Unit 1

Introduction to Systems

Short Introduction of Systems:

Systems constantly interact with their environment through inputs and outputs. For example, a weather monitoring system receives data from environment sensors and provides the current status of the weather and future forecasts to users. In a computing system, computers interact and communicate with peripheral devices like printers and scanners, and in a biological system animals interact with plants and other animals, forming a food chain.

Q.1 Define and describe the concept of a system. Explain the fundamental components, objectives, environment, and methods of communication within a system. OR
Discuss basic concept of a system in details.

Ans. Basic Concepts of Systems

A system is described by its objectives components, communication among components and environment in which it works. The components of a system communicate with each other to achieve the system's objective in an environment. Systems can be simple, like a thermostat, or complex, like the human body or a computer network.

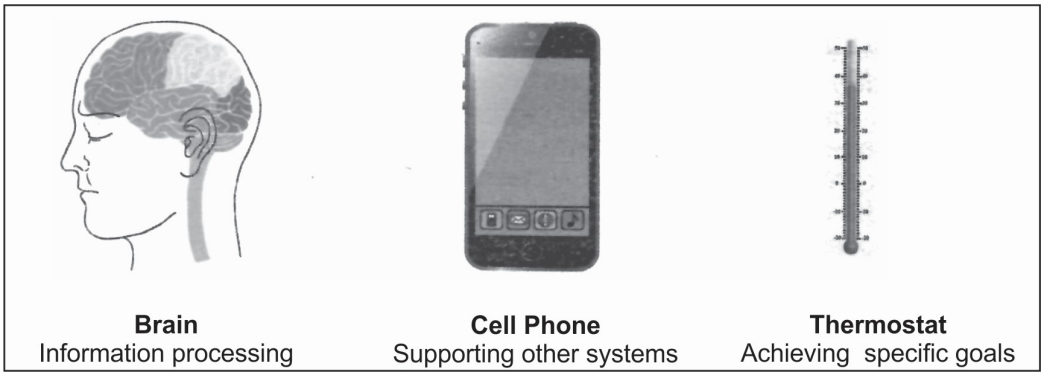
Objective

Every system has a purpose or goal that it wishes to fulfil. Analyzing a system's operation requires understanding its aim. This insight improves the efficiency and efficacy of the present system. A transport system aims to transfer people and products securely and effectively between locations. A computer system's principal goal is to process data and provide useful information to users.

Types of System Objectives

Systems can have different objectives depending on their nature and purpose. Common objectives include:

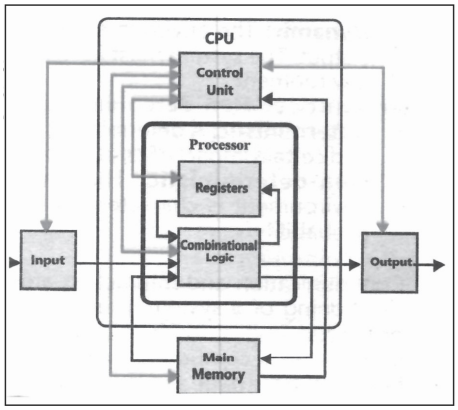
1. **Information Processing:** Collecting, storing, processing, and distributing information, for example.
   - A computer system processes user data to produce meaningful outputs.
   - The human brain processes information received by the human senses to perceive the environment.
2. **Supporting Other System:** Providing a platform or infrastructure for other systems to work, for example:
   - A cell phone provides a platform to run different applications.
   - The sun provides energy to all species on Earth to live.
3. **Achieving specific goals:** Completing tasks or processes, for example:
   - A thermostat system maintains a set temperature in an environment.
   - A car engine system aims to convert fuel into mechanical energy efficiently.



Components

Components are the building blocks of any system. Each component plays a specific role and contributes to the overall functionality of the system. Understanding the role of each component of the system is

essential to understand how the entire system works. This helps in identifying problems, improving performance, and refining system design. Smooth and proper working of these components together ensures the system meets its objectives.



Environment

The environment of a system includes everything external to the system that interacts with it. It consists of all external factors that affect the system's operation. Understanding the env ironment of a system is important as it influences the system's performance and behavior by providing inputs and receiving outputs. Intelligent systems adjust to changes in their environment to continue their functionality. There are several properties of a system's environment that affect system design and its functionality. Two of these properties are described as follows:

Static vs. Dynamic

- **Static:** The environment remains unchanged unless the system provides an output. There are no changes occurring in the environment while the system is working internally.
- **Dynamic:** The environment can change independently of the system's output. The system must account for changes that occur over time in the environment.

Deterministic vs. Non-deterministic

- Deterministic: A deterministic system is characterized by its fully known and certain impact of its output on the environment.
- Non-deterministic: The impact of the system's output on the environment is characterized by inherent uncertainty, randomness, or probability.

Communication

Communication and interaction among system components is key to the functioning of a system. It ensures that components work together in an organized and smooth manner to achieve the system's objectives. For example, in a computing system the CPU communicates with memory to fetch and store data, and in a biological system brain sends signals to muscles to initiate movement.

Q.2 Define and Describe the concept of Natural System with its types.

Ans. Systems can be broadly categorized into two types, namely natural and artificial systems. Understanding the differences and similarities between these types helps us apply system theory across various fields. Natural systems are naturally built and occur in nature without human intervention. While artificial systems are created by humans to fulfill specific needs or purposes.

Natural Systems

Natural systems are those that exist in nature and operate independently of human involvement. They are governed by natural laws and process.

Physical Systems

Physical systems are composed of physical components and governed by the laws of physics. They include things ranging from sub atomic particles, atoms, planets, stars, galaxies and customs. Physical systems, like any kind of matter, emerge from the interactions of electrons, protons, neutrons and sub-atomic particles which are governed by electric and atomic forces.

Chemical Systems

Chemical systems involve substances and their interactions, transformations, and reactions. They are governed by the laws of chemistry. Chemical systems, according to chemical principles, forming new substances. For example, a chemical system like water (H2O) is formed when hydrogen atoms bond with oxygen atoms, following chemical rules and reactions.

Biological Systems

Biological systems consist of living organisms and their interactions. They are governed by biological processes such as growth, reproduction, and metabolism. Biological systems emerge from chemical systems when molecules interact in complex ways to form living cells, which then organize into tissues, organs, and organisms.

Psychological systems

Psychological systems involve the mind and behavior. They include thoughts, emotions, and mental processes, governed by the principles of Psychology. Psychological systems emerge from biological systems when the brain's physical and chemical processes give rise to thoughts, emotions, and behaviors which are influenced by an individual's experiences and environment.

Q 3: Describe the concept of Artificial Systems in details.

Ans. Artificial systems are created and developed by people so that they may fulfill certain functions or address certain issues. These systems can be as small as a wheel or as large as the United Nations. Each system is designed very deliberately to perform the task, improve the efficiency of the processes, and provide solutions to various issues in different sectors.

> **Do You Know?**
> *The Metro Train System in Lahore is an artificial system created for efficient transportation. The railway system consists of tracks, trains, stations, and control systems that transport people between locations.*

Artificial systems are a vital part of the contemporary society because they reinforce productivity, solve complex problems, and improve people's well being. There are different types of artificial systems, some of which are described below:

Knowledge Systems

A knowledge system is unique because it is developed to capture, process, facilitate, store, retrieve and manage information. Such systems facilitate in managing and utilizing the resources of knowledge effectively for the purpose of decision-making, learning and problem-solving.

1. **Mathematics:** Mathematics is field of knowledge which is studied to focus problems connected to numbers, their amounts, forms, structures and patterns.
2. **Logic:** Logic is a theoretical model consisting of concepts and strategies on identifying and assessing rationale. That is why it is based on all logical thinking processes and practice of critical analysis.
3. **Databases:** A database system can best be described as software for managing data, particularly to enable easy retrieval, management, and updating of data. Some of the examples are relational database management system like MySQL while others are NoSQL database management system like MongoDB.
4. **Information Management Systems:** These are specific applications developed with the purpose of capturing archiving, organizing and disseminating data.

Q.4 What do you know about Engineering & Social Systems? Discuss in details.

Ans. Engineering Systems

Products developed by engineers are complex frameworks or devices that apply engineering concepts to perform certain tasks or solve technical challenges. These are some examples of how engineers of various types develop systems according to their own special knowledge and perspective, given to them through their original visions and approaches.

1. **Civil Engineering Systems:** Concentration on developments such as constructing houses, roads, bridges and even maintaining these structures. For instance, a structure used to provide a passage over water, valleys or roads is termed a bridge.
2. **Mechanical Engineering Systems:** Engage in planning and creating devices that make a utilization of forces from outside to accomplish work. For instance, a robotic arm applied in assembly line for packaging of products in factories.
3. **Chemical Engineering Systems:** Focuses on converting raw materials into useful products through chemical processes, considering internal molecular interactions. For example, a water treatment plant that purifies water using chemical processes like coagulation and filtration.
4. **Electrical Engineering Systems:** Involves the study and application of electricity, electronics and electromagnetism to develop electrical systems. For example a home automation system that controls lighting, heating and security using a smartphone app. This system uses electric signals and power to operate various home appliances and systems remotely.

5. **Software Engineering Systems:** Is the process of designing, developing and maintaining software to perform certain tasks eradicating errors. For instance, an online tool assisting a library in tracking books, users as well as stock in their procession.

Social System

Social systems refer to structured frameworks established by individuals to effectively handle social interactions, organizational governance, and communal endeavors. The basic goal of these systems is to maintain in order, provide services and facilitate social connections.

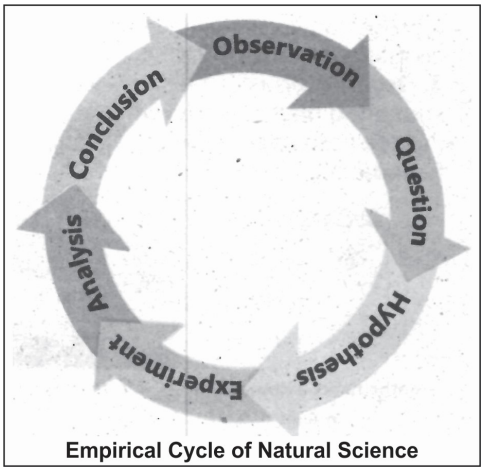
1. **Academic institutions:** are entities that provide educational services to students. Schools, colleges and universities are examples of educational institutions that provide instruction via the use of administrative, teaching, and support staff.
2. **Governments:** Organizational institutions that wield authority and control over a community or country. Examples include democratic systems, where representatives are elected and authoritarian regimes, where power is centralized.
3. **Organizations:** are entities formed to achieve specific goals and are often structured hierarchically with well-defined roles and responsibilities. Examples include corporations like Apple and non-profit organizations such as the Edhi Foundation.

Q.5 Examine the relationship between systems and different branches of science, including natural science, design science, and computer science. How do these branches utilize system theory to understand and improve their software systems, computer networks, and the internet?

OR

What do you know mean by System and Science? Briefly discuss.

Ans. Knowledge is our understanding of various systems in the universe around and within us. Science is a systematic way to validate this understanding. Science can be divided into two main types: natural science and design science. Both natural and design sciences study systems, but they approach them differently. In natural science, scientist study existing natural systems to understand their workings.



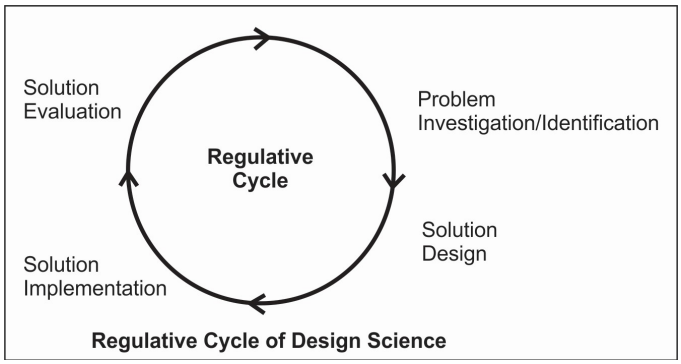
Empirical Cycle of Natural Science

Natural science is meant to uncover the objectivity and functionality of natural systems in the natural world. Its nature is descriptive, meaning that the scientists seeks to understand and describe natural phenomena.

- **Design Science** is focused on designing and creating artifact (tools, systems, methods) to achieve specific goals. The nature of design science is prescriptive, meaning that it aims to prescribe and create artificial systems. To achieve this design science researchers follow the regulative cycle.

Examples

- **Natural Science:** Studying the ecosystem of a forest to understand how different species interact (descriptive).
- **Design Science:** Developing a new software system to manage forest data and improve conservation efforts.



Regulative Cycle of Design Science

Computer Science

Computer science is the study of how computers work, including at what they can do and their limitations. To understand computer science, we use methods of both design science and natural science.

Natural science of computer science

Natural science of computer science focuses on finding the basic rules that control how computer systems work. This involve the study of various algorithms and their characteristics.

- **Study of Algorithms**

  Researchers analyze existing an algorithm to understand their efficiency and limitations. For example, studying different sorting algorithms and their characteristics which arrange given data in an order.

Design Science of Computer Science

- **Development of new software tools**

  Researchers create new tools or applications to solve specific problems. For example: Designing a new programming language that makes it easier for developers to write secure computer programs.

Improvement of computer system

Researcher work on enhancing existing systems to perform better. For example, creating a more efficient database management system that can handle larger amounts of data faster and with fewer errors.

Q.6 Explain Computer System with its Objectives and Components in details. OR Describe the main characteristics of a computer as a system, including its objectives, components and interactions among these components.

Ans. A computer is a complex system designed to process data and perform tasks according to a set of instructions.

Objectives

The main objective of a computer is to perform computations, process data, and execute different tasks efficiently. For example, a personal computer's objective is to run software applications such as word processors, web browsers and games through various computational processes.

Components

A computer is composed of many essential components that operate in conjunction. These component include:

Interface Components:

Interface components refer to the fundamental parts of a computer system, including input devices such as the keyboard and mouse, which allow users to interact with the computer.

Computer output devices, such as monitors and printers, are used to presents or generate results from the computer's operations.

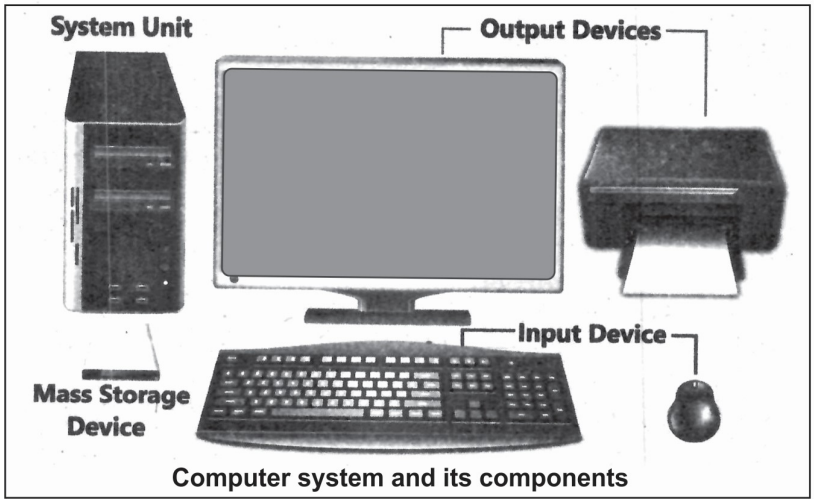
Processing Components

- The processing components of a computer consist of the CPU, which acts as the Central processing Unit responsible for computations and executing command.
- Random Access Memory (RAM) is a transient storage that stores data and instructions for the CPU, whereas Storage (Hard Drive or SSD) is a permanent storage for data and software needed for future processing.
- The operating system is responsible for receiving information from interface components and determining the appropriate actions to take.
- Application software refers to programs that are executed by the operating system when required to perform one or more specified tasks.

Communication Components

Communication components in a computer refer to the physical elements that provide communication between different components of the computer.

- In a computer, the motherboard serves as the primary circuit board that interconnects all components by using cables and circuits.
- A system bus is a collection of electrically conductive cables that transmit data between the CPU and all other interconnected components. There are three distinct types of buses: data bus, address bus, and control bus.



Computer system and its components

Q.7 Provide a detailed explanation of how a computer interacts with its environment. Include examples of user input, network communication, and power supply.

Ans. The components of a computer interact with each other to perform tasks. For example, when you open a file using your mouse or keyboard, several components of your computer interact seamlessly to make this action happen. Here's a step-by-sep explanation of the process.

1. User Action or input. You double-click on a file icon using your mouse or press a key combination to open a file. For example, you double-click on a document named "report.docx" on your desktop.
2. Input Device. The mouse or keyboard sends a signal to the computer indicating that you want to open the file. For example, the mouse sends sensory input to the computer's operating system through the USB connection.

Environment

The computer system environment includes any external devices that interact with the computer. For example.

- **Power Supply:** Provides electrical power to allow the computer to work.
- **Network:** Connects the computer to other systems and the internet.
- **Peripherals:** Include printers, scanners and external discs that expand the computer's capabilities.

Interaction with the environment

User Input: A user types on the keyboard and the computer processes the input to display text on the screen.

Network Communication: The computer sends and receives data over the internet to browse websites or download files.

Power Supply: The computer relies on a stable power supply to function correctly.

Q.8 Explain the Von Neumann architecture of a computer. Include a discussion on the main components, their functions, and the step-by-step process of how the architecture operates.

Ans. The Von Neumann architecture is a computer paradigm that delineates a system in which the hardware of the computer has four primary components: the memory, the Central Processing Unit (CPU), input mechanisms, and output mechanisms. This model is called the John von Neumann model, the Neumann model named in honor of the mathematician and physicist who contributed to its development during the 1940s.

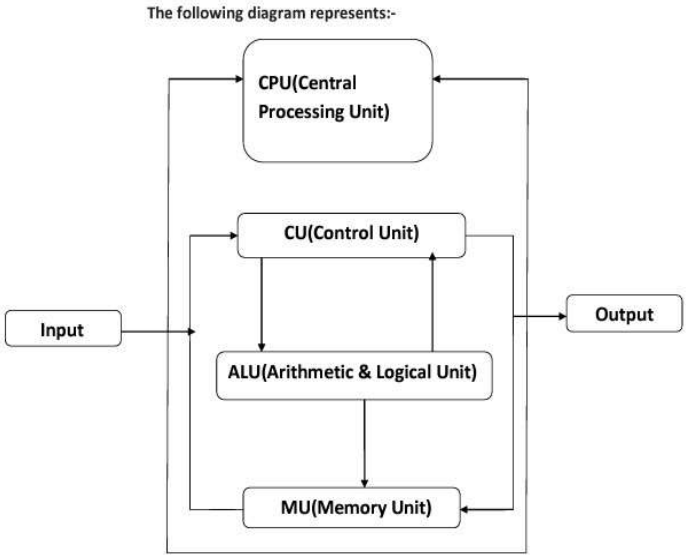
Components

Now we will look at brief overview of the key parts that constitute the architecture of the von Neumann computer.

Memory

Contain both input data and the instructions (program) required for CPU processing. For instance, consider the RAM of your computer: when a program starts it is loaded into RAM to enable faster execution compared to when it runs from the hard disk.

Central Processing Unit (CPU) Performs addition and subtraction and executes commands provided by the memory. The system has two main components: The Arithmetic Logic Unit (ALU) performs mathematical computations and logical operations.



A Control Unit (CU) is a peripheral that governs the activities of the CPU by instructing the ALU and memory to execute tasks according to the program instruction. It ensures the proper and timely execution of duties by all the other components.

When doing the calculation 2 + 2 on a calculator application, the Arithmetic Logic Unit (ALU) handles the numerical values while the Control Unit (CU) supervises the whole procedure.

Input devices:

Enable users to input data and instructions into the computer system.

Illustrative examples include keyboard, mouse, and microphone. Entering text on the keyboard transmits data to the CPU for subsequent processing.

Output devices:

Present or communicate the outcomes of the tasks executed by the computer. Consider, for instance, a monitor and printer, upon completion of data processing, the CPU transmits the outcomes to the monitor for visual display.

A system bus is a communication mechanism that facilitates the movement of data between components inside a computational system. It comprises:

Data Bus: Transports data.

Address Bus: Maintains data destination information.

Control Bus: Transports control electrical signals.

Q.9 Explain the Working of Von Neumann Architecture.

Ans. The Von Neumann architecture encompasses three essential stages for a CPU to carry out instructions, namely retrieval, interpretations, execution, and storage to demonstrate this procedure, we will use the example two-digit addition with basic calculator application.

Fetching

Description: The central processing unit retrieves an instruction from the computer's memory. This instruction specifies the operation to be executed by the CPU.

Hardware Components: Memory, CPU (Program Counter (PC), Instruction Register (IR)

Specification: The Program Counter (PC) stores the memory address of the subsequent instruction. Once the address is stored in memory, the instruction located at that location is retrieved and placed into the instruction Register (IR).

Do You Know?

John von Neumann (1903–1957) was a Hungarian-American Mathematician, Physicist, Computer Scientist, and Polymath.

Decoding

In order to determine the necessary action, the Control Unit (CU) decodes the instruction.

Comprising components: Control Unit (CU).

Detail: The **Control Unit (CU)** decodes the opcode (operation code) of the instruction and determines the required procedures and data.

Execution

Description: The CPU processes the instruction. When the instruction involves a computation, it is

Involved Components: ALU, CU.
Detail: The Arithmetic and Logic Unit (ALU) carries out mathematical and logical calculations, while he Control Unit (CU) handles data transmission activities.
Storing:
Description: The outcome of the computation is either returned to memory or sent to an output device.
Involved Components: Memory and output Device.
Specification: The outcome is either stored in a designated memory location or sent to an output device, such as a display.

Q.10 Explore the Characteristics of Von-Neumann Architecture with its merits and demerits.

Characteristics.

Ans. Following are the key characteristics of the Von Neumann computer architecture:

1. **Single Memory Store:** Both program instructions and data are stored in the same memory space. For example, in a computer game, both the game's code and the data (like scores and player position) are Stord in the same RAM.
2. **Sequential Execution:**
   Instructions are processed one after another in a sequence. For example, when your computer runs a program, it follows the steps one by one in the order they are written.
3. **Stored Program Concept:** Programs are stored in memory and can be changed by the computer. For example, when you update a software program, the new instruction replaces the old one in memory.

Advantages and Disadvantages:

The advantages and disadvantages of Von Neumann computer architecture are discussed here.

Advantages:

- **Simplified Design:** By combining instructions and data into a single memory area, architecture is simplified.
- **Flexibility:** Programs can be easily changed by changing memory contents.

Disadvantages:

- **The Von Neumann bottleneck** occurs when a single memory area limits the CPU's ability to retrieve instructions and data quickly.
- **Security Risks:** Having data and instructions stored in the same area poses a problem where one program can alter another's instructions in a manner that is security risk. The Von Neumann architecture is key important aspect of the design and structure of many computers, serving as a central model on how they operate. It is like a recipe fed into the computer, which follows it exactly ensuring that both data and instructions are properly processed However, this model has been essential in the evolution of computing technology, despite its limitation.

Q.11 Explain Hardware and Software with different type of Computing Systems, Also explains Networking Systems.

Ans. A computer system is a structured set of hardware and software components specifically designed for data processing and the performance of various operations. These systems can range from simple technological tools, such as calculators used for performing mathematical calculations to complex network of linked computers.

- **Hardware** of a computer system refers to the tangible components of the system. These include the Central Processing Unit (CPU), Random Access Memory (RAM), storage devices, and input and output devices.
- **Software** refers to a collection of instructions that dictate the requirements and actions that hardware must do. There exist two primary categories. System software and application software. **System Software** encompasses the Operating System (OS) and utility applications responsible for managing the computer's resources such as Windows, macOS, and Linux distributions. **Application software** refers to software applications that are specifically developed to carry out certain functions for the user, such as word processors web browsers, and games.

- **Electricity:** Electricity is the power source that enables the hardware components to function. Without electricity the hardware components cannot function and the computing system will not operate.

Types of computing Systems:

Computing systems come in various types some of these include the followings

- **Computer**
- **Software Systems**
- **Computer Networks**
- **Internet**

Computer Network Systems:

A computer network system connects multiple computers and devices, enabling the efficient exchange of resources and information.

Objectives:

- **Resource Sharing:** Allow multiple users to share resources like files, printers. and internet access within an office or other settings.
- **Communication:** Enable efficient communication between devices and users.
- **Data Management** Facilitate easy data management and collaboration.

Components

Networking Hardware

Routers: Routers are devices that transmit data packets between their networks

Switches connect devices in a network and facilitate communication.

Network Cables: A physical medium for data transfer.

Network Software

Protocols: Rules and conventions for data exchange such as **TCP/IP.**

Network Operating Systems: Software that manages network resources, such as Windows Server

Q.12 What do you know about Internet? Explain with Protocols.

Ans. The internet is a vast and complex system designed to connect multiple networks worldwide, include private public, academic, business, and government networks. Its primary objective is to facilitate communication and data exchange between computers and users globally

Internet Protocols

- **TCP/IP (Transmission Control Protocol/ Internet Protocol):** The core protocols that govern data transmission over the internet.
- **User Datagram Protocol (UDP):** Faster but less reliable.
- **File Transfer Protocol (FTP):** Used for Transforming files between computers.
- **Post Office Protocol (POP):** Used for retrieving emails from server/network.

Interaction among Components:

The components of the internet interact with each other to perform different tasks. For example, when a user requests a web page through a web browser, several components of the internet work together to display its contents on the user's screen.

Environment:

The internet operates in a diverse and dynamic environment, connecting various types of networks across different locations including homes, offices, data centers, and mobile networks. This environment influences the design security, and performance of the internet.

Topic wise Short Questions (Additional)

Natural & Artificial Systems

Q.1 Define Natural System.

Ans. Natural systems are those that exist in nature and operate independently of human involvement. They are governed by natural laws and process.

Q.2 Mention some examples of Natural System.

Ans. Following are the examples of some natural systems that exists in nature.

- **Physical systems**
- **Chemical systems**
- **Biological systems**
- **Psychological systems**

Q.3 Differentiate between Physical and Chemical Systems.

Ans. Physical systems are composed of physical components and governed by the laws of physics. They include things ranging from sub atomic particles, atoms, planets, stars, galaxies and customs. **Chemical systems** involve substances and their interactions, transformations, and reactions. They are governed by the laws of chemistry.

Q.4 What are the Biological Systems?

Ans. Biological systems consist of living organisms and their interactions. They are governed by biological processes such as growth, reproduction, and metabolism.

Q.5 What do you know about Psychological Systems?

Ans. Psychological systems involve the mind and behavior. They include thoughts, emotions, and mental processes, governed by the principles of Psychology.

Q.6 What are the Artificial Systems?

Ans. Artificial systems are created and developed by people so that they may fulfill certain functions or address certain issues. These systems can be as small as a wheel or as large as the United Nations. Each system is designed very deliberately to perform the task, improve the efficiency of the processes, and provide solutions to various issues in different sectors.

Q.7 Mention some important types of Artificial Systems.

Ans. There are different types artificial systems, some of which are described below:

- **Knowledge Systems**
- **Engineering Systems**
- **Social systems**

Q.8 How Artificial System works?

Ans. Artificial systems are a vital part of the contemporary society because they reinforce productivity, solve complex problems, and improve people's well-being.

Q.9 Define Knowledge System.

Ans. A knowledge system is unique because it is developed to capture, process, facilitate, store, retrieve and manage information. Such systems facilitate in managing and utilizing the resources of knowledge effectively for the purpose of decision-making, learning and problem-solving.

Q.10 Describe the role of Mathematics in Knowledge System.

Ans. Mathematics is field of knowledge which is studied to focus problems connected to numbers, their amounts, forms, structures and patterns.

Q.11 What is Information Management Systems (IMS)?

Ans. These are specific applications developed with the purpose of capturing archiving, organizing and disseminating data.

Q.12 How Engineering System works?

Ans. Products developed by engineers are complex frameworks or devices that apply engineering concepts to perform certain tasks or solve technical challenges.

Q.13 Give some examples of Engineering Systems.

Ans. These are some examples of how engineers of various types develop systems according to their own special knowledge and perspective:

- **Civil Engineering Systems:**
- **Mechanical Engineering Systems:**
- **Chemical Engineering Systems:**
- **Electrical Engineering Systems:**
- **Software Engineering Systems**

Q.14 What do you know about Software Engineering Systems?

Ans. It is the process of designing, developing and maintaining software to perform certain tasks eradicating errors. For instance, an online

Do You Know?

The origin of the Internet dates back to the 1960s as a project funded by the U.S. Department of Defense.

tool assisting a library in tracking books, users as well as stock in their procession.

Q.15 What are the Social Systems?

Ans. Social systems refer to structured frameworks established by individuals to effectively handle social interactions, organizational governance, and communal endeavors. The basic goal of these systems is to maintain in order, provide services and facilitate social connections.

Q.16 Write some examples of Social Systems?

Ans. Here are few examples of social systems:

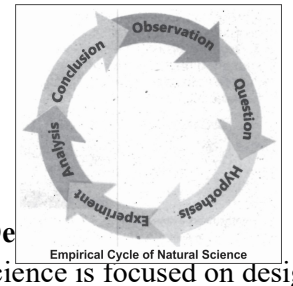
- **Academic institutions**
- **Governments**
- **Organizations**

Q.17 How would you relate System with Science?

Ans. Knowledge is our understanding of various systems in the universe around and within us. Science is a systematic way to validate this understanding. Science can be divided into two main types: natural science and design science. Both natural and design sciences study systems, but they approach them differently. In natural science, scientist study existing natural systems to understand their workings.

Q.18 Draw the empirical cycle of natural science.

Ans.



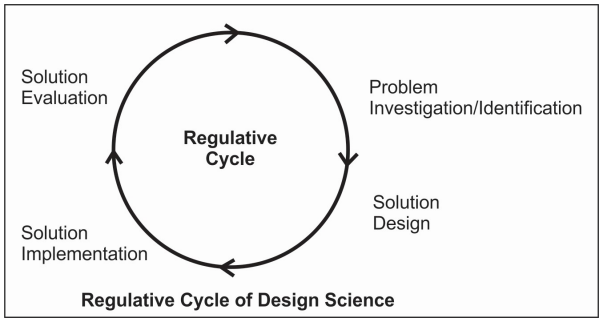
Empirical Cycle of Natural Science

Q.19 What is De

Ans. Design Science is focused on designing and creating artifact (tools, systems, methods) to achieve specific goals. The nature of design science is prescriptive, meaning that it aims to prescribe and create artificial systems. To achieve this design science researchers follow the regulative cycle.

Q.20 Draw Regulative Cycle of Design Science.

Ans.



Regulative Cycle of Design Science

Q.21 What is the study of Algorithms?

Ans. Researchers analyze existing an algorithm to understand their efficiency and limitations. For example, studying different sorting algorithms and their characteristics which arrange given data in an order.

Q.22 What is the main objective of computer?

Ans. The main objective of a computer is to perform computations, process data, and execute different tasks efficiently. For example, a personal computer's objective is to run software applications such as word processors, web browsers and games through various computational processes.

Q.23 What are the three main external devices that interact with computer?

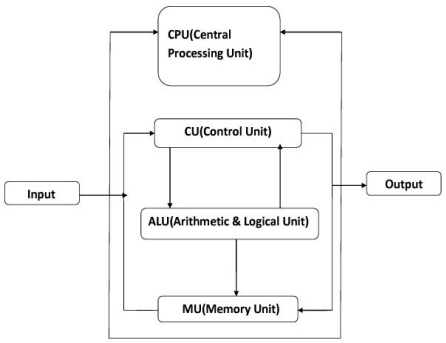
Ans. For example.

- **Power Supply:** Provides electrical power to allow the computer to work.
- **Network:** Connects the computer to other systems and the internet.
- **Peripherals:** Include printers, scanners and external discs that expand the computer's capabilities.

Von Neuman Architecture & Internet Protocols

Q.24 Draw Von Neumann Architecture.

Ans.



Q.25 What are the components of Von Neumann Architecture?

Ans. Now we will look at brief overview of the key parts that constitute the architecture of the von Neumann computer.

- **Memory**
- **Central Processing Unit (CPU)**
- **Input devices**
- **Output devices**

Q.26 What are the main types of Buses?

Ans. There are three main types of buses available:

Data Bus: Transports data.

Address Bus: Maintains data destination information.

Control Bus: Transports and control electrical signals.

Q.27 Make list of working components of Von Neumann Architecture.

Ans. Following are the list of working components:

- **Fetching:**
- **Decoding:**
- **Execution:**
- **Storing:**

Q.28 Differentiate between Hardware and Software.

Ans. Hardware of a computer system refers to the tangible components of the system. These include the Central Processing Unit (CPU), Random Access Memory (RAM), storage devices, and input and output devices.

Software refers to a collection of instructions that dictate the requirements and actions that hardware must do. The two primary categories are: **System software and application software.**

Q.29 What are the Internet Protocols?

Ans. TCP/IP (Transmission Control Protocol/ Internet Protocol): The core protocols that govern data transmission over the internet.

User Datagram Protocol (UDP): Faster but less reliable.

File Transfer Protocol (FTP): Used for Transforming files between computers.

Post Office Protocol (POP): Used for retrieving emails from server/network.

Multiple Choice Questions (Additional)

Natural and Artificial Science

Choose the correct option.

1. Which of the following is an example of a natural system?
   (a) Banking system
   (b) Human circulatory system
   (c) Transportation
   (d) Computer system
2. What is the key difference between natural and artificial systems?
   (a) Natural systems are created by humans, while artificial systems exist naturally
   (b) Natural systems exist naturally, while artificial systems are man-made
   (c) Natural systems are always simple, while artificial systems are complex
   (d) Natural systems require programming, while artificial systems do not
3. Which of the following is NOT an example of an artificial system?
   (a) Solar system
   (b) Traffic control system
   (c) Automated billing system
   (d) Railway reservation system
4. Which of the following best describes an artificial system?
   (a) A system that exists naturally without human intervention

(b) A system that is created, designed, and controlled by humans
(c) A system that cannot be modified once created
(d) A system that always operates automatically

5. Which of the following is an example of a hybrid system (combination of natural and artificial systems)?
(a) Human respiratory system
(b) A weather forecasting system
(c) A dam controlling river water flow
(d) A simple pendulum

Computer System

6. Which of the following is the "brain" of a computer system?
(a) Hard Disk Drive (HDD)
(b) Central Processing Unit (CPU)
(c) Random Access Memory (RAM)
(d) Power Supply Unit (PSU)
7. Which component of the computer system is responsible for temporarily storing data and instructions while the CPU processes them?
(a) RAM (Random Access Memory)
(b) ROM (Read-Only Memory)
(c) Hard Disk Drive (HDD)
(d) Graphics Processing Unit (GPU)
8. Which of the following is an input device?
(a) Monitor
(b) Printer
(c) Keyboard
(d) Speaker
9. Which of the following is a storage device used to permanently store data in a computer?
(a) Random Access Memory (RAM)
(b) Cache Memory
(c) Hard Disk Drive (HDD)
(d) Arithmetic Logic Unit (ALU)
10. What is the primary function of an operating system in a computer system?
(a) To provide hardware components
(b) To manage hardware and software resources
(c) To act as an input device
(d) To manufacture computer parts
11. Which of the following is a key characteristic of the Von Neumann architecture?
(a) Separate memory for instructions and data
(b) Instructions and data are stored in the same memory
(c) Data is stored in a separate storage unit from instructions
(d) No need for a central processing unit (CPU)
12. What is the main disadvantage of the Von Neumann architecture?
(a) High cost of components
(b) Difficulty in executing machine language instructions
(c) Limited data storage capacity
(d) Bottleneck due to shared memory access for instructions and data
13. Which of the following components is NOT a part of the Von Neumann architecture?
(a) Central Processing Unit (CPU)
(b) Input/Output devices
(c) Control Unit (CU)
(d) Graphics Processing Unit (GPU)
14. In Von Neumann architecture, which component is responsible for controlling the flow of instructions and data?
(a) Arithmetic Logic Unit (ALU)
(b) Control Unit (CU)
(c) Cache Memory
(d) Input/Output devices
15. How does the Von Neumann architecture differ from the Harvard architecture?
(a) Von Neumann has separate memory for data and instructions, while Harvard shares the same memory
(b) Von Neumann stores data and instructions in the same memory, while Harvard stores them separately
(c) Von Neumann has no control unit, while Harvard does
(d) Von Neumann is used in modern processors, while Harvard is outdated

Internet Protocols

16. Which of the following protocol is used to transfer web pages from a web server to a web browser?
(a) FTP (File Transfer Protocol)

(b) HTTP (Hypertext Transfer Protocol)
(c) SMTP (Simple Mail Transfer Protocol)
(d) SNMP (Simple Network Management Protocol)

17. Which protocol is used to send emails over the Internet?
    (a) POP3 (Post Office Protocol 3)
    (b) FTP (File Transfer Protocol)
    (c) SMTP (Simple Mail Transfer Protocol)
    (d) IMAP (Internet Message Access Protocol)
18. Which protocol is responsible for assigning IP addresses to devices on a network?
    (a) DNS (Domain Name System)
    (b) DHCP (Dynamic Host Configuration Protocol)
    (c) TCP (Transmission Control Protocol)
    (d) ARP (Address Resolution Protocol)
19. What is the primary purpose of the DNS (Domain Name System) protocol?
    (a) To assign IP addresses to devices
    (b) To map domain names to IP addresses
    (c) To ensure secure transmission of data
    (d) To transfer files over the internet
20. Which protocol ensures reliable data transmission between two devices over the Internet?
    (a) UDP (User Datagram Protocol)
    (b) TCP (Transmission Control Protocol)
    (c) IP (Internet Protocol)
    (d) ICMP (Internet Control Message Protocol)

Type of Systems

21. Which systems involve the mind and behavior?
    (a) Artificial (b) Chemical
    (c) Psychological (d) Biological
22. Which systems involve Substances and their Interactions?
    (a) Artificial (b) Chemical
    (c) Psychological (d) Biological
23. Which system consist on living organism?
    (a) Artificial (b) Chemical
    (c) Psychological (c) Biological

Answer Key

1	b	**2**	b	**3**	a	**4**	b	**5**	c	**6**	b	**7**	a	**8**	**c**
9	c	**10**	b	**11**	b	**12**	d	**13**	d	**14**	b	**15**	b	**16**	b
17	c	**18**	b	**19**	b	**20**	b	**21**	c	**22**	b	**23**	d		

Solved Exercise

Multiple Choice Questions

1. **What is the primary function of a system?**
   (a) To work independently
   (b) To achieve a common goal
   (c) To create new systems
   (d) To provide entertainment
2. **What is one of the fundamental concepts of any system?**
   (a) Its size
   (b) Its objective
   (c) Its age
   (d) Its prize
3. **What is an example of a simple system?**
   (a) A human body
   (b) Computer network
   (c) A thermostat regulating temperature
   (d) The Internet
4. **What type of environment remains unchanged unless the system provides an output?**
   (a) Dynamic
   (b) Static
   (c) Deterministic
   (d) Non-deterministic
5. **What are the basic components of a system?**
   (a) Users, hardware, software
   (b) Objectives, components, environment, communication
   (c) Input, outputs, processes
   (d) Sensors, actuators, controllers
6. **What concept does the theory of systems aim to understand?**
   (a) Hardware design
   (b) System interactions and development over time
   (c) Software applications
   (d) Network security
7. **What role does the Operating System (OS) play in a computer?**

(a) It performs calculations and executes instructions
(b) It temporarily stores data and instructions for the CPU
(c) It receives input from interface components and decides what to do with it
(d) It provides long-term storage of data and software

8. **Which of the following describes the Von Neumann architecture's main characteristic?**
(a) Separate memory for data and instructions
(b) Parallel execution of instructions
(c) Single memory store for both program instructions and data
(d) Multiples CPUs for different tasks

9. **What is a disadvantage of the Von Neumann architecture?**
(a) Complex design due to separate memory spaces
(b) Difficult to modify programs stored in memory
(c) Bottleneck due to single memory space for instructions and data
(d) Lack of flexibility in executing instructions

10. **Which of the following transports data inside a computer among different components?**
(a) Control Unit **(b) System Bus**
(c) Memory (d) Processor

Answer Key

1	b	**2**	b	**3**	c	**4**	b	**5**	b
6	b	**7**	c	**8**	c	**9**	c	**10**	b

Short Questions

Q.1 Define system. What are its two types?

Ans. The idea of a system is useful to explain both the external reality as well as the internal one. An information system is simply an organized set of components that are coordinated to perform a designated function. Systems can be broadly categorized into two types, namely Artificial Systems and Natural Systems.

Q.2 Differentiate between Natural and Artificial systems.

Ans. Natural systems are those that exist in nature and operate independently of human involvement. They are governed by natural laws and process. **Artificial systems** are created and developed by people so that they may fulfill certain functions or address certain issues. These systems can be as small as a wheel or as large as the United Nations.

Q.3 Describe the main components of a computer system.

Ans. Components

A computer composed of many essential components that operate in conjunction. These components include:

Interface components refer to the fundamental parts of a computer system, including input devices such as the keyboard and mouse, which allow users to interact with the computer.

Processing Components

- **CPU**
- **Memory (RAM & ROM)**
- **Operating System (OS)**
- **Software and its types**

Q.4 List and describe the types of computing systems.

Ans. Computing Systems:

A computer system is a structured set of hardware and software components specifically designed for data processing and the performance of various operations.

- **Hardware** of a computer system refers to the tangible components of the system. These include the Central Processing Unit (CPU), Random Access Memory (RAM), storage devices, and input and output devices.
- **Software** refers to a collection of instructions that dictate the requirements and actions that hardware must do. There exist two primary categories. System software and application software.
- **Electricity:** Electricity is the power source that enables the hardware components to function. Without electricity the hardware components cannot function and the computing system will not operate.

Q.5 What are the main components of the Von Neumann architecture?
Ans. See Short Question No. 25
Q.6 What is the Von Neumann computer architecture? List its key components.
Ans. The Von Neumann architecture is a computer paradigm that delineates a system. This model is called the John von Neumann model, the Neumann model named in honor of the mathematician and physicist who contributed to its development during the 1940s.
Following are the key characteristics of the Von Neumann computer architecture:
Single Memory Store: Both program instructions and data are stored in the same memory space.
Sequential Execution: Instructions are processed one after another in a sequence.
Stored Program Concept: Programs are stored in memory and can be changed by the computer
Q.7 What are the four main steps in the Von Neumann architecture's instruction cycle?
Ans. See Short Question No. 27
Q.8 What is the Von Neumann bottleneck?
Ans. The Von Neumann bottleneck occurs when a single memory area limits the CPU's ability to retrieve instructions and data quickly. The Von Neumann bottleneck is a barrier in the speed of data transfer between a computer's CPU (Central Processing Unit) and memory (RAM). This concept stems from the architecture proposed by John von Neumann in 1945, which remains the foundation of most current computers.

Q.9 What is the key advantage of the Von Neumann architecture?
Ans. Advantages:

- **Simplified Design:** By combining instructions and data into a single memory area, architecture is simplified.
- **Flexibility:** Programs can be easily changed by changing memory contents.

Q.10 What are the three main requirements for a computing system to function?
Ans. A computer system is a structured set of hardware and software components specifically designed for data processing and the performance of various operations.

- **Hardware** of a computer system refers to the tangible components of the system. These include the Central Processing Unit (CPU), Random Access Memory (RAM), storage devices, and input and output devices.
- **Software** refers to a collection of instructions that dictate the requirements and actions that hardware must do. There exist two primary categories. System software and application software.
  Electricity: Electricity is the power source that enables the hardware components to function. Without electricity the hardware components cannot function and the computing system will not operate.

OR

- A computing system requires the following to function:
  Hardware: The physical components that carry out instructions.
  Software: refers to programs and operating systems that send instructions to hardware.
  Human-ware (Users): The individuals who interact with, use, and benefit from the system.
  These components work together to provide a fully working computing environment.

Long Questions

Q.1 Define and describe the concept of a system. Explain the fundamental components, objectives, environment, and methods of communication within a system.
Ans. Long Question No. 1
Q.2 Differentiate between natural and artificial systems. Discuss their characteristics, functions, and purpose with relevant examples.
Ans. Long Question No. 2,3
Q.3 Examine the relationship between systems and different branches of science, including natural science, design science, and computer science. How do these branches utilize system theory to understand and improve their software systems, computer networks, and the internet?
Ans. Long Question No. 5

Q.4 Explore the different types of computing systems such as computers, software system, computer networks, and the internet.
Ans. Long Question No. 11
Q.5 Describe the main characteristics of a computer as a system, including its objectives, components and interactions among these components.
Ans. Long Question No. 6
Q.6 Explain the Von Neumann architecture of a computer. Include a discussion on the main components, their functions, and the step-by-step process of how the architecture operates.
Ans. Long Question No. 8
Q.7 Provide a detailed explanation of how a computer interacts with its environment. Include examples of user input, network communication, and power supply.
Ans. Long Question No. 7
Q.8 Describe the process of retrieving and displaying a file using a computer based on the interactions among different components. Provide a step-by-step explanation of how input is processed, data is transferred and results are displayed on the screen.
Ans. The process of retrieving and displaying a file on a computer requires a number of interactions between hardware and software components. It begins with the user entering information, such as double-clicking a file icon with a mouse or browsing a file manager with a keyboard.
Input: I/O (input/output), pronounced "eye-oh," describes any action, program or device that sends data to or from a computer. Common I/O devices include printers, hard disks, keyboards and mice. Input/output devices are important in computer programming because they make it easier for computing equipment to connect across networks.
Input Processing: Data processing is a sequence of processes conducted on data to transform, analyze, and organize it into a suitable format for future use.
Raw data is transformed into meaningful or consumable formats through a variety of processes and procedures. Data collection, filtering, sorting, and analysis are common stages in this process. The goal is to extract relevant data that can be used in decision-making processes or to complement existing technologies. To accomplish this, data engineers and data scientists use a variety of data processing tools and procedures to ensure that the output is accurate and useful.
Output: Output devices are constantly evolving as technology improves. Every day, new types of display outputs, printers, and audio devices are introduced. These devices are in charge of conveying data in a format that humans can understand, such as text, images and audios.

Activities

Activity 1

Objective: To introduce the concept of systems and understand how different components interact.
Required Material:
Poster boards, markers, sticky notes, chart paper, drawing tools.
Activity type: Group
Activity Task Detail: Start with a discussion where the teacher introduces the concept of systems using examples like cars and schools. Students will contribute their examples and ideas. Next perform, a brainstorming session, where students will work in groups to identify and list the systems they interact with daily. They will then create a system map on poster boards, labeling the components and their interactions. Finally, during a gallery walk, each group will present their system map, followed by a feedback session where the teacher provides feedback and answer questions.
Output: Each group will produce a system map poster illustrating their chosen system, and students will enhance their presentation and explanation skills.
Ans. Practical Work/Class Work/Lab Work

Activity 2

Objective: To apply the principles of system design and understand the process of creating a functional system.
Required Material: Computers or tables with diagramming software (e.g., Lucid chart), paper, pencils, markers.
Activity Type: Pair
Activity Tasks Detail: Begin with an introduction where the teacher presents an example of a simple system. Students will then work in pairs to define the objective of their chosen system, list its components, describe their interactions, and outline the system's environment. The pairs will use diagramming software to create a system prototype or diagram. Finally, they will present their designs to the class in a review and feedback session.
Output: Each pair will produce a system prototype or diagram and receive feedback to refine their design ideas.
Ans. Practical Work/Class Work/Lab Work

Activity 3: Interactive Simulation

The purpose of this activity is with the aim of understanding how variability affects the system of interest.

Materials Needed

Computers or tablets with internet access and online simulation tools (like an ecosystem simulator).

Activity Tasks Detail

Individual or Group Assignments the teacher will begin by explaining what system dynamics entail as well as provide an overview on how the simulation will be implemented. Students will then work with the simulation tool, manipulating different variables and analyzing how the system reacts. Using an S-curve to review their results, the students will be reflecting on how changes impact the entire system during the discussion. The teacher will emphasize that all these parts are integrated and balanced, and the students will follow this aspect during their conversation.
Outcome: They produce detailed observation notes as well as better insights into system dynamics and balance.
Ans. Practical Work/Class Work/Lab Work

Activity 4

Objective: To experience managing a system and making decisions to keep it functional.
Required Material: Computers or tablets with internet access, city simulation game (e.g., SimCity).
Activity Types: Pair (Group of two students)
Activity Tasks Detail: Begin with an introduction to the simulation game, explaining its objectives and mechanics. Students will then play the game in pairs, making strategic decisions to manage their city. After gameplay, a debriefing session will allow students to discuss their experiences, challenges, and strategies. The teacher will link these experiences to system management concepts discussed in class.
Output: Hands-on gameplay experience and reflection on system management challenge and strategies.
Ans. Practical Work/Class Work/Lab Work

Activity 5

Objective: Students will discover how computer components work together to process and display data.
Required Material: Markers, index cards and a flowchart template are required.
Pair-based activity: Tasks Begin with an introduction to data processing in computer. Students will work in pairs to create a flowchart illustrating the data stream from input to output. Each pair will present their flowcharts and participate in a class discussion to highlight key points.
Output Improved presentation and debating skills, as well as through flowcharts depicting the data path.
Ans. Practical Work/Class Work/Lab Work

Activity 6

Objective: Students will discover learn about the different components of a computer and their functions.
Required Material: Physical computer parts (CPU, RAM, etc.) diagrams of computer systems, worksheets for labeling and note-taking.
Activity Tasks Detail: The teacher will start with an overview of key computer components. Students will then work in small groups identifying and labeling computer parts using worksheets. Groups will present their findings in a session, followed by a Q&A where the teacher clarifies any misunderstandings.
Output: Labeled worksheets, enhanced presentation skills, and a deeper understanding of computer components.
Ans. Practical Work/Class Work/Lab Work

Activity 7: Computing System Around Us

Activity Tasks Detail: Start with an introduction on computing systems. Students will then research and list various computing systems. Students will then research and list various computing systems they use daily completing a worksheet. In a group sharing session students will discuss their findings. The class will engage in a discussion to highlight key points, and students will begin preparing a short presentation on a computing system for the next class.
Output: Completed worksheets, group insights and a short presentation on a chosen computing system.
Ans. Practical Work/Class Work/Lab Work