3. What are the two primary types of charge carriers in semiconductors?
4. Explain the concept of doping in semiconductor materials.
5. What is the significance of the P-N junction in electronic devices?
6. What is meant by the majority and minority charge carriers in semiconductors?
7. In what types of electronic devices are P-N junctions commonly used?

Write long answer to the following questions.

1. Discuss the properties that make semiconductors essential for electronic devices, and provide examples of common semiconductor devices and their applications.
2. Explain how the introduction of dopants alters the electrical behavior of the material and why it is crucial in semiconductor device manufacturing.

3. Describe the formation and operation of P-N junctions. Discuss how P-N junctions are used in electronic devices, providing examples of applications in diodes, transistors, and solar cells.
4. How do minority charge carriers in semiconductor materials. influence the conductivity and behavior of semiconductor devices? Pprovide examples to illustrate their significance.
5. How do energy bands influence the conductivity of semiconductors.

Project Work

Activity 1: Provide a collection of common electronic components (resistors, capacitors, diodes, LEDs, transistors, etc.) and have students identify and categorize them. Discuss the purpose of each component and how they are used in circuits.

Activity 2: "Circuit Detective"

1. Materials: Breadboard, resistors, wires, batteries, multimeter
    a. Instructions:
        i. Create simple series and parallel circuits.
        ii. Measure current and voltage at different points in the circuit.
        iii. To verify measurements, apply KCL (current in = current out) and KVL (sum of voltages in a loop = 0).
    b. Learning Outcome: Gain practical understanding of KCL and KVL through observation and calculation.

Introduction to Computer System

Unit 2

2.1 Introduction to Basic Components of Computer System

A computer consists of hardware and software. The hardware and software of a computer are integrated, and they work together to fulfill the commands of the user. Computer hardware is the physical component of a computer that can be seen and touched. A computer has different hardware components. Keyboard, mouse, monitor, microprocessor, hard disk, RAM, etc. are computer hardware. The components of a computer are classified into four units. They are the input unit, the output unit, the memory unit, and the processing unit.

2.2 Input Unit: Keyboard, Mouse, Scanner and Digital Camera

A computer requires data and instructions to produce useful information. To enter data or instructions into a computer, input units are used. Input units are the components of a computer through which data or instructions are entered into the computer. It is the medium through which a user communicates with the computer. An input unit is also called an input device. A computer may have more than one input unit. The keyboard, mouse, joystick, touch screen, touchpad, scanner, digital camera, etc. are input units. When you enter data or instructions using input units, they convert the input data or instructions into computer-understandable form, i.e., binary form, and pass the binary form data or instructions to the computer for further processing.

Keyboard

A keyboard is the basic input device that helps to input data or instructions into a computer. It consists of keys marked with alphabets, numbers, and some other characters. A user can input data like letters, text, numbers, and symbols through a keyboard. When a key on the keyboard is pressed, it generates the corresponding binary code of a character and sends it to the computer. The computer again converts the binary code back to the corresponding character and displays it on the monitor. For example, when an alphabet key 'A' is pressed, the keyboard generates binary code '01000001'.

A standard keyboard consists of 104 keys. A multimedia keyboard has more than 104 keys. The keys on a keyboard are grouped into five different groups as:

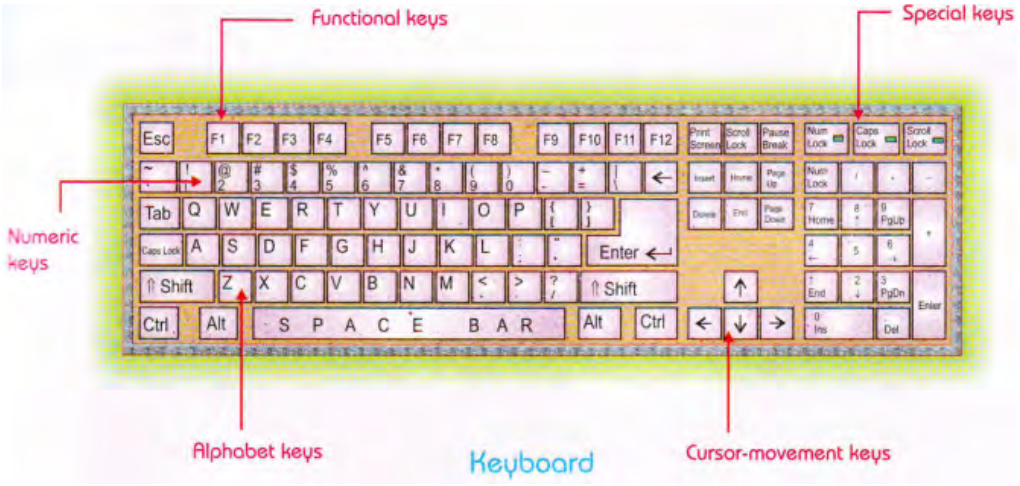
a. Alphabet keys

b. Numeric keys

c. Cursor-movement keys

d. Functional keys

e. Special purpose keys



All keys marked with A to Z and punctuation symbols are alphabet keys. Keys marked with 0 to 9 and mathematical symbols are numeric keys. Keys marked with F1 to F12 are the function keys, and they are used for entering commands. Keys marked with arrow signs (←, ↑, →, ↓) are cursor movement keys (i.e., also known as arrow keys), and they are used to move the cursor in the specified direction. The Space bar, Enter key, Back Space key, Caps Lock key, Esc key, Ctrl key, Alt key, Shift key, Delete key, Home key, End key, and Insert key are the special purpose keys.

A keyboard performs the following tasks

a. It accepts or reads data and instructions from the user.

b. It converts these inputs into a computer-acceptable form, i.e., binary code.

c. It supplies the converted inputs to the computer system for further processing, which are stored temporarily in RAM.

A wireless keyboard is a computer keyboard that connects to a computer without a physical

cable, using technologies like Bluetooth or radio frequency (RF) with a USB receiver. It is powered by batteries and allows for greater mobility and a clutter-free workspace.

Mouse

A computer mouse is a basic input device that allows a user to input data and commands displayed on the desktop or in the dialogue boxes by selecting them. It is a small handheld input device that is used, especially in the graphic user interface (GUI), to point and select icons, data, and commands displayed on the screen. Since it points to icons, data, and commands displayed on the desktop, menus, or dialogue boxes, it is also called a pointing device. A computer mouse can be used to control the position of the cursor and point and select items on the screen, but it cannot be used to enter text into the computer like a keyboard. A computer mouse may be a **mechanical mouse** or an **optical mouse**.


Mechanical mouse


Optical mouse

A mechanical mouse is not used nowadays. It consists of a plastic housing or casing with a flat bottom, a ball that projects through its bottom surface, and two push buttons and a scroll button on the top of the casing. When a mouse is moved, the ball moves in the direction of the mouse, which rotates a pair of wheels inside the mouse. The rotation of wheels generates electric signals that are sent to the computer system. The computer system converts the signals into the motion of the mouse pointer along the X and Y axes on the screen. The buttons are used to select an item on the monitor and to do other tasks. The left button works like the Enter key.

Nowadays, an optical mouse is common on a computer. It looks like a mechanical mouse, but instead of a ball and wheels, it uses a light-emitting diode (LED), optical sensor, and digital signal processor to detect the movement of the mouse.

A wireless mouse is a pointing device that connects to a computer without the need for a physical wire. It typically communicates with the computer through radio frequency (RF)

technology (via a USB receiver) or Bluetooth. Wireless mouse are powered by batteries and offer greater flexibility and freedom of movement compared to wired mouse.

Scanner

A scanner is an input device that works more like a photocopy machine. It can scan and convert photos, printed text, handwritten documents, and drawings into digital images and transfer these digital images to the computer system. The digital images stored on a computer can be manipulated.

A scanner consists of two components: the first component generates the optical images of photos or other printed documents by illuminating them, and the second component converts the optical images into digital format and transfers them to a computer. The common optical scanner devices are Optical Mark Recognition (OMR), Optical Character Reader (OCR), and Magnetic Ink Character Reader (MICR).

Digital Camera

A digital camera is an input device that captures pictures or videos and stores them in digital format on its memory chip. It consists of an electronic photosensitive sensor that captures the photographs. The photos or videos stored in the digital camera can be viewed and erased immediately. The photos or videos from the camera can be transferred directly to the computer. Using suitable software, photos or videos on the computer can be edited according to the requirements.

Thunderbolt Interface

The Thunderbolt interface is a high-speed hardware interface developed by Intel in partnership with Apple for connecting external peripherals to computers. It combines data, video, audio, and power in a single connection and allows for high-speed data transfer (up

to 40 Gbps in Thunderbolt 3 and 4). Thunderbolt employs the USB-C connector to connect external displays, storage devices, and docking stations.

2.3 Introduction to processing unit: ALU & Control Unit

The main component of the processing unit is the microprocessor. It is the part of the computer system that interprets and executes program instructions. It works with an operating system, executing a set of instructions and controlling different peripheral devices by sending and receiving control signals. The microprocessor controls the flow of data by directing it to enter the system, placing data in memory, sending it to the ALU for processing, and directing the output of information.Microprocessor

A microprocessor is an integrated circuit formed on a single chip that executes instructions and carries out arithmetic and logical operations. So, it is known as the brain of the computer. The circuitry of a microprocessor contains millions of tiny electronic components. The capability of a microprocessor increases as the number of electronic components in the microprocessor increases. More electronic components deposited on a single chip means more number of instruction sets in it. The instruction set of a microprocessor contains all the commands or instructions that it can understand and work on.

		
Ryzen 7	***Intel 7***	***Ryzen 7***

The first microprocessor ,'Intel 4004', which was developed by Marcian Ted Hoff of Intel Corporation in 1971 AD, contained 2300 transistors. The Intel 4004 could execute only a few instructions and manipulate only tiny amount of data at a time. The new Pentium microprocessor contains more than 3.3 million transistors. The speed of a computer depends mainly on its microprocessor. The microprocessor has three main parts.

a. Control Unit (CU)

b. Arithmetic Logic Unit (ALU)

c. Registers

All these work together to process the computer's data.

a. The Control Unit controls the workings of all computer parts. It controls the movement of data inside and outside the CPU. It communicates between registers and the ALU and between the CPU and all the input, output, and storage devices. It directs all the parts of the computer system to perform their tasks.

b. The Arithmetic Logic Unit (ALU) performs all arithmetic operations like addition, subtraction, multiplication, division, and logical operations like greater than, less than, not equal, etc.

c. Registers are small memory units used to store immediate data, instructions, and results while processing data.

Function of Microprocessor

The basic task of a microprocessor is to input the instructions from the memory, decode and process them, and produce the output. It performs three basic tasks while processing the information. They are as follows:

1. Performing some basic calculations using the ALU for example, addition, division, multiplication, subtraction, etc.
2. Moving data from one location to another.
3. It has a Program Counter (PC), which is a pointer that stores the address of the next instruction. It keeps track of the PC and performs instructions accordingly.

Types of Microprocessor

The different types of microprocessors are as follows:

a. Based on Size (Bit Size)

Microprocessors are classified by how much data they can process at a time.

- **8-bit –** Older processors, used in early computers and calculators. (Example: Intel 8085)
- **16-bit –** Faster than 8-bit, used in some gaming consoles. (Example: Intel 8086)
- **32-bit –** Common in computers in the 2000s, faster than 16-bit. (Example: Intel Pentium)

- **64-bit –** Found in modern computers and smartphones, very fast. (Example: Intel Core i7, AMD Ryzen)

b. Based on How They Work

i. CISC (Complex Instruction Set Computer)

CISC is a type of computer architecture in which a single instruction can execute multiple low-level operations, such as memory load, store, or arithmetic operations. For example, Intel x86 processors.

Features

- A large set of instructions
- Instructions can be complex and variable in length
- Emphasizes hardware complexity to reduce software complexity

ii. RISC (Reduced Instruction Set Computer)

RISC is a computer architecture that uses a small set of simple instructions, each designed to be executed in one clock cycle. Example: ARM processors (commonly used in smartphones)

Features

- Fewer instructions
- Fixed instruction length
- Emphasizes software efficiency and simplicity in hardware design

CISC aims to accomplish more with each instruction (complex hardware), while RISC performs simpler operations more quickly and efficiently (simple hardware).

c. Based on Usage

- **General-Purpose Microprocessors –** Used in computers and laptops. (Example: Intel Core, AMD Ryzen)
- **Embedded Microprocessors –** Found in everyday devices like washing machines, ATMs, and smart TVs. (Example: ARM Cortex)
- **Digital Signal Processors (DSPs) –** Used in audio and video processing, like in mobile phones and music players. (Example: Texas Instruments TMS320)
- **Graphics Processing Units (GPUs) –** Help in gaming, animation, and AI. (Example: NVIDIA GeForce, AMD Radeon)

d. Based on the Company Making Them

- **Intel –** Makes processors like Pentium, Core i5, Core i7.
- **AMD –** Competes with Intel, makes Ryzen processors.
- **ARM –** Used in most smartphones and tablets. (Example: Apple M1, Snapdragon)
- **IBM –** Makes high-power processors for servers.

2.4 Introduction to Display unit: Monitor Resolution, Color and Refresh Rate, CRT, LCD, and LED

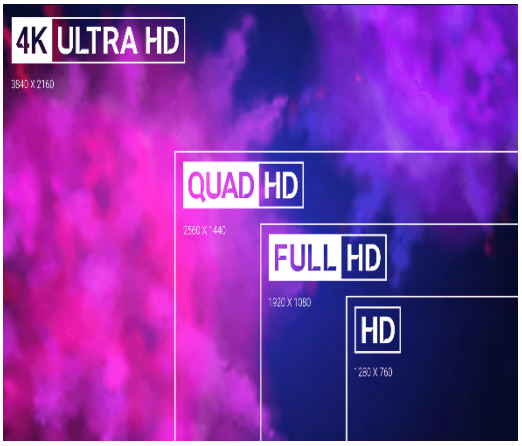
A computer user needs to see data and instructions being input through the input devices. A computer needs to present or display information being processed on it to a user. To display or present data, instructions, or information to the user, an output unit is used. An output unit is the component of a computer that displays or presents data, information, etc. to the user in human-understandable language. An output unit is also called an output device. Monitor, printer, speaker, plotter, projector, etc., are the output devices.

Output devices are categorized into:

a) Softcopy Output Device

b) Hardcopy Output Device

Softcopy Output Device



The output devices like the monitor, speaker, and projector are softcopy output devices. The output displayed or presented by these devices is not permanent. The information displayed on the monitor disappears as soon as you turn off the monitor. So, such an output device that presents or displays data or information in human-understandable language temporarily is known as a softcopy output device. The output displayed or presented through a softcopy output device is known as a softcopy. The softcopy lasts for a short time.

Monitor

A monitor is a softcopy output device that displays data or information being entered and

processed on a computer. It is the basic output device of the computer that looks like a television. It is also called a Visual Display Unit (VDU). It can display text, images, videos, etc. temporarily on its display screen. The output displayed on the monitor is called the soft copy.

Monitor Resolution

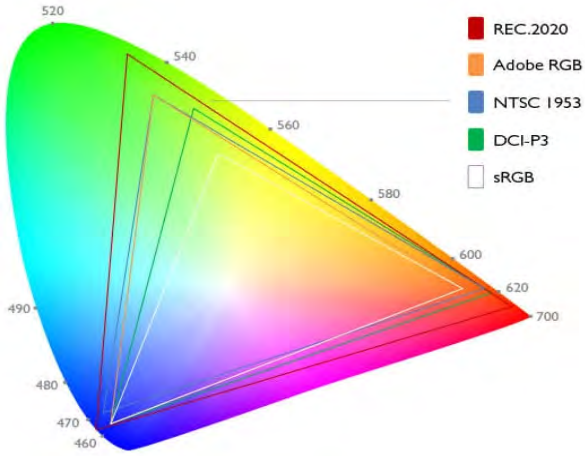
Monitor resolution, also known as screen resolution or display resolution, is the number of distinct pixels that a monitor or display can show both horizontally and vertically. It is commonly stated as the width by the height in pixels, such as "1920x1080," which is a popular Full HD (FHD) resolution. Monitor resolution plays an important role in defining the level of detail and clarity that may be seen on a screen. Higher resolutions typically result in crisper and more detailed images.

The common monitor resolutions are:

- **HD (High Definition):** 1280x720 pixels (720p) or 1366x768 pixels (often used for laptop displays).
- **Full HD (FHD):** 1920x1080 pixels (1080p). This is a standard resolution for most modern monitors and HDTVs.
- **2K (QHD - Quad High Definition):** 2560x1440 pixels. It offers even higher resolution and is commonly used in gaming monitors and some high-end laptops.
- **4K Ultra High Definition (UHD):** 3840x2160 pixels (commonly referred to as 4K). It provides four times the resolution of Full HD and is used in high-quality monitors, TVs, and content-creation displays.
- **8K Ultra High Definition (UHD):** 7680x4320 pixels (commonly referred to as 8K). 8K displays offer incredibly high resolution, mainly used in professional content creation and some premium television displays.

Color Representation

Color representation is the methods and systems used to define and display colors in a variety of applications, such as digital photography, graphics, printing, and display technologies. Colors are defined and reproduced accurately using a variety of color models and representations.



The common color representations are:

- **RGB (Red, Green, Blue):** RGB is an additive color model used in digital displays, such as monitors, television screens, and digital cameras. It represents colors as combinations of red, green, and blue light. Each color channel is typically represented by an 8-bit value, allowing for 256 shades of each primary color, resulting in millions of possible colors.
- **CMY(K) (Cyan, Magenta, Yellow, Key/Black):** CMY(K) is a subtractive color model used in color printing. Cyan, magenta, and yellow are the primary subtractive colors, and black is often added (hence CMYK) to improve the richness of dark colors and achieve a true black. In this model, colors are subtracted from white light to produce the desired color.
- **HSL and HSV (Hue, Saturation, Lightness/Value):** These models describe colors based on their perceptual attributes. Hue represents the type of color, saturation indicates the intensity or purity of the color, and lightness (in HSL) or value (in HSV) represents the brightness of the color. These models are often used in image processing and graphic design to manipulate and choose colors.

Refresh Rate

The refresh rate of a monitor, which is commonly measured in Hertz (Hz), is the number of times per second that the display hardware updates the image being displayed. It defines the number of unique frames that can be displayed on the screen every second and is an important parameter for motion smoothness and quality, as well as visual pleasure.

Monitor Refresh Rate

- **60Hz vs. 120Hz vs. 144Hz vs. 240Hz:** Monitors come with different refresh rate options, such as 60Hz, 120Hz, 144Hz, and even 240Hz. The higher the refresh rate, the smoother the motion appears on the screen.
- **Standard Refresh Rate:** Historically, 60Hz has been the standard refresh rate for many monitors, offering 60 frames per second (FPS). This is suitable for everyday computing and media consumption.
- **Gaming and High Refresh Rates:** Gamers often prefer higher refresh rates, such as 120Hz, 144Hz, or 240Hz, as they provide smoother gameplay and faster response times. High refresh rates reduce motion blur and make fast-moving images appear clearer.
- **Graphics Card Compatibility:** To fully benefit from a high refresh rate monitor, you need a compatible graphics card capable of generating a similar number of frames per second. For example, if you have a 144Hz monitor, you ideally want your graphics card to consistently produce 144 FPS or higher.
- **4K and High Resolution Monitors:** High-resolution monitors (e.g., 4K) may have a standard 60Hz refresh rate due to the increased demand on the graphics card to render higher pixel counts. However, 4K monitors with higher refresh rates are becoming available.
- **Eye Strain and Comfort:** Some users may experience less eye strain with higher refresh rates, especially when working with text, as it makes the screen appear smoother when scrolling.

CRT Monitor

LCD Monitor

According to the display technology used in monitors, they may be Cathode Ray Tube (CRT) monitors or Flat Panel Display monitors.

A CRT monitor is based on the cathode ray tube technology. A CRT is an evacuated glass tube with an electron gun in its neck and a fluorescent-coated surface opposite the electron gun. The display screen of the CRT monitor is covered with tiny phosphor dots, which are called pixels (picture elements). The pixels on the monitor form images. So, the higher the number of pixels, the better the display quality. CRT monitors can be monochrome or color. A monochrome monitor can display text or images only in two colors (black and white colors). A color monitor displays text or images in millions of colors. A CRT monitor is bulky and heavy. It consumes more electricity.

Nowadays, flat-panel monitors are mostly used instead of CRT monitors. A flat-panel monitor is based on liquid crystal technology. In the flat panel monitor, liquid crystal molecules are placed between two electrode plates. When electrical current is applied on the electrodes, the electrodes determine and supply the different amount of electric current to the liquid crystal molecules and the crystal molecules form the image on the screen. To illuminate the image for users to see, flat-panel monitor uses the backlighting technology.

Liquid crystal display (LCD) monitors and light emitting diode (LED) monitors are flat-panel monitors. They both use a special kind of liquid crystal to form images. The only difference is their backlighting. In LCD monitors, compact fluorescent lamps (CFL) are used for backlighting, whereas in LED monitors, LEDs are used for backlighting. LCD monitors and LED monitors are both thin and lightweight, and they occupy less desk space. They consume less electricity. The LCD monitor and LED monitor can display pictures, text, and videos more clearly than the CRT monitors. Since LCD and LED monitors

consume a lesser amount of electricity than CRT monitors, they are used in notebooks and laptop computers. LCD monitors are also used in desktop computers.

Nowadays, plasma monitors are also used on computers. A plasma monitor is a plasma display panel (PDP) monitor in which tiny cells containing noble gases and a tiny amount of mercury are placed between two pieces of glass. When electric charge is passed through the cells, the gases become ionized, turn into plasma, and emit ultraviolet light. This ultraviolet light strikes the inside of the glass panel, causing it to emit visible light, and images are formed. Plasma monitors can provide a larger, higher-resolution display with better colour reproduction than LCD and LED monitors. It is specially used for certain tasks, like photo editing or graphic design.

Exercise

Choose the correct answer from the given alternatives.

1. Which is not the input device?

   a. Keyboard b. Joystick c. Plotter d. Digital camera

2. Which of the following is used for playing games?

   a. Mouse b. Touchpad c. Joystick d. Microphone

3. What is equal to 2 million cycle?

   a. 1 GHz b. 2 GHz c. 2 MHz d. 1MHz

4. Which printer can print a digital model into a tangible and solid object?

   a. Graphic Plotter b. 3D printer

   c. Laster printer d. Inkjet printer

5. Which is an impact printer?

   a. Dot-matrix printer b. Laster printer

   c. Inkjet printer d. None of the above

Write short answer to the following questions.

1 Define computer hardware. List any two input and output devices.

2 Write the uses of a keyboard and a mouse.

3 List any four input devices.

4 What is an output device? List any two output devices.

5 What is microprocessor? Write its major parts.

6 Write the functions of CU and ALU.

7 What is the monitor? Explain its types.

Write long answer to the following questions.

1 Explain the basic components of a computer system and describe how they work together to perform computing tasks.

2 Discuss the importance of the input unit, processing unit, and output unit in a computer system.

3 The Central Processing Unit (CPU) is often called the "brain" of the computer. Explain the role of the Arithmetic Logic Unit (ALU) and the Control Unit (CU) in processing data.

4 Explain the concept of monitor resolution. How does it affect the quality of images displayed on a screen? Provide examples of different screen resolutions.

5 What is the refresh rate in a display unit? Why is it important for gaming and multimedia applications?

6 Compare and contrast CRT, LCD, and LED monitors in terms of technology, power consumption, and display quality.

Project Work

1. Make a presentation on the "Input device" and present in the clean.
2. Make a presentation on the "Output device" and present in the clean.
3. Draw a chart paper about different types of computer hardware with names and display it into your classroom.
4. Visit one of the IT solution offices such as the computer maintenance center and sales, and collect the list of latest available devices.

Unit 3 Overview on System's Core

3.1 Introduction to System BIOS

System BIOS Functions and Operations

The System BIOS (Basic Input/Output System) is software built into a computer's motherboard that allows the computer to boot up and interact with its components. When you power on your computer, the BIOS checks to see if all of the major components, such as the keyboard, display, and storage, are functioning properly. It then helps load the operating system, allowing the computer to boot up. The BIOS also lets you change fundamental computer settings such as the boot order and system time via a simple interface. The computer must function properly.

System BIOS Functions

a) Power-On Self-Test (POST)

b) Bootstrapping the operating system

c) Initializing hardware components

d) Providing the BIOS Setup Utility

e) Facilitating communication between the OS and hardware

f) Managing basic system performance and power settings

System BIOS Functions and Operations

The System BIOS performs essential operations to ensure the computer starts up and runs properly. When the computer is turned on, the BIOS carries out a Power-On Self-Test (POST) to check if the hardware components, like the RAM, CPU, and storage, are working correctly. It then, initializes these components and prepares them for use. Next, the BIOS locates and loads the operating system from the storage device into memory, enabling the computer to start. It also acts as a bridge between the hardware and software, facilitating communication and basic input/output operations. The BIOS allows users to adjust system settings, such as boot order or system time, through its setup utility.

3.2 Introduction to Motherboard

The motherboard is called PCB (Printed Circuit Board) or system board or main circuit board. All parts of the computer system like the microprocessor, slots, ports, etc. are mounted on the motherboard. So, it is also called the backbone of the computer system. It also connects important chips like ROM chips, network chips, sound cards, etc.

Function of Motherboard

a. Different slots join the modem, TV card, etc. in the motherboard.

b. The motherboard helps in data communication among different hardware.

c. **BIOS** (Basic Input Output System) programs are stored in ROM and ROM is attached to the motherboard to boot the system.

Motherboard Form Factors

Motherboard form factors define the size, shape, layout, and compatibility of a motherboard with computer cases and components. The common motherboard form factors are:

a) ATX (Advanced Technology Extended): The most popular form factor, offering good expansion options and suitable for desktops.

b) Micro-ATX: A smaller version of ATX, with fewer expansion slots, ideal for compact builds.

c) Mini-ITX: A very small form factor designed for compact and energy-efficient systems, like home theaters or small PCs.

d) E-ATX (Extended ATX): Larger than ATX, designed for high-performance systems with additional features and more expansion slots.

e) Flex-ATX: A variation of micro-ATX, commonly used for small and budget-friendly systems.

f) BTX (Balanced Technology Extended): Designed to improve cooling and airflow, but less common than ATX.

g) ITX (Information Technology Extended): A family of smaller form factors, including Mini-ITX, used for compact and portable systems.

3.3 Peripheral Component Interconnect (PCI) Local Bus

The Peripheral Component Interconnect (PCI) local bus is a standardized computer bus system that links various hardware components, such as expansion cards, to the motherboard of a computer. It allows for high-speed communication between the computer's processor, memory, and attached devices like as sound cards, network cards, and graphics cards. PCI was introduced in the early 1990s to replace previous, slower bus systems, and it quickly gained popularity due to its ability to handle plug-and-play functionality and many devices. It operates at fast speeds and facilitates data transfer, making it a critical component in enhancing computer performance at the time. The Peripheral Component Interconnect (PCI) local bus operates:

a) Connection to Motherboard: The PCI bus is a slot on the motherboard where expansion devices (such as a sound card or network card) can be installed. These cards interface with the CPU and memory via the PCI bus.

b) Plug-and-Play: When a card is inserted into a PCI slot, the computer immediately recognizes the hardware and allocates system resources such as interrupts and memory addresses.

c) High-Speed Communication: The PCI bus allows for fast data flow between the CPU, memory, and attached peripherals.

d) Multiple device support: The PCI bus may support numerous devices at the same time by sharing a communication channel, allowing the CPU to accomplish a variety of tasks efficiently.

3.4 Power: The Internal Power Supply, Parts of Power Supply

The internal power supply is known as the Power Supply Unit (PSU). It is a vital component of a computer that supplies electrical power to the rest of the system. It transforms electricity from a wall outlet (AC power) into lower-voltage DC power that the computer's components, such as the motherboard, CPU, and storage devices, can use. The PSU keeps the system running smoothly by providing continuous and safe power.

Part of a Power Supply

a) Transformer: Sets the input voltage to the proper levels for the computer.

b) Rectifiers: convert alternating current (AC) into direct current (DC) for components.

c) Filter: Smoothes out fluctuations in DC power to produce a stable output.

d) Regulator: Keeps the voltage within safe limits and protects components from surges.

e) Cooling fan: prevents overheating by dispersing heat generated during operation.

f) Connectors: cables and plugs that provide electricity to various components, including the motherboard (24-pin), CPU (8-pin), and storage devices (SATA or Molex).

3.5 Introduction to Hard Drives

A hard drive, often known as a hard disk drive (HDD), is a type of computer storage device that permanently stores data. It stores the operating system, programs, and personal data like as papers, images, and videos. HDDs are well-known for their huge storage capacity and are widely utilized in desktop computers, laptops, and servers.

3.5.1 Construction and Operation of Hard Disk Drive

Construction of a Hard Drive

a) Platter: Circular disks coated with a magnetic material, where data is stored. There can be multiple platters in a hard drive.

b) Spindle: Holds the platters in place and spins them at high speeds, usually 5,400 to 7,200 RPM (revolutions per minute).

c) Read/Write Head: A small magnetic head that reads and writes data to the platters.

d) Actuator Arm: Moves the read/write head across the platter to access data at different locations.

e) Actuator (Motor): Controls the movement of the actuator arm with precision.

f) Controller Board: Manages data transfer between the hard drive and the computer.

g) Enclosure: Protects the internal components from dust and damage.

Operation of a Hard Drive

a) Data Storage: Data is stored on the platters in the form of magnetic patterns. Each platter has tracks, divided into sectors, to organize the data.

b) Data Reading/Writing

- When you save a file, the controller board sends instructions to the actuator arm.
- The arm moves the read/write head to the correct location on the spinning

platter.

- The head changes the magnetic polarity to write data or detects polarity to read data.

c) **High-Speed Access:** The spinning platters and precise movement of the read/write head allow data to be accessed quickly.

3.6 Partitioning, Partition Size and Drive Lettering

Partitioning

Partitioning is the process of dividing a hard drive into separate sections, called partitions, to organize and manage data better. Each partition acts as an independent storage area. For example:

- A single physical hard drive can have multiple partitions, like one for the operating system and others for personal files or backup.

Steps of Partitioning

Step1 Use a tool like Disk Management (on Windows) or Disk Utility (on macOS).

Step2 Select the hard drive and choose to create a new partition.

Step3 Specify the size and format of the partition (e.g., NTFS, FAT32, or ext4).

Partition Size

The size of a partition determines how much storage is allocated to it.

- A hard drive with 1TB capacity can be split into multiple partitions, like:
  - 200GB for the operating system.
  - 400GB for files and media.
  - 400GB for backups.
- Partition size depends on the user's needs and system requirements.

Drive Lettering

In Windows, each partition is assigned a drive letter (e.g., C:, D:, E:) to identify it.

1. The C: drive is typically the default partition for the operating system.
2. Additional partitions receive letters like D:, E:, and so on.
3. Optical drives or USB devices also get drive letters when connected.

Example Demonstration

1. 1TB drive is partitioned into three parts:

- C: 200GB for Windows.
- D: 400GB for personal files.
- E: 400GB for backups.

2. Each drive is formatted, named, and appears as a separate storage location in the file explorer.

3.7 Formatting and Types

Formatting is the process of preparing a storage device, such as a hard drive, SSD, or USB flash drive, for use by a computer. It involves creating a file system on the device so that the operating system can store, organize, and access files. Formatting removes all existing data on the device and sets up the structure for new data storage.

Types of Formatting

1. Quick Formatting

- This is a fast way of formatting a drive, which removes the file system and marks the space as available for new data.
- It does **not** erase the actual data from the drive, just the references to the data, meaning the data can potentially be recovered with special software.
- Often used when the drive is new or being reused for a different purpose.

2. Full Formatting

- In addition to removing the file system, full formatting also scans the disk for bad sectors and marks them as unusable.
- It takes longer than quick formatting and completely erases all data on the drive, making it harder (or nearly impossible) to recover files.
- It's ideal for preparing a drive for long-term use or for wiping the device securely.

File System Types

When formatting a drive, you also choose the type of **file system** to use. The file system determines how data is stored and organized on the drive. Some common types include:

1. NTFS (New Technology File System)

- Commonly used in Windows operating systems.
- Supports large file sizes, file permissions, and file compression.
- More secure and reliable than older systems, suitable for modern applications.

2. **FAT32 (File Allocation Table 32)**
    - Works across many operating systems, including Windows, macOS, and Linux.
    - Supports drives up to 2TB in size but has a file size limit of 4GB.
    - Often used for smaller drives or when compatibility across different systems is needed.
3. **exFAT (Extended File Allocation Table)**
    - Designed for larger external drives (over 32GB) and flash drives.
    - Works well with both Windows and macOS.
    - Can handle large files like videos, making it ideal for external storage devices.
4. **HFS+ (Hierarchical File System Plus)**
    - Used by macOS systems for internal hard drives.
    - It supports file permissions, journaling, and other advanced features.
5. **ext4 (Extended File System 4)**
    - Common in Linux operating systems.
    - Supports large file sizes and modern journaling features to improve reliability.

Exercise

Choose the correct answer from the given alternatives.

1. Which component is responsible for temporarily storing data and instructions that the CPU is currently working with?

   a. Hard Disk Drive (HDD)
   b. Random Access Memory (RAM)
   c. Central Processing Unit (CPU)
   d. Motherboard

2. What role does the BIOS play in the computer's startup process?

   a. Basic input/output System; it controls hardware components
   b. Binary Input/output Software; it manages data storage
   c. Best input/output System; it connects to the internet
   d. Backup input/output Software; displays error messages

3. What is a motherboard form factor?

   a. The speed of the CPU
   b. The physical layout and dimensions of a motherboard
   c. The number of expansion slots on the motherboard
   d. The type of RAM supported by the motherboard

4. What are the primary components of a hard disk drive (HDD)?

   a. Central Processing Unit (CPU) and memory
   b. Platters, actuator arm, and read/write heads
   c. Keyboard, mouse, and monitor
   d. Power supply and cooling fan

5. The data storage capacity of a hard disk drive is mainly determined by:

   a. The speed of the CPU
   b. The number of USB ports
   c. The size of the power supply
   d. The number of platters and their data density

6. In a hard disk drive, where is data physically stored?

a. In the CPU's cache memory b. On the motherboard

c. On magnetic platters d. In RAM

7. What does the term "formatting" refer to in the context of computer storage?

a. Changing the font style in a document

b. Preparing a storage device for data storage and retrieval

c. Organizing files into folders

d. Calculating the total file size on a drive

8. Which of the following is not a common file system used for formatting storage devices in Windows operating systems?

a. FAT32 b. NTFS c. HFS+ d. exFAT

9. The HFS+ file system is commonly used in which operating system?

a. Windows b. Linux c. macOS d. Android

Write short answer to the following questions.

1. What is the primary function of System BIOS in a computer?
2. What is the BIOS setup utility? How can it be accessed?
3. What is a motherboard? Why is it a critical component of a computer?
4. What is the BIOS? What role does it play on the motherboard?
5. What is the significance of the motherboard's form factor? How does it affect the computer's size and compatibility?
6. What is the PCI local bus? What is its primary function in a computer system?
7. What types of devices are commonly connected to the PCI bus in a computer?
8. What is disk partitioning, and why is it important in computer storage management?
9. What factors should you consider? When determining the size of a partition on a hard drive?
10. Why are drive letters used to identify partitions or storage devices in Windows operating systems?
11. How are drive letters assigned to are partitions in Windows? Can they be changed?

Write long answer to the following questions.

1. Discuss how the motherboard serves as the central nervous system of a computer and its vital role in connecting and coordinating various hardware components.
2. Explain the significance of disk partitioning in computer storage. How does partitioning help organize and manage data on storage devices?
3. How does the choice of an operating system and software applications influence partition size and organization? Provide examples of how different systems handle partitioning.
4. Describe how drive letters are assigned to partitions or storage devices in Windows operating systems. Can drive letters be changed, and if so, how?
5. In Windows, what are the steps involved in changing the drive letter of a partition or storage device? Discuss the potential implications of drive letter changes on software and data accessibility.

Project Work

Activity 1: Use partition management software (e.g., Disk Management in Windows, GParted in Linux) to create, delete, and resize partitions on a secondary storage drive. You can practice partitioning without risking data loss.

Activity 2: Install a secondary operating system alongside your primary one, which often involves creating a new partition for the secondary OS. This will help you learn about partitioning for different operating systems.

Activity 3: Install VMware Workstation Player (Free for Personal Use)

Step 1: Download

1. Go to the official VMware website: https://www.vmware.com
2. Navigate to Products > Workstation Player
3. Click Download for Windows (or Linux, depending on your OS)

Step 2: Install

1. Run the downloaded .exe file.
2. Follow the on-screen instructions:
    - o Accept the license agreement

- Choose the installation location
- You can leave default settings checked (like enhanced keyboard driver)

3. Click Install

Step 3: Launch VMware

- After installation, open VMware Workstation Player
- You can now create or run virtual machines (VMs)

Troubleshooting Techniques

Unit 4

Troubleshooting is the process of finding and fixing problems in a system, such as a computer, network, or software. Here's a list of common troubleshooting problems with their causes and solutions:

a. Computer won't turn on

- **Cause:** The power cable is unplugged or the power button is not pressed properly
- **Solution** Check the power cable and make sure it's plugged in. Press the power button correctly.

b. No Internet Connection

- **Cause:** Wi-Fi is turned off or router is not working
- **Solution** Turn on Wi-Fi. Restart the router or check if the internet provider is down.

c. Mouse or Keyboard not Working

- **Cause:** Loose or disconnected cable/battery issue (wireless)
- **Solution** Reconnect the cable or change the battery. Try plugging it into another USB port.

d. Computer is Running Slow

- **Cause:** Too many programs are open or not enough memory
- **Solution** Close unused programs. Restart the computer. Delete unnecessary files.

e. Screen is Frozen

- **Cause:** Software crash or not responding to program
- **Solution** Press Ctrl + Alt + Delete, then end the program. If it doesn't work, restart the computer.

f. No Sound on the Computer

- **Cause:** Volume is muted or speaker is not connected
- **Solution** Unmute the volume. Check speaker cables or try headphones.

4.1 General Troubleshooting Techniques

Troubleshooting is the process of identifying and resolving problems or issues within a computer system, software, or hardware. Using effective troubleshooting techniques can help resolve most problems quickly and efficiently. Here are some general troubleshooting steps:

Step1 Identify the problem: Clearly define the issue you are experiencing. Is the computer not turning on? Is there a software error? Understanding the problem is the first step in solving it.

Step2 Check the Basics:

a. Ensure all cables and connections are securely plugged in.

b. Make sure the power supply is functioning, and the device is turned on.

c. For software issues, check if the program is installed correctly and updated.

Step3 Restart the System: Sometimes, simply restarting the computer or software can resolve many issues, such as frozen programs or minor software glitches.

Step4 Check for Error Messages: Look for any error messages or codes that might provide clues about the issue. You can often find solutions to these specific errors online.

Step5 Use Safe Mode (for software issues): If a problem occurs while the computer is starting, you can boot into Safe Mode, which starts the computer with only essential programs and drivers. This can help isolate and fix problems.

Step6 Check for Hardware Issues:

a. Inspect hardware components like the keyboard, mouse, monitor, or storage device for visible damage or disconnections.

b. If possible, test the hardware on another computer to verify if it's functioning properly.

Step7 Update Drivers and Software: Ensure that all system drivers (like for graphics or network cards) and software programs are up-to-date. Outdated drivers or software can often cause problems.

Step8 Use Diagnostic Tools: Many operating systems and third-party tools provide built-in diagnostic tools that can scan for issues. These tools can check hardware health, memory, or disk problems.

Step9 Check System Logs (for advanced users): Reviewing system logs can provide

useful information about errors or crashes. This is especially helpful when dealing with complex problems or software issues.

Step10 Isolate the Problem: If the issue is with a specific piece of hardware or software, try removing or disabling it temporarily to see if the problem is resolved. For instance, disconnect external devices or uninstall recently added software.

Step11 Seek Help or Research: If you cannot resolve the issue on your own, seek help online or consult the device's manual or support team. Often, others may have encountered and solved the same problem.

4.2 Steps of troubleshooting

Troubleshooting is a structured approach to identifying and fixing problems. The steps below outline a systematic process that can help resolve most computer or device issues.

Step1 **Identify the Problem:** Start by clearly understanding what the issue is. Is the system not turning on? Is there a specific error message? Asking questions like "What exactly is wrong?" will help define the problem more clearly.

Step2 **Check for Simple Solutions**

a. Ensure all cables, power connections, and external devices are securely plugged in.

b. Verify that the device is powered on and that all necessary components are functioning (e.g., is the power button on, are the monitors and keyboard working?).

Step3 **Reproduce the Problem:** Try to recreate the issue in a controlled environment. This helps you understand the specific conditions under which the problem occurs, such as when using a particular software or after connecting an external device.

Step4 **Restart the System or Software:** A simple restart can solve many issues, especially if the problem is related to system glitches or temporary software errors.

Step5 **Check for Error Messages or Codes:** Take note of any error messages or codes that appear. Error codes often provide specific details that can be used to search for solutions.

Step6 **Isolate the Problem:** Determine whether the problem is related to hardware or software. Disconnect external devices, boot the system in Safe Mode, or use diagnostic tools to narrow down the source of the issue.

Step7 **Consult Documentation or Help:** Refer to the user manual, help files, or online resources for potential solutions. Many common issues are documented, and others may have experienced and resolved similar problems.

Step8 **Check for Updates:** Ensure that all drivers, software, and the operating system are up to date. Outdated drivers or software can lead to issues, so keeping everything updated is essential.

Step9 **Perform System Diagnostics:** Use built-in or third-party diagnostic tools to check for hardware problems, such as memory or hard drive failures. Many operating systems have diagnostic utilities to help with this.

Step10 **Test with Known Good Components:** If the issue could be related to hardware (e.g., a malfunctioning hard drive or RAM), test with known working components to isolate the problem.

Step11 **Fix or Replace Faulty Components:** Once you have identified the faulty component (software or hardware), proceed with a solution such as reinstalling or updating software, or replacing the damaged hardware.

Step12 **Verify the Solution** After applying a fix, test the system thoroughly to ensure that the problem is resolved and no new issues have emerged.

Step13 **Document the Issue and Solution** If the issue was solved, document the problem and the steps you took to resolve it. This can help if the problem arises again or for future reference.

4.3 Troubleshooting Boot Problems

Troubleshooting boot problems can be a frustrating but necessary task when your computer fails to start properly. These issues can stem from various hardware or software issues. A step-by-step guide to help you diagnose and fix boot problems:

Step1 **Check Hardware Connections:** Ensure all cables and peripheral devices are properly connected. Verify that there are no loose components inside the computer, such as RAM or expansion cards.

Step2 **Power Supply and Outlet:** Make sure the power outlet is working. Test the power supply unit (PSU) or try a different power cable if available.

Step3 **Monitor and Display:** Ensure your monitor is powered on and connected correctly. Test with another monitor or cable to rule out display issues.

Step4 **External Devices:** Disconnect external devices like USB drives, printers, or

external hard drives to see if they are causing conflicts.

Step5 **BIOS/UEFI Settings:** Enter the BIOS/UEFI setup by pressing the appropriate key (usually displayed during startup, often F2, F12, Del, or Esc). Check the boot device order to ensure the correct drive is selected as the primary boot device.

Step6 **Safe Mode:** If you're using Windows, try booting into Safe Mode. This can help identify if a driver or software issue is causing the problem. On Windows 10/11, you can access Safe Mode by pressing Shift while clicking the Restart option from the login screen or using the System Configuration utility (msconfig). On older versions of Windows, press F8 during startup to access the Advanced Boot Options menu.

Step7 **Bootable Media:** Create a bootable USB or DVD containing your operating system (e.g., Windows, Linux). Boot from the installation media and select "Repair" or "Troubleshoot" options.

Step8 **Error Messages:** Pay attention to any error messages or codes displayed during boot. These can provide valuable clues about the problem.

Step9 **Run Diagnostic Tools:** Many computer manufacturers provide built-in diagnostic tools accessible from the BIOS/UEFI menu. Use these tools to check for hardware issues.

Step10 **Reinstall or Repair Operating System:** - If the boot problem persists, you may need to repair or reinstall your operating system. - For Windows, you can use the installation media to repair or reinstall the OS. - For Linux, you can use a live CD/USB to repair or reinstall the OS.

Step11 **Data Recovery:** - Before reinstalling the OS, consider data recovery options if you have important files on the system. You can use live Linux distributions or data recovery software for this purpose.

4.4 Troubleshooting boot time error messages

Troubleshooting boot time error messages is essential for identifying and resolving issues that prevent your computer from starting up properly. Here are steps to help you address common error messages during boot:

Step1 **Read the Error Message:** Pay close attention to the error message displayed on the screen. The message often provides clues about the specific problem.

Step2 **Restart Your Computer:** Sometimes, a boot error may be a temporary glitch. Try

restarting your computer to see if the issue resolves itself.

Step3 **Safe Mode:** If you're using Windows, try booting into Safe Mode to see if the error persists. Safe Mode loads a minimal set of drivers and can help isolate software-related issues.

Step4 **System Restore (Windows):** If you can access Safe Mode, consider using System Restore to revert your system to a previous working state. To perform a System Restore in Windows, go to "Control Panel" > "Recovery" > "Open System Restore."

Step5 **Last Known Good Configuration (Windows):** During boot, you can try selecting the "Last Known Good Configuration" option if available. This reverts system settings to a previously working state.

Step6 **Check Hardware Connections:** Ensure all hardware components are properly connected, including RAM, hard drive/SSD, and peripheral devices. Re-seat components like RAM and expansion cards if necessary.

Step7 **Check for Disk Errors:** Boot from a bootable USB or DVD (e.g., Windows installation media or a live Linux distribution). Use built-in disk utilities to check for and repair disk errors. For Windows, you can use "chkdsk," and for Linux, use "fsck."

Step8 **BIOS/UEFI Settings:** Access the BIOS/UEFI settings and review the boot device order and settings. Ensure the correct boot drive is selected.

Step9 **Error Codes:** Note any error codes or specific details in the error message. Use these details to search online for solutions or check the manufacturer's documentation for troubleshooting guidance.

Step10 **Update or Roll Back Drivers:** If the error message mentions a specific driver, consider updating or rolling back that driver to a previous version.

Step11 **Repair Operating System:** Use the installation media (e.g., Windows or Linux bootable USB) to repair or reinstall the operating system. This can often fix boot-related issues.

Step12 **Data Recovery:** If necessary, consider data recovery options before reinstalling the OS. You can use live Linux distributions or data recovery software to retrieve important files.

Step13 **Seek Professional Help:** If you're unable to resolve the issue on your own or if it's a hardware-related problem, consult a professional technician or contact the manufacturer's support for assistance.

4.5 Troubleshooting system slowdowns

Troubleshooting system slowdowns can be frustrating, but it's essential to identify and resolve the underlying issues to restore your computer's performance. Here are steps to help you diagnose and address system slowdowns:

Step1 **Identify the Cause:** Determine when the slowdowns occur. Is it during startup, while running specific applications, or generally throughout computer use?

Step2 **Monitor Resource Usage:** Use Task Manager (Windows) or Activity Monitor (macOS) to monitor CPU, RAM, and disk usage. Identify any processes or applications that are consuming excessive resources.

Step3 **Close Unnecessary Applications:** Close unused or unnecessary applications and background processes to free up system resources.

Step4 **Restart Your Computer:** Sometimes, a simple reboot can resolve performance issues caused by temporary glitches or memory leaks.

Step5 **Update Software:** Ensure your operating system, drivers, and software applications are up to date. Outdated software can lead to compatibility issues and performance problems.

Step6 **Scan for Malware and Viruses:** Perform a full system scan using reputable antivirus and anti-malware software. Malware and viruses can significantly impact system performance.

Step7 **Check for Disk Errors:** Run disk checks (e.g., "chkdsk" on Windows, "fsck" on Linux/macOS) to identify and repair disk errors that can slow down your system.

Step8 **Manage Startup Programs:** Disable unnecessary startup programs to reduce boot time and system resource usage. On Windows, use the "Task Manager" > "Startup" tab. On macOS, go to "System Preferences" > "Users & Groups" > your user > "Login Items."

Step9 **Manage Background Services:** Disable or modify background services and scheduled tasks that consume system resources unnecessarily.

Step10 **Optimize Disk Space:** Free up disk space by deleting unnecessary files and applications. - Consider moving large files to external storage or cloud storage solutions.

Step11 **Upgrade Hardware:** If your computer›s hardware is outdated, consider upgrading components such as RAM, the hard drive to an SSD, or the graphics card.

Step12 **Monitor Temperatures:** Overheating can cause performance issues. Monitor your CPU and GPU temperatures using tools like HWMonitor or SpeedFan and clean dust from the computer›s fans and heat sinks.

Step13 **Check for Software Conflicts:** Identify and resolve software conflicts, especially if you recently installed new software or drivers.

Step14 Use System Maintenance Tools: On Windows, use built-in tools like «Disk Cleanup» and «Defragment and Optimize Drives» to maintain your system. - On macOS, use «Disk Utility» to check and repair disk permissions.

Step15 Reinstall Operating System: As a last resort, consider reinstalling your operating system to start with a clean slate. Be sure to back up your data before doing this.

Step16 Seek Professional Help: If you've tried the above steps and still experience slowdowns, it may be a hardware issue or a more complex software problem. In such cases, consult a professional technician for further diagnosis.

4.6 Troubleshooting Specific Components

Troubleshooting specific components in your computer can be necessary when you're experiencing issues with specific hardware or peripherals. Here are some common components and steps to troubleshoot them:

Step1. **Troubleshooting a Graphics Card**

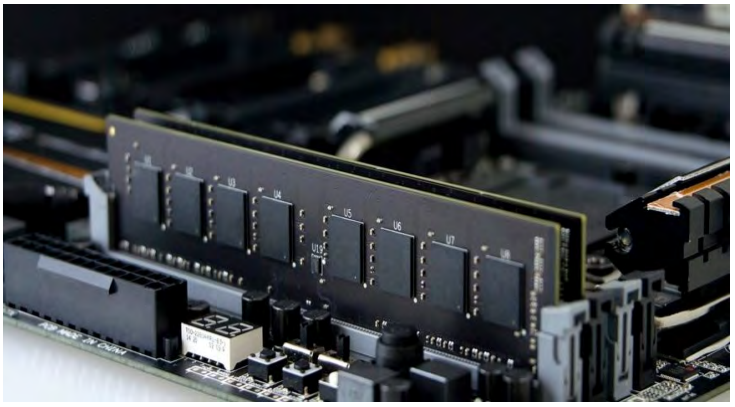
If you're experiencing graphical issues like artifacts, screen flickering, or no display:

- Check if the graphics card is seated correctly in the PCIe slot.
- Ensure that the power connectors to the graphics card are secure.
- Update or reinstall graphics drivers.
- Monitor temperatures using software like MSI Afterburner or GPU-Z to check for overheating.

Step 2. **Troubleshooting RAM (Memory)**

If you're encountering system crashes, BSOD (Blue Screen of Death), or frequent application errors:

- Reseat the RAM modules to ensure they are properly seated.
- Run a memory diagnostic tool, like Windows Memory Diagnostic, to check for RAM issues.
- Consider testing individual RAM modules to identify faulty ones.
- Ensure RAM is compatible with your motherboard and configured correctly in BIOS/UEFI settings.



Step 3. **Troubleshooting Hard Drive/SSD:**

If you're experiencing slow file access, data corruption, or system freezes:

- Check disk health using SMART monitoring tools (e.g., CrystalDiskInfo for Windows).

- Run a disk scan and repair utility (e.g., “chkdsk” on Windows, “fsck” on Linux/macOS).
- Ensure that the hard drive or SSD is securely connected.
- Backup critical data regularly to prevent data loss.

Step 4. **Troubleshooting CPU**

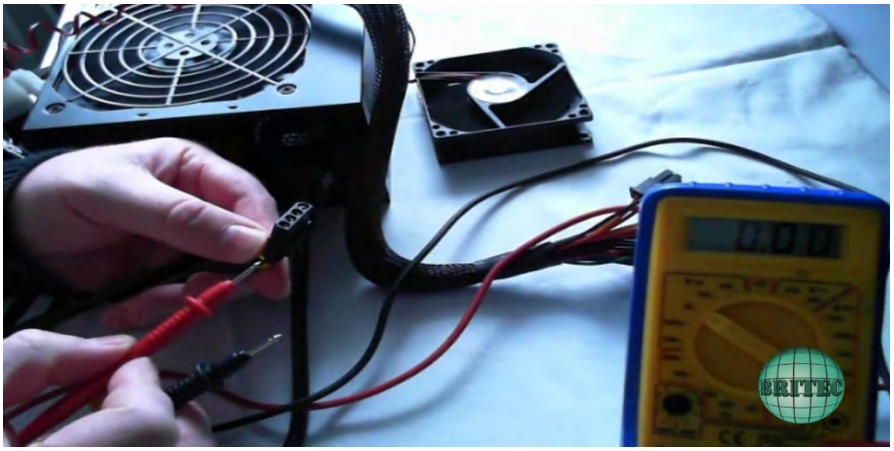
If your computer is overheating, experiencing system crashes, or running slow:

- Monitor CPU temperature using software like Core Temp.
- Clean the CPU heatsink and fan to remove dust and improve cooling.
- Ensure the CPU cooler is seated properly.
- Check for thermal paste application and reapply if necessary.

Step 5. **Troubleshooting Power Supply Unit (PSU)**

If your computer randomly shuts down or restarts:

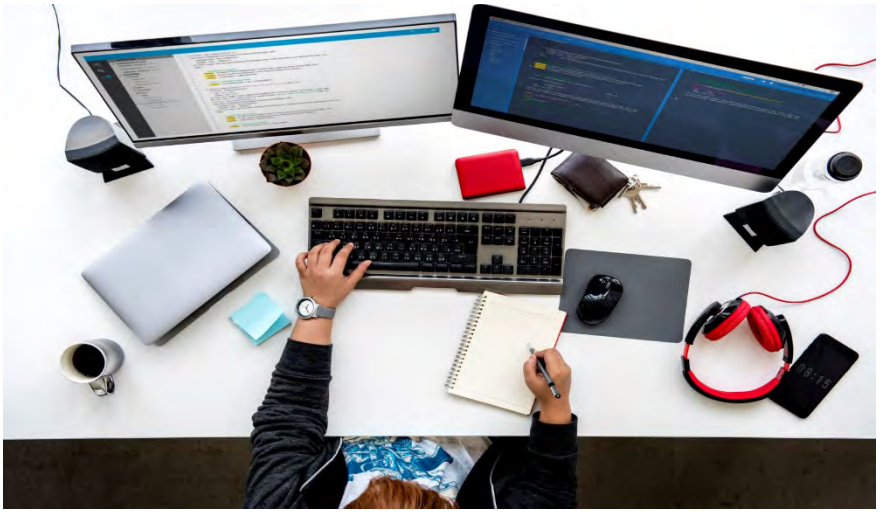
- Test the PSU with a PSU tester or replace it with a known working one.
- Ensure all power connectors are securely connected to the motherboard, GPU, and other components.



Step 6. **Troubleshooting Peripherals (e.g., Keyboard, Mouse, USB devices)**

If your peripherals are not working correctly or not recognized:

- Try connecting them to different USB ports.
- Test the peripherals on another computer to rule out hardware issues.
- Update or reinstall drivers for the specific device if applicable.



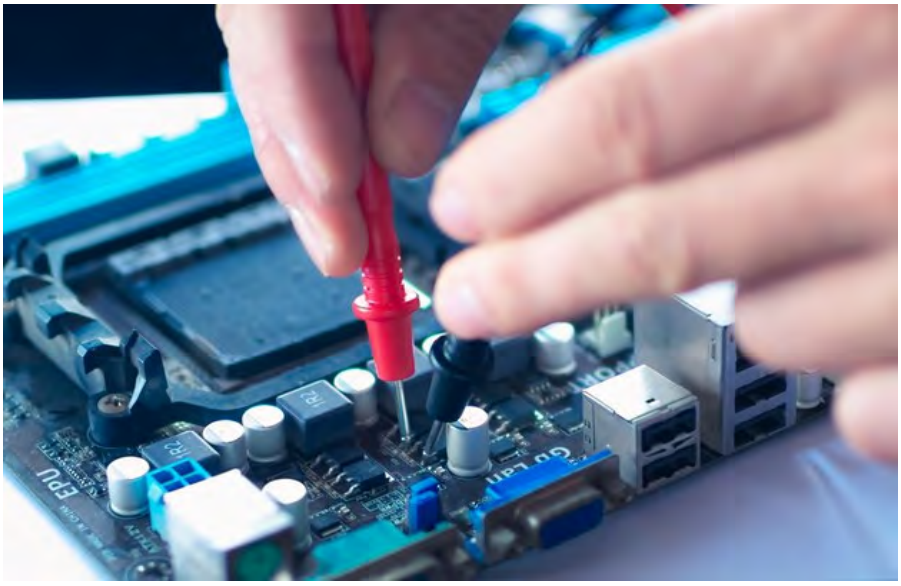
Step 7. **Troubleshooting Motherboard Issues**

If you suspect motherboard-related problems, such as no power or erratic behavior:

- Inspect for visual damage or burnt components on the motherboard.
- Check for loose or damaged cables and connections.
- Clear CMOS settings by removing the CMOS battery or using a jumper, if

necessary.

- Consult your motherboard's manual for specific troubleshooting steps.



Step 8. **Troubleshooting Network Components (e.g., Ethernet/Wi-Fi)**

If you're experiencing network connectivity issues:

- Restart your router and modem.
- Check Ethernet cables for damage.
- Update or reinstall network drivers.
- Use network diagnostic tools like the "ipconfig" command on Windows or "ifconfig" on Linux.

Step 9. **Troubleshooting Optical Drives**

If your CD/DVD/Blu-ray drive is not reading discs or ejecting properly:

- Clean the optical drive's lens with a lens cleaning kit.
- Check for loose or damaged cables.
- Update or reinstall optical drive drivers.

Common Printer Problems & How to Fix Them

The basic troubleshooting guide for printers when they are not working properly:

1. Printer Not Printing

Solutions:

- Check if the printer is powered on and connected (USB or Wi-Fi).
- Make sure it is set as the default printer:
- o Windows: Settings > Devices > Printers & scanners > Set as default
- Clear the print queue:
- o Right-click printer > "See what's printing" > Cancel all documents
- Restart the printer and the computer.

2. Printer Offline

Solutions:

- Go to Control Panel > Devices and Printers > Right-click your printer > Select "Use Printer Online".
- Check Wi-Fi or USB connection.
- Restart the printer and reconnect it.

3. Paper Jam

Solutions:

- Turn off the printer.
- Open all access panels and gently remove jammed paper.
- Check for tiny scraps stuck inside.
- Close everything securely and restart.

4. Low or Empty Ink/Toner

Solutions:

- Check ink/toner levels from the printer software.
- Replace cartridges if needed.
- Run the print head cleaning utility from the printer software.

5. Poor Print Quality

Solutions:

- Clean the print heads/nozzles.
- Align the printer heads (found in printer settings).
- Use high-quality paper and the correct paper type setting.

6. Driver Issues

Solutions:

- Go to the printer manufacturer's website.
- Download and install the latest drivers for your printer model.

Exercise

Choose the correct answer from the given alternatives.

1. If your computer is displaying a “Blue Screen of Death” (BSOD) error in Windows, what should you do first?

   a. Reboot the computer

   b. Update the BIOS

   c. Write down the error code and message

   d. Install a new operating system

2. What is the primary purpose of using diagnostic software in troubleshooting?

   a. To order replacement parts

   b. To monitor network traffic

   c. To identify and repair hardware or software issues

   d. To clean and optimize the hard drive

3. You are experiencing slow internet speeds on your home network. What is the first step to troubleshoot this issue?

   a. Call your internet service provider (ISP)

   b. Restart the modem and router

   c. Upgrade your computer’s hardware

   d. Clear your browser cache

4. Your computer emits a series of beeping sounds during startup. What do these beep codes typically indicate?

   a. Successful boot

   b. Hardware or POST (Power-On Self-Test) errors

   c. Software conflicts

   d. Internet connectivity issues

5. You receive an “Out of Memory” error when using a software application. What should you do to troubleshoot this issue?

   a. Upgrade your hard drive

b. Increase the CPU clock speed

c. Close unnecessary programs and files

d. Reinstall the operating system

6. What is the purpose of creating a system restore point in Windows as a troubleshooting technique?

a. To reset the computer to factory settings

b. To create a backup of personal files

c. To provide a recovery point in case of software issues

d. To improve network connectivity

Write short answer to the following questions.

1. What is the first step in troubleshooting when a computer won't start, and there are no visible signs of power?
2. How can you identify and diagnose hardware or software issues when a computer displays error messages during startup?
3. How can you determine if a slow internet connection is due to a problem with your ISP or an issue with your local network?
4. When a laptop overheats and shuts down unexpectedly, what can you do to address this issue?
5. If a smartphone or tablet is not charging properly, what are some potential troubleshooting steps to consider?
6. What is the role of diagnostic tools and software in the troubleshooting process?
7. How can creating a system restore point in Windows be a useful troubleshooting technique?

Write long answer to the following questions.

1. Describe a step-by-step approach to troubleshoot and identify the root cause of boot problems, including both hardware and software aspects.
2. What steps would you take to identify and resolve common printing problems, such as print quality issues or connectivity problems?
3. When a computer emits beep codes during startup, it's a sign of hardware issues. Provide a guide to understanding and interpreting common beep codes and taking

appropriate troubleshooting actions.

4. Explain the process of data recovery, including utilizing backup solutions, file recovery software, and cloud services to retrieve lost data.

Project Work

1. Install or reinstall an operating system on a computer. Practice troubleshooting issues that may arise during the installation process, such as driver conflicts, partitioning problems, or boot errors.
2. Disassemble and reassemble a computer, paying attention to components like RAM, CPU, and power connections. Troubleshoot common hardware issues, such as loose connections or incompatible components.
3. Delete a file accidentally and attempt to recover it using file recovery software. Learn how to search for and restore lost data.
4. Explore online IT training platforms or virtual labs that offer guided troubleshooting exercises. Many platforms offer hands-on labs for various technologies and scenarios.

Unit 5 Repair and Maintenance

5.1 Preventive Maintenance of the System

Preventive maintenance (PM) is a proactive approach to maintaining systems and equipment by performing regular inspections, servicing, and repairs to prevent unexpected failures and ensure optimal performance. This strategy emphasizes early detection and correcting potential issues before they lead to costly breakdowns or interruptions.

Objectives of Preventive Maintenance

a) Regular maintenance decreases the likelihood of system failure, assuring uninterrupted operation and increased dependability.

b) Routine maintenance and timely replacement of parts improve the longevity of components and systems.

c) Preventive methods reduce unplanned outages, resulting in smoother operations and productivity.

d) Regular cleaning, calibration, and adjustments keep systems in top condition, resulting in efficient performance.

e) Long-term, proactive maintenance saves money on costly emergency repairs and replacements.

Examples in Various Systems

- Computers and electronics maintenance includes software updates, malware scanning, hardware connection checks, and dust removal.
- Industrial machinery maintenance includes lubricating moving parts, tightening bolts, and replacing worn components.
- Automobile maintenance includes oil changes, tire rotations, and brake inspections.

5.2 Fixing Wireless Network ConnectionIssues

The step-by-step guide to troubleshooting and fixing common wireless network connection issues is as follows:

Step 1. Check Basic Settings

- Ensure **Wi-Fi** is enabled on the device.
- Confirm the device is within range of the Wi-Fi router.
- Check the **Wi-Fi** icon on your device for connection status.

Step 2. Restart Devices

- Restart the **Wi-Fi** router/modem by turning it off, waiting 10-15 seconds, and turning it back on.
- Restart your **device** (laptop, phone, etc.).

Step 3. Verify Network Credentials

- Ensure you're connecting to the correct Wi-Fi network (SSID).
- Double-check the password entered for the Wi-Fi network.

Step 4. Forget and Reconnect

- On your device:

Step1 Open the **Wi-Fi settings**.

Step2 Select the network you're trying to connect to.

Step3 Click **Forget Network**.

Step4 Reconnect to the network by entering the password.

Step 5. Check Router Settings

- Access the router settings: Open a web browser. Enter the router's IP address (e.g., 192.168.1.1 or 192.168.0.1). Log in using the admin credentials.
- Ensure the **Wi-Fi signal is enabled**.

C Check if **MAC address filtering or parental controls** are blocking your device.

Step 6. Diagnose Connection Issues

- **Windows:**

Step1 Right-click the **network icon** in the taskbar.

Step2 Select **Troubleshoot problems** and follow the on-screen steps.

- **Mac:**

Step1 Go to **System Preferences > Network**.

Step2 Click **Assist Me** and follow the diagnostic tool.

- **Smartphones**
  - Use the **built-in network diagnostics** in the Wi-Fi settings.

Step 7. Update Drivers and Firmware

- **Device Drivers**
  - Update the network adapter drivers on your computer.
- **Router Firmware**
  - Access the router's settings and check for firmware updates.
  - Apply updates if available.

Step 8. Check for Interference

- Move closer to the router to reduce interference from walls or other electronic devices.
- Change the router's **Wi-Fi channel** (usually under the advanced wireless settings).

Step 9. Reset Network Settings

- **Windows**

  Step1 Go to **Settings > Network & Internet > Status**.

  Step2 Click **Network reset**.
- **Mac**
  - Remove and re-add the Wi-Fi interface under **System Preferences > Network**.
- **Smartphones**
  - Reset network settings in the **general settings** menu.

Step 10. Replace or Contact Support

- **If the issue persists**
  - Replace the router or network adapter if they are faulty.
  - Contact your Internet Service Provider (ISP) for further assistance.

5.3 Power Source and Power Protection

Power Source

The power source is the origin or supply of electrical power used to operate devices,

equipment, or systems. Reliable power sources are crucial for uninterrupted operation and efficient functioning of various systems.

Types of Power Sources

- **Mains Power:** Electricity supplied by the utility grid, typically used for homes, offices, and industries.
- **Batteries:** Portable and rechargeable sources of power commonly used in mobile devices, UPS (Uninterruptible Power Supplies), and other electronics.
- **Generators:** Backup power devices that use fuel such as diesel or gasoline to produce electricity during outages.
- **Renewable Energy:** Includes solar panels, wind turbines, and hydroelectric systems, which generate electricity from natural resources.

Characteristics of Power Sources

- **Voltage and Current:** Determines the compatibility of the power source with the devices it powers.
- **Stability:** Stable power sources provide consistent voltage and frequency, reducing the risk of damage to equipment.

Power Protection

Power protection involves safeguarding devices and systems from power-related issues, such as surges, outages, and fluctuations, to ensure their longevity and functionality.

Common Power Problems

- **Power Surges:** Sudden increases in voltage that can damage sensitive equipment.
- **Power Outages:** Complete loss of power supply due to grid failures or other issues.
- **Voltage Sags/Dips:** Short-term drops in voltage levels that can cause devices to malfunction.
- **Electrical Noise:** Disturbances in the electrical signal that can affect equipment performance.

Power Protection Devices

- **Surge Protectors**
  - Protect devices from voltage spikes.
  - Commonly used for computers, TVs, and other sensitive electronics.

- **Uninterruptible Power Supply (UPS)**
  - Provides backup power during outages.
  - Offers surge protection and voltage regulation.
- **Voltage Regulators**
  - Maintain a consistent voltage level to prevent overvoltage or undervoltage issues.
- **Circuit Breakers**
  - Automatically cut off power when current exceeds safe levels, preventing overheating and fire hazards.
- **Power Conditioners**
  - Improve power quality by filtering electrical noise and stabilizing voltage.

5.4 Failure or Improper Operation of Video Cards

When a video card (graphics card) fails or operates incorrectly, it can cause a variety of visual and performance problems. Here's how to identify, diagnose, and perhaps resolve common video card issues:

Symptoms of Video Card Failure

1. Visual Artifacts

- Lines, dots, or shapes appear on the screen during regular use.
- Textures may appear distorted in games or videos.

2. No Display

- The screen remains blank, even when the computer is powered on.

3. Screen Flickering or Tearing

- Rapid changes in brightness or horizontal tearing of images on the screen.

4. Overheating

- System shuts down unexpectedly due to excessive heat generated by the video card.

5. Driver Crashes

- Frequent error messages like "Display driver stopped responding and has recovered."

6. Poor Performance

- Lagging or stuttering during gaming or high-resolution video playback.

7. Fan Noise or Failure

- Loud or inconsistent fan noises or a non-functional video card fan.

Diagnosing Video Card Issues

1. Check Connections

- Ensure the video card is securely seated in the PCIe slot.
- Verify that the monitor cables (HDMI, DisplayPort, DVI) are properly connected.

2. Test with Another Monitor

- Connect your computer to a different monitor to rule out monitor issues.

3. Inspect for Physical Damage

- Look for signs of burnt components, damaged ports, or broken fans on the video card.

4. Monitor GPU Temperatures

- Use tools like MSI Afterburner or HWMonitor to check GPU temperatures during operation.
- Normal temperatures should be between 30°C and 80°C depending on usage.

5. Test in Safe Mode

- Boot the system into Safe Mode to see if the problem persists. If it doesn't, the issue may be driver-related.

6. Use Built-in Diagnostics

- Run built-in diagnostic tools in Windows or third-party applications like FurMark to stress test the GPU.

Common Fixes for Video Card Problems

1. Update Drivers

- Download the latest drivers for your GPU from the manufacturer's website (NVIDIA, AMD, or Intel).

- Completely uninstall old drivers using tools like Display Driver Uninstaller (DDU) before reinstalling.

2. Clean the Video Card

- Remove dust from the GPU and its fans using compressed air.
- Reapply thermal paste if overheating persists.

3. Test with a Different Power Supply

- Ensure your PSU provides sufficient wattage for your GPU.
- Replace the PSU if it's failing to deliver stable power.

4. Reseat the Video Card

- Power off the system and carefully remove and reinsert the video card.

5. Check for BIOS/UEFI Updates

- Update your motherboard BIOS to ensure compatibility with the video card.

6. Underclock or Adjust Fan Curves

- Reduce the clock speeds to lower the heat and improve stability using tools like MSI Afterburner.

7. Replace the Video Card

- If hardware damage or failure is confirmed, replace the GPU with a functional one.

5.5 Image Quality Problems in Monitors (Resolution, Layout)

Monitors can exhibit various image quality problems that impact clarity, sharpness, and usability. These problems often relate to resolution and layout settings. Below is a description of common issues and solutions:

1. Resolution Issues

Problem: Blurry or Pixelated Images

- **Cause:** The monitor is not set to its native resolution, causing images and text to appear blurry or pixelated.
- **Example:** A 1920x1080 monitor set to 1366x768 resolution.

Solution

- Identify the native resolution of your monitor (check specifications or user manual).
- Adjust the resolution settings:
    - **Windows:** Right-click the desktop > Display settings > Resolution > Select the native resolution.
    - **Mac:** Apple menu > System Preferences > Displays > Resolution > Select "Default for display."

Problem: Incorrect Aspect Ratio

- **Cause:** The resolution chosen does not match the monitor's aspect ratio, leading to stretched or squished images.
    - **Example:** Setting a 16:9 resolution on a 4:3 monitor.

Solution

- Use a resolution that matches your monitor's aspect ratio (e.g., 16:9 for widescreen monitors).

Problem: Flickering or Low Refresh Rate

- **Cause:** Low refresh rate or unsupported resolution causing unstable display.
    - **Example:** Setting a refresh rate of 30Hz on a 60Hz monitor.

Solution

- Increase the refresh rate in display settings:
    - **Windows:** Display settings > Advanced display settings > Refresh rate.
    - **Mac:** System Preferences > Displays > Refresh Rate.

2. Layout Issues

Problem: Misaligned Screen Elements

- **Cause:** Improper scaling settings cause icons, text, or applications to appear too large or too small.
- **Example:** A 4K monitor with 100% scaling may make text unreadably small.

Solution

- Adjust scaling settings
    - **Windows:** Display settings > Scale and layout > Adjust scaling percentage.

- **Mac:** System Preferences > Displays > Scale > Select a comfortable option.

Problem: Overscanning or Underscanning

- **Cause:** The display extends beyond the edges of the monitor (overscanning) or leaves black borders around the screen (underscanning).
- **Example:** Common with HDMI connections to TVs used as monitors.

Solution

- Use the monitor's on-screen display (OSD) menu to adjust overscan settings.
- For GPUs:
  - **NVIDIA Control Panel:** Adjust Desktop Size and Position > Scaling > Enable/ Disable overscan.
  - **AMD Radeon Settings:** Display > Scaling options.

Problem: Duplicate or Improper Multi-Monitor Layout

- **Cause:** Incorrect configuration of multiple monitors leads to misaligned displays or duplicate screens.
- **Example:** Primary and secondary monitors are swapped.

Solution

- Reconfigure the monitor layout:
  - **Windows:** Display settings > Rearrange displays > Drag to align.
  - **Mac:** System Preferences > Displays > Arrangement > Drag displays to correct position.

3. Color and Brightness Issues Related to Resolution and Layout

Problem: Washed-Out or Overly Dark Display

- **Cause:** Resolution or scaling settings can sometimes impact color accuracy.

  Solution

  - Calibrate your display:
    - **Windows:** Color Management > Advanced > Calibrate display.
    - **Mac:** System Preferences > Displays > Color > Calibrate.

Problem: Low Image Quality on External Displays

- **Cause:** Using an incompatible resolution or improper scaling for an external monitor.

Solution

- Match the external monitor's resolution and aspect ratio.

Prevention for image quality problems of **monitor**

- Use the **native resolution** and refresh rate for optimal clarity.
- Regularly update **graphics drivers** for compatibility with monitors.
- Ensure proper **connection cables** (HDMI, DisplayPort, etc.) to support the desired resolution and refresh rate.

5.6 Input and Output Device Connection Issues

Input and output (I/O) devices are critical for interacting with a computer system. Input devices like keyboards, mice, and scanners allow users to provide data, while output devices like monitors, printers, and speakers present processed data. Connection issues with these devices can disrupt workflows and cause frustration.

Understanding the common problems and their solutions is essential to maintain smooth operation.

1. Common Input Device Connection Issues

a. Keyboard and Mouse Issues

- **Problem:** Device not detected.
  - **Cause:** Faulty connection, outdated drivers, or hardware failure.

  Solution
    - Check the physical connection (USB or wireless receiver).
    - Replace batteries for wireless devices.
    - Test the device on another system to confirm functionality.
- **Problem:** Erratic behavior or unresponsiveness.
  - **Cause:** Signal interference (wireless) or dirt/debris (wired).

  Solution
    - Clean the device.
    - Reposition the wireless receiver closer to the device.
    - Update or reinstall drivers.

b. Scanner and Camera Issues

- **Problem:** Unable to scan or capture images.
  - **Cause:** Software incompatibility or loose connections.

  Solution
    - Reinstall or update the device software.
    - Check the cable or wireless setup.

2. Common Output Device Connection Issues

a. Monitor Issues

- **Problem:** No display or "No Signal" message.
  - **Cause:** Incorrect input source, loose cable, or incompatible resolution settings.
  - **Solution**
    - Verify the input source on the monitor matches the cable (HDMI, VGA, DisplayPort).
    - Check cable connections and test with another cable or port.
    - Adjust the resolution from the operating system settings.
- **Problem:** Flickering or distorted display.
  - **Cause:** Loose connection or refresh rate mismatch.

  Solution
    - Secure the cable and connectors.
    - Adjust the refresh rate in display settings.

b. Printer Issues

- **Problem:** Printer not detected or offline.
  - **Cause:** Network connectivity, driver issues, or cable disconnection.

  Solution
    - Ensure the printer is powered on and connected to the correct network.
    - Check and reinstall printer drivers.
- **Problem:** Print jobs stuck in queue.
  - **Cause:** Communication failure or print spooler issue.

  Solution
    - Restart the print spooler service in system settings.

- Clear and resend print jobs.

c. Audio Device Issues

- **Problem:** No sound or distorted audio.
  - **Cause:** Incorrect audio output device selection or damaged connectors.

Solution

- Check the sound settings and select the correct output device.
- Test with another cable or port.

Preventive Measures

- Use high-quality and compatible cables or peripherals.
- Regularly clean ports and connectors to prevent dust buildup.
- Keep drivers and firmware up to date for compatibility.
- Avoid overloading USB hubs with multiple devices.

5.7 Processor Power and Voltage Level

Processor Power

Processor power is the amount of electrical energy a CPU (Central Processing Unit) consumes to perform its operations. It is usually measured in **watts (W)** and depends on factors like:

- **Clock Speed:** Higher speeds require more power.
- **Number of Cores:** Multi-core processors consume more power than single-core processors.
- **Workload:** Running intensive tasks like gaming or video editing increases power usage.

Efficient processors are designed to balance performance with lower power consumption, which is important for laptops, mobile devices, and energy-saving purposes.

Voltage Level

The voltage level is the amount of electrical potential the processor supplies to operate. It is typically measured in **volts (V)** and is crucial for:

- **Stable Operation:** The CPU requires a specific voltage range to function reliably.
- **Power Efficiency:** Modern processors use dynamic voltage scaling to adjust voltage

based on the workload, reducing power consumption during light tasks.

- **Heat Generation:** Lower voltage reduces heat, improving efficiency and lifespan.

For example, modern processors operate at low voltage levels, usually between **0.8V** to **1.5V**, depending on their design and usage scenario. This balance of power and voltage ensures optimal performance while maintaining energy efficiency.

5.8 Introduction to Processor Cooling

Processor cooling is the process of managing and dissipating heat generated by the CPU (Central Processing Unit) to ensure it operates efficiently and reliably. When a processor performs calculations, it generates heat due to the flow of electricity and high-speed operations. If this heat is not managed, it can lead to overheating, reduced performance, or even permanent damage to the hardware.

To prevent such issues, cooling systems are used. Common methods include:

- **Air Cooling:** Using heatsinks and fans to draw heat away from the processor.
- **Liquid Cooling:** Circulating coolant through tubes and radiators for more efficient heat transfer.
- **Thermal Paste:** Applied between the processor and heatsink to enhance heat conduction.

5.9 Cooling and Ventilation

Cooling

Cooling refers to the process of lowering the temperature of electronic components, especially the processor, to prevent overheating and ensure efficient performance. In computers, cooling methods include:

- **Air Cooling:** Using fans and heatsinks to remove heat from components.
- **Liquid Cooling:** Circulating coolant to absorb and dissipate heat more effectively.
- **Passive Cooling:** Using heat-conductive materials like metal fins to disperse heat without fans.

Effective cooling prevents damage, improves performance, and extends the lifespan of hardware components.

Ventilation

Ventilation refers to the movement of air within and around a computer to maintain a

consistent temperature by expelling hot air and bringing in cooler air. Proper ventilation is achieved through:

- **Airflow Design:** Strategically placing intake and exhaust fans to promote efficient air circulation.
- **Case Design:** Using cases with vents, grills, or mesh panels to facilitate airflow.
- **Placement:** Ensuring the computer is not obstructed by walls or objects, allowing air to flow freely.

5.10 Virus Background

Background of Computer Viruses

A **computer virus** is a type of malicious software program designed to replicate itself and spread from one system to another, often without the user's knowledge. The concept of computer viruses originated in the 1970s, inspired by early theories of self-replicating programs.

Key Aspects of Virus Background

1. Origin

- The term "computer virus" was first coined in 1983 by Fred Cohen during his research on self-replicating software.
- Early viruses were simple and experimental, created to study program behaviors.

2. Functionality

- A virus attaches itself to legitimate programs or files. When executed, it spreads by infecting other files or systems.
- It can cause damage, steal information, or disrupt system functionality.

3. Types of Viruses

- **File Infectors:** Attach to executable files and spread when the file is run.
- **Boot Sector Viruses:** Infect the boot sector of a storage device, loading during system startup.
- **Macro Viruses:** Exploit macros in applications like word processors or spreadsheets.

4. Evolution

- Early viruses were manually transmitted via floppy disks or early networks.
- Modern viruses spread rapidly through the internet, email, or USB drives.
- Advanced viruses use stealth techniques to avoid detection by antivirus software.

5.11 Virus detection, protection, and prevention techniques

Virus Detection

Virus detection involves identifying the presence of malicious software in a computer system. Techniques include:

- **Antivirus Software:** Tools like Norton, McAfee, or Windows Defender scan files and programs for known virus signatures.
- **Behavioral Analysis:** Monitors programs for suspicious activities, such as unauthorized data access or unusual network behavior.
- **Regular Scanning:** Conducting full-system scans periodically to detect hidden threats.
- **File Integrity Monitoring:** Detects unauthorized modifications to critical system files.
- **Heuristic Analysis:** Identifies previously unknown viruses by analyzing code for virus-like characteristics.

Virus Protection

Protection focuses on safeguarding systems from being infected by viruses. Methods include:

- **Firewall:** Blocks unauthorized access to the system from external networks.
- **Antivirus Real-Time Protection:** Continuously monitors and scans files as they are accessed or downloaded.
- **Regular Updates:** Keep antivirus programs and operating systems up to date to protect against the latest threats.
- **Strong Passwords:** Use complex, unique passwords to protect sensitive accounts and files.
- **Email Filters:** Use spam filters to block phishing emails and malicious attachments.

Virus Prevention

Prevention ensures that viruses do not enter or spread within a system. Best practices include:

- **Avoid Suspicious Links and Attachments:** Refrain from clicking unknown links or downloading attachments from unverified sources.
- **Secure USB Devices:** Scan external drives before accessing their files.
- **Install from Trusted Sources:** Only download software from reputable websites or app stores.
- **Disable Macros:** Turn off macros in applications like Microsoft Office unless explicitly needed.
- **Backup Data Regularly:** Store backup's offline or in secure cloud storage to recover data in case of an attack.
- **Educate Users:** Train users to recognize signs of phishing and other cyber threats.

Exercise

Choose the correct answer from the given alternatives.

1. What is the primary goal of defragmenting a hard drive in a computer?

   a. Removing viruses and malware
   b. Organizing and optimizing file storage
   c. Upgrading the operating system
   d. Increasing internet speed

2. Which of the following is not considered the best practice in computer maintenance?

   a. Regularly updating software and operating systems
   b. Backing up important data
   c. Running scheduled antivirus scans
   d. Ignoring software updates to avoid conflicts

3. What is the recommended method for cleaning a computer keyboard?

   a. Using a vacuum cleaner
   b. Disassembling the keyboard for deep cleaning
   c. Compressed air and gentle cleaning with a cloth or brush
   d. Submerging the keyboard in water and letting it air dry

3. In terms of maintenance, what is the significance of backing up data?

   a. It keeps the computer clean
   b. It improves internet speed
   c. It prevents data loss in case of hardware failure or other issues
   d. It helps defragment the hard drive

5. What should be done with old or unused electronic components or devices to ensure environmentally responsible disposal?

   a. Throw them in the regular trash
   b. Recycle them at an e-waste facility
   c. Bury them in the backyard
   d. Donate them to a local school

Write short answer to the following questions.

1. What is the primary purpose of regularly cleaning the internal components of a computer?
2. What is the significance of backing up data In computer maintenance? How frequently should backups be performed?
3. What tools or equipment should you use to prevent electrostatic discharge when working on computer components?
4. How can you safely clean a computer keyboard to maintain its functionality and hygiene?
5. What is the role of thermal paste in computer maintenance, and how often should it be replaced?
6. Name one common best practice for maintaining a printer's functionality and print quality.

Write long answer to the following questions.

1. Describe the importance of regularly cleaning the internal components of a computer.
2. Discuss the specific components that should be cleaned, recommended cleaning tools, and the potential consequences of neglecting this maintenance.
3. What is hard drive defragmentation, and how does it optimize file storage and improve computer performance? Discuss when and how often defragmentation should be performed and common tools or methods for this task.
4. Explore the importance of data backup as a core element of computer maintenance. Describe different backup methods and frequencies, including full and incremental backups, and the role of data recovery in disaster scenarios.
5. Explain the risks of electrostatic discharge when working on computer components and electronic devices.
6. What should be the immediate steps taken if liquid is accidentally spilled on a laptop?

Unit 6 Backup and Recovery

6.1 Introduction to Backup and Recovery

Backup and Recovery refers to the process of creating copies of data and restoring them in case of data loss, corruption, or system failure. It is a critical component of data management and disaster recovery strategies, ensuring business continuity and personal data safety.

Backup

- **Definition:** A backup is a duplicate of important files, applications, or entire systems stored in a secure location for future use.
- **Types:**
  - o **Full Backup:** Copies all selected data every time.
  - o **Incremental Backup:** Saves only changes made since the last backup.
  - o **Differential Backup:** Saves changes made since the last full backup.
- **Storage Options:** Backups can be stored on external drives, network storage, or cloud services.

Recovery

- **Definition:** Recovery is the process of restoring data from a backup after a loss event, such as hardware failure, accidental deletion, or cyberattacks like ransomware.
- **Purpose:** To minimize downtime, restore functionality, and ensure data integrity.
- **Methods:**
  - o **File Recovery:** Restoring individual files or folders.
  - o **System Recovery:** Reinstating an entire operating system or environment.
  - o **Disaster Recovery:** Recovering critical systems and services in large-scale failures.

Importance of Backup and Recovery

- **Protection Against Data Loss:** Safeguards against hardware failures, malware attacks, or accidental deletions.

- **Business Continuity:** Ensures operations can continue without prolonged interruptions.
- **Compliance:** Meets regulatory requirements for data retention and security.
- **Peace of Mind:** Provides confidence that data can be restored when needed.

Advantages of Data Backup

a) **Data Protection:** Prevents data loss due to accidental deletion, hardware failure, or viruses.

b) **Disaster Recovery:** Helps recover important files after natural disasters, cyber-attacks, or system crashes.

c) **Business Continuity:** Keeps businesses running by restoring critical data quickly.

d) **Peace of Mind:** Reduces stress because you know your data is safe.

e) **Version Control:** Some backups allow you to restore earlier versions of a file.

Disadvantages of Data Backup

a) **Cost:** Buying external storage devices or cloud backup services can be expensive.

b) **Time-Consuming:** Backing up large amounts of data may take a long time.

c) **Security Risks:** If not properly protected, backup files can be hacked or misused.

d) **Storage Management:** Backups take up space and may require organization.

e) **Dependence on Backup System:** If the backup system fails, recovery may not be possible.

6.2 Backup Methods, Devices, and Media

Backup Methods

Backup methods define how data is copied and stored:

- **Full Backup:**
  - Copies all selected data regardless of previous backups.
  - **Advantages:** Easy to restore as it contains all data.
  - **Disadvantages:** Time-consuming and requires more storage.
- **Incremental Backup**
  - Backs up only the data that has changed since the last backup.
  - **Advantages:** Faster and requires less storage.

- **Disadvantages:** Restoring may take longer as multiple backups must be combined.

- **Differential Backup**
  - Copies all changes made since the last full backup.
  - **Advantages:** Faster than a full backup and simpler to restore than incremental.
  - **Disadvantages:** Gradually increases in size as more changes are made.
- **Mirror Backup**
  - Creates an exact copy of the source data.
  - **Advantages:** Data is always up-to-date and ready for restoration.
  - **Disadvantages:** Changes or deletions in the original are immediately reflected, so accidental changes can be replicated.

- **Cloud Backup**
  - Stores data on remote servers managed by cloud service providers.
  - **Advantages:** Accessible from anywhere; no physical device required.
  - **Disadvantages:** Requires internet access and may incur recurring costs.

Backup Devices

Backup devices are hardware tools used to store backup data:

- **External Hard Drives**
  - Portable and high storage capacity.
  - Commonly used for personal and small business backups.

- **Network-Attached Storage (NAS)**
  - Centralized storage device connected to a network.
  - Ideal for small to medium businesses.

- **Tape Drives**
  - Use magnetic tape for long-term data storage.
  - Often used for archival purposes in large organizations.

- **USB Flash Drives**
  - Compact and portable.

- Suitable for small data backups but limited in capacity.

- **RAID Systems**
  - A redundant array of independent disks, providing data redundancy and performance improvements.
  - Used in enterprise environments.

Backup Media

Backup media refers to the materials used to store data backups:

- **Hard Disk Drives (HDDs)**
  - Reliable and cost-effective for large data storage.
  - Can be external or internal.

- **Solid-State Drives (SSDs)**
  - Faster than HDDs but more expensive.
  - Ideal for quick backups and recovery.

- **Optical Discs (CDs/DVDs)**
  - Used for small-scale backups.
  - Less popular due to limited storage capacity.

- **Magnetic Tape**
  - Cost-effective for long-term storage.
  - Requires specialized tape drives.

- **Cloud Storage**
  - Off-site, scalable storage managed by third-party providers.
  - Examples: Google Drive, Microsoft OneDrive, Amazon S3.

6.3 Backup Scheduling and Media Rotation Systems

Backup Scheduling

Backup scheduling involves planning when and how often backups should occur to ensure consistent and reliable data protection.

Types of Backup Schedules

1. Daily Backups

- Runs every day, often during non-working hours to minimize disruption.
- Ideal for frequently updated data.

2. **Weekly Backups**
   - Performed once a week, typically for less frequently changing data.
   - Useful for creating long-term restore points.

3. **Incremental/Differential Backups**
   - Scheduled more frequently (e.g., hourly) to capture ongoing changes without the load of a full backup.

4. **Event-Based Backups**
   - Triggered by specific events like major system updates or before/after critical operations.

Best Practices for Backup Scheduling

- Use **automated tools** to minimize manual intervention.
- Schedule backups during off-peak hours to reduce performance impact.
- Combine frequent incremental backups with occasional full backups for efficiency.

Media Rotation Systems

Media rotation systems involve alternating storage media (e.g., tapes, drives) according to a predefined schedule. This strategy ensures data is distributed across multiple backups, enhancing reliability and security.

Popular Media Rotation Strategies

1. **Grandfather-Father-Son (GFS):**
   - **Daily (Son):** Store daily backups.
   - **Weekly (Father):** Store a weekly backup (e.g., every Friday).
   - **Monthly (Grandfather):** Store a backup at the end of the month.
   - Rotating through these ensures a combination of short-term and long-term backups.

2. **Tower of Hanoi**
   - Uses a mathematical rotation pattern where media are reused less frequently over time.

- Provides multiple restore points while optimizing media usage.

3. 3-2-1 Rule

- Keep **3 copies** of data: 1 primary and 2 backups.
- Store on **2 different types of media** (e.g., HDD and cloud).
- Keep **1 copy offsite** for disaster recovery.

Advantages of Media Rotation

- Protects against media failure by distributing backups across multiple storage devices.
- Enhances security by maintaining offsite backups.
- Reduces wear and tear on individual media.

Example: Implementing Backup Scheduling and Media Rotation

1. Schedule

- Daily incremental backups at 2:00 AM.
- Weekly full backups every Sunday at 3:00 AM.
- Monthly backups on the last day of each month at 4:00 AM.

2. Rotation System

- Uses 5 tapes or drives labeled **Monday to Friday** for daily backups.
- Reserves 4 additional tapes for **weekly backups**, rotating weekly.
- Dedicates 12 tapes for **monthly backups**, storing one per month offsite.

6.4 Introduction to RAID

RAID (Redundant Array of Independent Disks) is a technology used to combine multiple hard drives into a single unit to improve performance, data redundancy, or both. It helps manage the storage of data across different disks in a way that can enhance speed, provide backup options, and increase reliability. There are several RAID levels, each offering different trade-offs between speed, data redundancy, and cost.

Overview of Some Common RAID levels

1. RAID 0 (Striping)

- **Purpose:** Improve performance.

- **How it works:** Data is split into chunks and written across multiple drives. This increases read and write speeds, as the system can access multiple disks simultaneously.
- **Downside:** No redundancy. If one drive fails, all data is lost.

2. RAID 1 (Mirroring)

- **Purpose:** Provides data redundancy.
- **How it works:** Data is duplicated (mirrored) across two or more drives. If one drive fails, the other contains an exact copy of the data.
- **Downside:** Storage capacity is halved, as data is mirrored on each disk.

3. RAID 5 (Striping with Parity)

- **Purpose:** Balances between performance, redundancy, and storage efficiency.
- **How it works:** Data is striped across multiple drives, and parity information is distributed across the disks. If one drive fails, the parity information can be used to rebuild the lost data.
- **Downside:** Slight performance penalty due to the parity calculations, and it requires at least 3 disks.

4. RAID 10 (1+0)

- **Purpose:** Combines the benefits of RAID 1 and RAID 0.
- **How it works:** It mirrors data (like RAID 1) and stripes it (like RAID 0). This provides both redundancy and better performance.
- **Downside:** It requires at least 4 disks and sacrifices storage space, as each disk is mirrored.

5. RAID 6 (Striping with Double Parity)

- **Purpose:** Offers greater redundancy than RAID 5.
- **How it works:** Like RAID 5, but with two parity blocks instead of one. This allows for the failure of up to two disks without data loss.
- **Downside:** More storage space is used for parity, and the performance is lower compared to RAID 5.

6. RAID 50 (RAID 5+0)

- **Purpose:** Combines the features of RAID 5 and RAID 0.

- **How it works:** It combines striping (RAID 0) and parity (RAID 5) across multiple groups of disks, providing a balance of speed and redundancy.
- **Downside:** Requires at least 6 disks and is more complex to set up.

6.5 Recovery Techniques

Recovery techniques are essential strategies used to restore data, applications, or systems after a failure, corruption, or disaster. These techniques vary based on the cause and nature of the problem, such as hardware failure, software corruption, or data loss, and can apply to personal computers, servers, or cloud environments. A combination of different methods ensures the best possible outcome in restoring operations and mitigating data loss.

Data Backup and Restoration is one of the fundamental recovery techniques. This approach involves regularly creating copies of important data and storing them in secure locations, either locally or in the cloud. When data is lost or corrupted, it can be restored from the backup. Different types of backups—full, incremental, or differential—allow users to recover specific points in time. Having multiple copies of data in various locations (on-site and off-site) ensures protection against disasters like hardware failure or ransom ware attacks.

RAID Recovery is another critical technique, especially for systems using Redundant Array of Independent Disks (RAID). RAID provides redundancy, allowing data to be rebuilt when a disk fails. Depending on the RAID level, such as RAID 1 (mirroring) or RAID 5 (striping with parity), recovery methods vary. In a RAID 1 system, if one disk fails, the data can be mirrored from the second disk. In RAID 5, the data can be reconstructed using the parity information stored across the remaining disks. RAID recovery is essential for businesses that need high uptime and data availability.

File System Repair helps address issues caused by corruption or errors in a file system. Operating systems can experience corruption due to improper shutdowns, disk errors, or software issues, leading to the inability to access data. File system repair tools, like chkdsk for Windows or fsck for Linux, scan and fix file system errors. This technique restores the file system's integrity, making it possible to access files again without losing data.

Data Recovery Software is commonly used to recover files that have been accidentally deleted or lost due to corruption. These programs work by scanning

storage devices for traces of deleted data that have not yet been overwritten. Even when files are deleted from a system, recovery software can sometimes retrieve them from unallocated disk space. Popular tools for data recovery include Recuva, Disk Drill, and EaseUS, which help recover files from damaged or corrupted storage media.

Cloud-based recovery leverages cloud storage solutions to restore lost data. Many cloud platforms, such as Google Drive or AWS, have built-in versioning and retention features that allow users to retrieve previous versions of files or restore deleted data. This method is especially beneficial for users who rely heavily on cloud services for data storage, providing an easy way to recover files without needing physical access to storage devices.

Virtual Machine Recovery is crucial in virtualized environments, where entire systems run as virtual machines (VMs). Virtual machines are often backed up or snapshotted to ensure quick recovery in case of system failure. If a VM becomes corrupted or deleted, recovery can be as simple as restoring it from a backup or snapshot. This approach is widely used in enterprise environments where virtualized infrastructures are common.

Disaster Recovery Planning (DRP) is an overarching strategy to handle large-scale disruptions, such as natural disasters, cyber-attacks, or system-wide failures. A well-designed disaster recovery plan includes procedures for restoring systems and data quickly to minimize downtime. DRP often involves offsite backups, cloud storage, and predefined recovery procedures that are regularly tested to ensure effectiveness. It also includes clear roles and responsibilities for staff to ensure swift and efficient recovery.

Physical Disk Recovery is employed when a storage device, such as a hard drive or solid-state drive, experiences physical damage. In these cases, traditional data recovery methods may not work, and specialized techniques are required. Professional data recovery services have clean room environments and advanced tools to recover data directly from damaged disks by replacing failed components or extracting data from the disk's media. This technique is typically used when data is critical and other recovery methods have failed.

Logical Recovery involves the recovery of data from logical errors, such as partition corruption, accidental file deletion, or file system damage. In such cases, the data

itself is not physically damaged, but the structure that allows access to it has been compromised. Tools like TestDisk or PhotoRec scan for lost partitions or missing data structures and attempt to recover the data by reconstructing the file system or partition table.

Finally, **Data Duplication Recovery** is an important technique used to recover data from systems where duplication is employed. Duplication reduces storage needs by eliminating duplicate copies of data, and recovery involves reconstructing the original data from duplicated stores. This technique is often used in enterprise backup solutions, allowing for efficient data storage while ensuring that recovery is still possible when needed.

Exercise

Choose the correct answer from the given alternatives.

1. Which backup method involves copying all selected files and folders every time a backup is performed, regardless of whether they have changed since the previous backup?

   a. Full backup
   b. Incremental backup
   c. Differential backup
   d. Selective backup

2. What is the role of a backup retention policy in data management?

   a. Determining which files are most important
   b. Deciding when and how often backups are performed
   c. Managing the length of time backup data is stored
   d. Reducing the size of backup files

3. When discussing data recovery methods, what does “bare-metal recovery” typically involve?

   a. Recovering only certain files or folders
   b. Reinstalling the operating system and applications
   c. Recovering data from cloud-based storage
   d. Performing data recovery on a metal surface

4. Which of the following is an example of an off-site backup location?

   a. An external hard drive connected to the same computer
   b. A network-attached storage (NAS) device in the same building
   c. A cloud storage service
   d. Another folder on the same hard drive

5. Why is it important to periodically test your backups in a disaster recovery plan?

   a. To identify which files need to be backed up
   b. To ensure that backup software is up to date
   c. To verify that backups are complete and can be successfully restored
   d. To determine the backup schedule

6. Which of the following is a key benefit of cloud-based backup solutions?

   a. Faster backup speed

   b. Physical control over the backup server

   c. Scalability and remote accessibility

   d. Lower cost compared to local backups

Write short answer to the following questions.

1. What is the primary purpose of a backup in data management?
2. Differentiate between a full backup and an incremental backup.
3. Why is it important to establish a backup retention policy?
4. Why is it crucial to periodically test backups in a disaster recovery plan?
5. Define “disaster recovery” in the context of data management.
6. What are the key benefits of using cloud-based backup solutions?

Write long answer to the following questions.

1. Describe the importance of regular backups, different backup types (full, incremental, differential), and the role of a backup retention policy.
2. Discuss various methods for data recovery, including file-level recovery, point-in-time recovery, and bare-metal recovery. Provide examples of scenarios where each method is most suitable.
3. Describe the backup and recovery strategies commonly employed by businesses. Discuss the use of on-site and off-site backups, as well as cloud-based solutions.
4. Explain the steps involved in conducting backup tests and the significance of verifying the integrity of backup data.
5. Discuss how these tools simplify the backup process and manage backup schedules.

Project Work

1. Establish a backup schedule that suits your needs. Consider daily, weekly, or custom backup frequencies for different data types.
2. Explore various backup tools and software solutions to become familiar with their features and user interfaces.
3. Regularly test your backup and restore procedures to confirm that data can be

recovered successfully. Create a simulated data loss scenario and recover the data.

4. Develop a data restoration plan that includes step-by-step procedures for recovering data and systems. Share this plan with relevant team members.

5. Experiment with different data recovery software to retrieve files that have been permanently deleted or lost due to various reasons.