



Chapter # 1

Introduction to System



Student Learning Outcomes

Understand System Theory:

- Define and describe general system theory, its types, objectives, components, and interactions.
- Explain the concept of a system, including objectives, components, and communication.
- Describe what constitutes a system and its role in various domains.
- Explain the importance of system objectives and common objectives such as processing information, supporting applications, and achieving specific goals.
- Understand the role and importance of system components and their interactions.
- Explain the significance of interactions among various systems.
- Differentiate between natural and artificial systems.
- Categorize and describe various types of natural and artificial systems, their objectives, components, and interactions.
- Provide examples of natural systems, including physical, chemical, biological and psychological systems along with their characteristics.
- Provide examples and functions of artificial systems, including knowledge systems, engineering systems, and social systems.
- Analyze systems to identify their objectives, components, and interactions.
- Compare and contrast different types of systems, highlighting variations in objectives, components, and interactions.
- Conduct research on specific system types and present findings effectively.
- Create diagrams or models to visually represent the structure and interactions of systems.
- Assess the role and importance of system objectives in real-world applications.
- Demonstrate understanding of how systems apply to different fields and serve specific functions.

Computing Systems

- Define and describe a computer as a system, including its objectives, architecture, components, and interactions.
- Understand the primary objectives of a computing system, including processing data, executing instructions, and providing a user interface.
- Recognize the role and importance of computer system components and their interactions.
- Identify necessary and auxiliary components of a computer system.
- Identify different types of computing systems, such as computers, software, computer networks, and the Internet.

- Understand the Von Neumann architecture and its core components: CPU, motherboard, memory, storage devices, input/output ports, and devices.
- Explain the relationship between the CPU, memory, and storage, and how data flows within a system.
- Describe how components within a computer system interact to execute tasks, such as how the CPU fetches, decodes, and executes instructions stored in memory.
- Differentiate between the roles of hardware and software in a computer system.
- Define and describe Computing system and its types including Computer, Software, Network and the Internet.
- Describe the main functions of system software, such as operating systems, and application software.

Subjective Type Questions

Long Questions prepared in the light of new Examination Techniques
(Knowledge, Understanding, Application, Analytical & Conceptual)

1.1 THEORY OF SYSTEMS

Q.1. Explain a concept of system in detail.

Ans. System:

A system is a set of interrelated components working together towards a common goal. Think of it like a team, where each member plays a specific role, but they all collaborate to achieve a shared objective.

Concept of a System:

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. All the components of the system are in some way related to each other and the functioning of the other components enhances the operation of the system.

Example: Let us consider a simple example, such as a car, depicted in Figure 1.1: it is made up of an engine, wheels, brakes, and other related items. Every part plays a unique task, but collectively they are responsible for making the car move. Likewise, every computer, organism, machine, or device has components that work together to achieve an outcome.

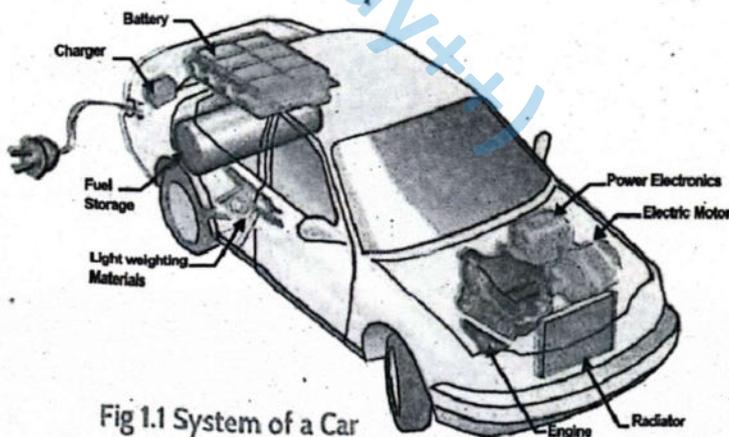


Fig 1.1 System of a Car

Fundamental Components:

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 fulfill. 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.

Examples:

- 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 systems:

Providing a platform or infrastructure for other systems to work.

Examples:

- 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,

Examples:

- A thermostat system maintains a set temperature in an environment.
- A car engine system aims to convert fuel into mechanical energy efficiently.



Fig. 1.2 Types of System 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 environment 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.

System's Interaction with the Environment:

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.2. Differentiate between natural and artificial systems**Ans. Natural Systems:**

Natural systems are those that exist in nature and operate independently of human involvement.

Characteristics:

- 1 Occur naturally without human intervention.
- 2 Governed by natural laws and processes.
- 3 Vary in size and form, from atoms to galaxies.

Functions:

- 1 Part of the interconnected web of life.
- 2 Contribute to the balance of ecosystems.
- 3 Provide resources for humans.

Purposes:

- 1 Not designed for specific purposes.
- 2 Exist to fulfill the laws of nature.

Examples:

- 1 Physical Systems: Atoms, planets, weather patterns, galaxies.
- 2 Chemical Systems: Water, air, the process of photosynthesis.
- 3 Biological Systems: Plants, animals, human bodies.
- 4 Psychological Systems: Emotions, thought processes, behaviors.

Artificial Systems:

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. Artificial systems are a vital part of the contemporary society because they reinforce productivity, solve complex problems, and improve people's well-being. These are systems such as knowledge management systems, engineering achievement systems and indeed social systems which are the framework of success of human civilization.

Characteristics:

- 1 Created by humans to fulfill specific needs or purposes.
- 2 Designed and constructed using technological advancements.
- 3 Often have a defined structure and function.

Functions:

- 1 Solve problems.

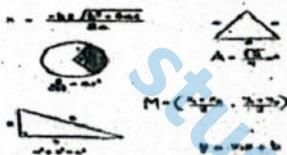
- ② Improve efficiency.
- ③ Enhance human capabilities.

Purposes:

- ① Fulfill specific human needs.
- ② Improve quality of life.
- ③ Drive progress and innovation.

Examples:

- ① Knowledge Systems: Databases, search engines, educational software.
- ② Engineering Systems: Bridges, cars, smart phones, robots.
- ③ Social Systems: Governments institute, schools, non-profit organizations.



Mathematics a Knowledge System



Attack Bridge a Engineering System



Punjab University a Social System

Fig. 1.5 Types of Artificial Systems

1.3

SYSTEM AND SCIENCE

Q.3. Explain the relationship between systems and different branches of science in detail.

Ans. System and Science:

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:

- (i) Natural Science
- (ii) Design Science

(i) 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 scientists seek to understand and describe natural Phenomena.

To achieve this, natural scientists follow the empirical cycle of natural science.

Example:

Studying the ecosystem of a forest to understand how different species interact descriptively.

(ii) Design Science:

Design Science is focused on designing and creating artifacts (tools, systems,

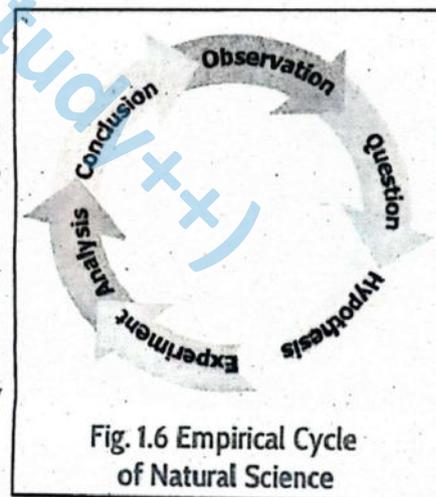


Fig. 1.6 Empirical Cycle of Natural Science

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.

Example:

Developing a new software system to manage forest data and improve conservation efforts (prescriptive).

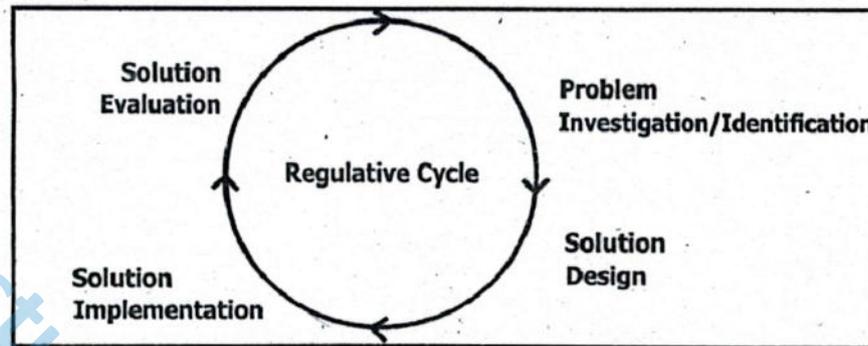


Fig. 1.7 Regulative Cycle of Design Science

(iii) 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 involves the study of various algorithms and their characteristics.

Study of Algorithms:

Researchers analyze existing algorithms to understand their efficiency and limitations. For example, studying different sorting algorithms and their characteristics which arrange given data in an order, like Quick Sort or Merge Sort. To understand their speed and how they perform with different kinds of data.

Design Science of Computer Science:

Design science of computers focuses on creating and improving *computer tools and systems* to make them work better.

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 Systems: Researchers 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.4. Explain the different types of computing systems.

Ans. Types of Computing Systems:

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

1. Computer
2. Software Systems
3. Computer Networks
4. Internet.

Computer as a System:

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

Objective:

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 composed of many essential components that operate in conjunction. These components 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 present 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. These buses provide the flow of data, the address of data or instructions, and control signals from the CPU to other components concurrently.

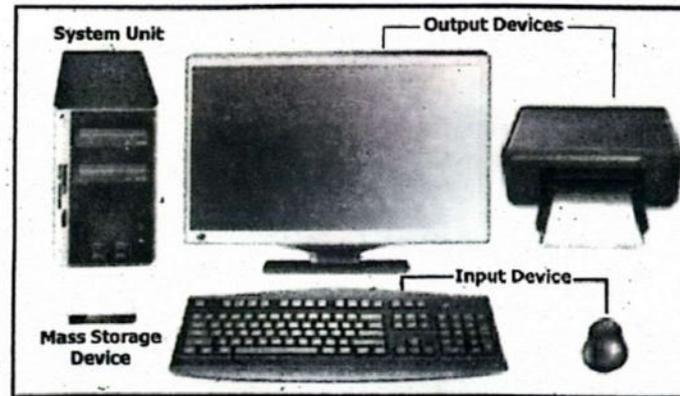


Fig. 1.8 Computer System and its components

Interactions among Components:

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 is a step-by-step 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:** A computer interacts with its environment to perform its functions.

For examples:

- **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.

Software Systems:

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 Operation 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.

Computer Network as a Systems

A computer network 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: 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.

Environment:

A computer network operates in various environments, such as office buildings, data centers, or across the globe via the Internet. The environment influences network design, security, and performance.

Types of Computer Networks:

Local Area Network (LAN): Connects computers in a specific area, such as a single building or school. For example, an office network that connects everyone. Employee PCs and printers.

● **Wide Area Network (WAN):** Connects computers across larger geographic

regions, such as cities, nations, and even continents. For example, consider the Internet which links computers worldwide. In summary, a computer network is an important system that enables resource sharing and communication among connected devices, using hardware and software components that work together seamlessly to perform various tasks.

Internet as a System:

The Internet is a vast and complex system designed to connect multiple networks worldwide, including 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 transferring 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.

Q.5 Describe the main characteristics of a computer as a system.

Computer as a System:

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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:

- **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.

1.5 THE ARCHITECTURE OF VON NEUMANN COMPUTERS

Q.6: Explain the Von Neumann architecture of a computer .

Ans. The Architecture of Von Neumann Computers:

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.

1. **Memory:** Contains 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.

2. **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) and the Control Unit (CU). 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 instructions. 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.

3. **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.

4. **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 outcome 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.

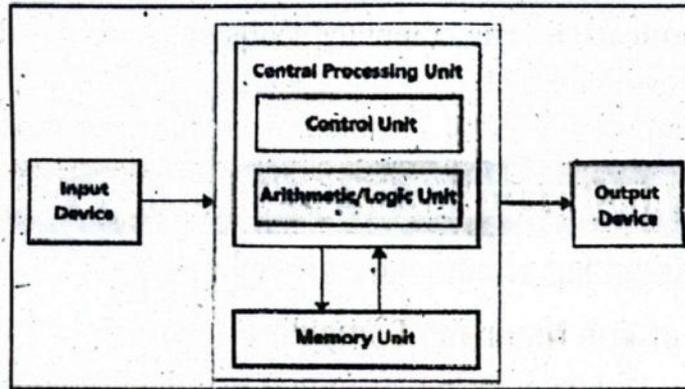


Fig. 1.9 Von Neumann computer Architecture

It comprises:

Data Bus: Transports data.

Address Bus: Maintains data destination information.

Control Bus: Transports control electrical signals.

Working:

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

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 executed by the Arithmetic Logic Unit (ALU). Any task that requires transferring data between several locations is managed by the CU.

Involved Components: ALU, CU:

Detail: The Arithmetic and Logic Unit (ALU) carries out mathematical and logical calculations, while the 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.

1.6**COMPUTING SYSTEMS**

Q.7: Explain how a computer interacts with its environment.

Ans. Computer as a System:

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

Objective:

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.

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:

A computer interacts with its environment to perform its functions.

For examples:

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

Typing a document, entering a web address in a browser, selecting a menu option.

Network Communication:

The computer sends and receives data over the Internet to browse websites or download files.

Sending an email, accessing a website, downloading a file.

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

Example: Provides electrical power to allow the computer to work.

Q.8: Describe the process of retrieving and displaying a file using a computer.

Ans. Retrieving and Displaying a File:

User Action or Input: The user double-clicks on a file icon using a mouse, or press a key combination to open the file. The mouse or keyboard sends this input to the computer.

Input Device: The mouse or keyboard sends a signal to the computer's operating system via the USB connection or other input mechanisms, indicating the user's request to open the file.

Operating System: The operating system receives the input and interprets the user's intention to open the file.

● **Central Processing Unit (CPU):** The CPU retrieves the file's location and instructions for opening the file from the memory.

● **Memory:** The memory stores the program instructions and the location of the file on the storage device.

● **Storage Device:** The storage device (hard drive, SSD, etc.) Contains the actual data of the file.

● **Data Transfer:** The CPU sends commands to the storage device to retrieve the file data.

System Bus: The data is transferred from the storage device to the memory through the system bus, which includes the data bus, address bus, and control bus.

● **CPU Processing:** The CPU processes the file data according to the program instructions.

Output Device: The CPU sends the processed data (the content of the file) to the output device, which is typically the display screen.

Screen Display: The screen displays the content of the file, making it visible to the user.

The entire process happens seamlessly and quickly due to the complex interactions of the different components working together.

Conceptual Long Questions

Q.1: How natural systems interact and evolve from one another? Provide examples to illustrate the complexity and interdependence of these systems in nature.

Ans. Natural Systems

Natural systems are those that exist in nature and operate independently of human involvement. They are governed by natural laws and processes. Natural systems are of various forms and sizes, from very tiny objects like atoms and cells in our body to very huge like forests, oceans and the cosmos. Following are examples of some natural systems that exists in nature.

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, to planets, stars, galaxies, and cosmos. 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. For example hydrogen gas (H₂) is formed when an electron, proton, and neutron combine, following the rules of physics and natural forces.

Chemical Systems:

Chemical systems involve substances and their interactions, transformations, and reactions. They are governed by the laws of chemistry. Chemical systems emerge from physical systems when atoms and molecules interact and bond 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.2: Explore the role of artificial systems in modern society, particularly in fields like AI, engineering, and knowledge management.

Ans. Artificial Systems

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.

Artificial systems are a vital part of the contemporary society because they reinforce productivity, solve complex problems, and improve people's well-being. These are systems such as knowledge management systems, engineering achievement systems and indeed social systems which are the framework of success of human civilization. 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 a 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 a basis of 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.

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 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 stocks in their possession.

Q.3: How can the concept of systems theory be applied to understand the intricate workings of a human body and how its various subsystems interact to ensure its survival and well-being?

Ans. Systems theory helps us understand the human body by recognizing it as an integrated system:

- **Interconnectedness:** Organs and systems work together, not in isolation.
- **Hierarchy:** Systems are organized in a nested structure (cells → tissues → organs → organ systems → body).

- **Emergence:** New functions arise from the interaction of components (e.g., consciousness from brain activity).
- **Feedback Mechanisms:** Maintain homeostasis (e.g., temperature regulation, blood sugar control).

Understanding these interactions is crucial for diagnosing and treating diseases.

Summary

- A system is a collection of parts that work together to achieve a common goal.
- A system is described by its objective, components, communication among components and environment in which it works.
- Components are the building blocks of any system. Each component plays a specific role and contributes to the overall functionality of the system.
- The environment of a system includes everything external to the system that interacts with it. It consists of all external factors that affect system's operation.
- Systems can be broadly categorized into two types, namely natural and artificial systems.
- Natural systems are those that exist in nature and operate independently of human involvement.
- Artificial systems are designed and constructed by humans. Social systems are organized structures created by humans to manage social relationships, governance, and community activities.
- Computer science is the study of how computers work. It looks at what computers can do and what limitations they have.
- A computer is a complex system designed to process data and perform tasks according to a set of instructions.
- The Von Neumann architecture involves several key steps for a CPU to execute instructions, including fetching, decoding, executing, and storing.
- System software is the basic software that helps a computer run and manage its hardware and software resources.
- Application software is the software designed to help users perform specific tasks or activities.

Additional MCQs

1. **What is a system?**
 - (a) A collection of unrelated components.
 - (b) A complex machine that performs a specific task.

- (c) An organized set of components that work together to achieve a common goal.
(d) A naturally occurring phenomenon that exhibits specific characteristics.
2. **Which of the following is NOT an example of a system?**
(a) A car (b) A human body
(c) A single cell (d) A computer network
3. **What is the purpose of the Von Neumann computer architecture?**
(a) To create a more efficient system for processing information.
(b) To define the structure and function of a digital computer.
(c) To improve the speed and performance of data transfer.
(d) To develop a new type of computer based on Artificial Intelligence.
4. **What is the significance of the idea of a system?**
(a) It helps us to understand the functioning of individual components.
(b) It simplifies the analysis of complex phenomena.
(c) It provides a framework for studying the interactions between different elements.
(d) All of the above.
5. **What does a thermostat system do?**
(a) Provides a platform to run different applications.
(b) Maintains a set temperature in an environment.
(c) Processes user data to produce meaningful outputs.
(d) Converts fuel into mechanical energy efficiently.
6. **Why is it important to understand the objective of a system?**
(a) To improve the efficiency and efficacy of the system.
(b) To make the system more complicated.
(c) To ensure the system is only used for its intended purpose.
(d) To make the system more expensive.
7. **What is an example of a system that is designed by humans?**
(a) A car (b) A human body (c) A plant (d) A rock
8. **Which of the following is NOT a characteristic of a system?**
(a) It has components.
(b) Its components work together to achieve a common goal.
(c) It is always made of physical objects.
(d) It is always static and unchanging.
9. **An example of a natural system is:**
(a) A human body (b) A car
(c) A computer program (d) A network of computer
10. **What is an example of an artificial system?**
(a) A forest. (b) A river.
(c) A mountain range. (d) A smartphone.

11. **What is the main purpose of the Von Neumann computer architecture?**
- (a) To create a system that is easy to manufacture.
 - (b) To provide a framework for storing and processing information.
 - (c) To make computers more powerful.
 - (d) To enable computers to communicate with each other.
12. **What is the primary focus of Systems Theory?**
- (a) Analyzing complex structures in living organisms.
 - (b) Understanding the relationship between humans and society.
 - (c) Examining how systems operate, interact, and evolve.
 - (d) Developing new technologies to improve system efficiency.
13. **What is the main goal of a system that aims to "achieve specific goals"?**
- (a) To support the operation of other systems.
 - (b) To process information efficiently.
 - (c) To complete tasks or processes.
 - (d) To maintain a stable environment.
14. **In Systems Theory, what role does feedback play?**
- (a) It serves as a method for data collection.
 - (b) It helps in maintaining system stability.
 - (c) It is irrelevant to system performance.
 - (d) It only applies to mechanical systems.
15. **Components are the building blocks of any system. Each component plays a specific role and contributes to the:**
- (a) Overall design of the system.
 - (b) Overall functionality of the system.
 - (c) Overall aesthetics of the system.
 - (d) Overall security of the system.
16. **Understanding the role of each component of the system is essential to:**
- (a) Identify problems and improve performance.
 - (b) Enhance the overall system design.
 - (c) Ensure smooth working of the system.
 - (d) All of the above.
17. **The CPU (Central Processing Unit) is responsible for:**
- (a) Storing data and instructions.
 - (b) Executing instructions and performing calculations.
 - (c) Receiving input and displaying output.
 - (d) Managing the flow of data between different components.
18. **The main memory is responsible for:**
- (a) Storing the operating system only.
 - (b) Storing data temporarily while the computer is running.
 - (c) Storing permanent data and files.
 - (d) Managing the power supply to the CPU.

19. In a computer system, the term 'bus' refers to:
- (a) A physical vehicle for transporting data.
 - (b) A communication system that transfers data between components.
 - (c) A type of software used for data management.
 - (d) A storage device for large amounts of data.
20. What is the environment of a system?
- (a) Everything external to the system that interacts with it.
 - (b) The internal working of the system.
 - (c) The output of the system.
 - (d) The physical location of the system.
21. Which of the following is a characteristic of a static environment?
- (a) It changes independently of the system's output.
 - (b) It remains unchanged unless the system provides an output.
 - (c) It is characterized by inherent uncertainty.
 - (d) It has a fully known impact on the system's output.
22. Which of the following is an example of communication within a system?
- (a) The CPU communicates with memory to fetch and store data.
 - (b) The heart pumps blood through the circulatory system.
 - (c) The lungs exchange oxygen and carbon dioxide.
 - (d) The brain processes information from the senses.
23. A system that is characterized by its fully known and certain impact on the environment is called a:
- (a) Dynamic system.
 - (b) Non-deterministic system.
 - (c) Deterministic system.
 - (d) Static system.
24. What is the significance of understanding the environment of a system?
- (a) It influences the system's performance and behavior.
 - (b) It determines the system's output.
 - (c) It defines the system's structure.
 - (d) It determines the system's lifespan.
25. Which of the following is NOT a property of a system's environment that affects system design and functionality?
- (a) Static vs. Dynamic
 - (b) Deterministic vs. Non-deterministic
 - (c) The color of the system's components.
 - (d) Open vs. Closed
26. Which of the following best describes a closed system?
- (a) It interacts freely with its environment.
 - (b) It does not exchange matter or energy with its surroundings.
 - (c) It is always in a state of change.
 - (d) It relies on external inputs for its operation.
27. Which of the following is NOT an example of how systems interact with their environment?
- (a) A car engine running on gasoline.

- (b) A weather monitoring system providing forecasts to users.
(c) A computer communicating with a printer.
(d) Animals interacting with plants in a food chain.
28. Which of the following is NOT a characteristic of a natural system?
(a) Exists in nature
(b) Operates independently of human involvement.
(c) Is created by humans to fulfill specific needs or purposes
(d) Governed by natural laws and processes
29. Which of the following is an example of a physical system?
(a) A forest (b) A cell (c) An atom (d) A human body
30. Which of the following is NOT a component of a chemical system?
(a) Substances (b) Interactions (c) Transformations (d) Living organisms
31. What is the primary difference between natural and artificial systems?
(a) Natural systems are more complex. (b) Artificial systems are more efficient.
(c) Natural systems exist in nature without human intervention.
(d) Artificial systems are always better than natural systems.
32. How do biological systems emerge from chemical systems?
(a) When molecules interact and bond according to chemical rules and reactions.
(b) When living organisms consume food. (c) When humans create new life forms.
(d) When natural disasters occur.
33. Which of the following statements about psychological and artificial systems is TRUE?
(a) Psychological systems are more complex than artificial systems.
(b) Artificial systems are more adaptable than psychological systems.
(c) Psychological and artificial systems are independent of each other.
(d) Psychological and artificial systems can interact and influence each other.
34. Which of the following is NOT a characteristic of psychological systems?
(a) They involve the mind and behavior.
(b) They are governed by the principles of Psychology.
(c) They emerge from biological systems.
(d) They are primarily based on external stimulation.
35. Which of the following BEST describes the purpose of artificial systems?
(a) To replicate the complex functions of living organisms.
(b) To provide solutions to problems and improve efficiency.
(c) To create artificial intelligence that can surpass human capabilities.
(d) To replace human workers in all sectors of society
36. Logic, as a theoretical model, is crucial for:
(a) Understanding complex theories.
(b) Developing artistic expressions.
(c) Analyzing historical events.
(d) Making ethical decisions.

37. **Databases are essential for:**
(a) Storing and retrieving large amounts of data.
(b) Creating artistic masterpieces.
(c) Conducting scientific experiments.
(d) Predicting future events.
38. **Information Management Systems are primarily used for:**
(a) Controlling traffic flow.
(b) Capturing and distributing information.
(c) Designing architectural structures.
(d) Conducting financial transactions.
39. **Which of the following is NOT an example of a social system?**
(a) A school (b) A government (c) A corporation (d) A bridge
40. **The Metro Train System in Lahore is an example of an Artificial Engineering System. What makes it "Artificial"?**
(a) It was built by humans.
(b) It uses advanced technology and control systems.
(c) It is not found naturally in the environment.
(d) All of the above.
41. **Which of the following best describes the purpose of "Social Systems"?**
(a) To provide entertainment for the masses.
(b) To maintain order, provide services, and facilitate connections.
(c) To conduct scientific research and experiments.
(d) To control the flow of traffic.
42. **The primary goal of natural science is:**
(a) To create new systems or artifacts.
(b) To solve specific problems or achieve goals.
(c) To understand the objectivity and functionality of natural systems.
(d) To make strategic decisions to manage complex systems.
43. **What is the purpose of the regulative cycle in design science?**
(a) To analyze existing algorithms.
(b) To study natural phenomena.
(c) To create new software tools.
(d) To guide the process of designing and creating artifacts.
44. **Which of the following is NOT a component of a computer's interface?**
(a) Keyboard (b) Mouse (c) Monitor (d) Operating system
45. **What is the primary function of a computer's Central Processing Unit (CPU)?**
(a) To perform computations and execute commands
(b) To store data and software
(c) To receive information from interface components
(d) To transmit data between the CPU and other components

46. **What is the primary function of a computer's operating system?**
(a) To perform calculations
(b) To store data permanently
(c) To manage the computer's resources and provide a user interface.
(d) To transmit data between components
47. **Which statement is TRUE about RAM and storage (Hard Drive or SSD)?**
(a) RAM is permanent storage, while storage is temporary.
(b) RAM is temporary storage, while storage is permanent.
(c) RAM stores data, while storage stores instructions.
(d) RAM is used for input, while storage is used for output.
48. **Which of the following is NOT a type of bus used in a computer system?**
(a) Data bus (b) Address bus (c) Control bus (d) Power bus
49. **Which of the following statements about software is TRUE?**
(a) Software is the physical component of a computer.
(b) Software consists of instructions that tell the hardware what to do.
(c) Software cannot be updated once installed.
(d) Software is only used for gaming applications.
50. **In the context of computer networks, what does the term "bandwidth" refer to?**
(a) The physical distance between network devices
(b) The maximum rate of data transfer across a network connection
(c) The number of devices connected to a network
(d) The type of cables used in a network setup
51. **What is an example of a user action or input?**
(a) The computer displaying a document.
(b) The mouse sending a signal to the computer.
(c) The computer processing data.
(d) Double-clicking on a file icon.
52. **What is the role of the power supply in a computer system?**
(a) Provides electrical power to allow the computer to work.
(b) Processes user input from the keyboard.
(c) Connects the computer to other systems and the internet.
(d) Stores data and programs.
53. **Which of the following is NOT an example of a peripheral device?**
(a) Printer (b) Scanner (c) External hard drive (d) CPU
54. **Who is credited with developing the Von Neumann architecture?**
(a) John Von Neumann (b) Alan Turing
(c) Charles Babbage (d) Grace Hopper

55. Which of the following is NOT a primary component of the Von Neumann architecture?
- (a) Memory (b) Network
(c) CPU (d) Input mechanism
56. Which of the following best describes the fetch-decode-execute cycle?
- (a) The process of storing data in memory.
(b) The sequence of operations that the CPU performs to execute instructions.
(c) The method of transferring data between devices.
(d) The way a computer communicates with peripheral devices.
57. In the context of computer architecture, what does "I/O" stand for?
- (a) Input/Output (b) Internal/Output
(c) Input/Operation (d) Instruction/Output
58. What is the function of the ALU (Arithmetic Logic Unit) in a CPU?
- (a) To manage memory allocation.
(b) To perform arithmetic and logical operations.
(c) To control input and output devices.
(d) To store data temporarily.
59. Which of the following statements about RAM (Random Access Memory) is true?
- (a) It is a permanent storage solution.
(b) It is volatile memory that loses its data when power is turned off.
(c) It is used primarily for long-term data storage.
(d) It is slower than hard disk storage.
60. Which of the following is an example of secondary storage?
- (a) CPU (b) RAM (c) Hard drive (d) Cache memory
61. What does the term "bus" refer to in computer architecture?
- (a) A type of software application.
(b) A communication system that transfers data between components.
(c) A storage device for data.
(d) A type of input device.
62. What is the role of the Control Bus?
- (a) Transports data. (b) Transports control electrical signals.
(c) Determines the address of data. (d) Executes instructions.
63. Which of the following is NOT a component of a system bus?
- (a) Data Bus (b) Address Bus
(c) Arithmetic Logic Unit (ALU) (d) Control Bus
64. What is the purpose of the Address Bus?
- (a) To transport data. (b) To control electrical signals.
(c) To maintain data destination information.
(d) To execute instructions.

65. The Program Counter (PC) in the Von Neumann architecture is responsible for:
- Executing arithmetic and logical operations.
 - Decoding instructions.
 - Storing the address of the next instruction to be fetched.
 - Managing data transmission.
66. Which of the following is NOT a component of a computer system's hardware?
- Central Processing Unit (CPU)
 - Random Access Memory (RAM)
 - Operating System
 - Input and Output Devices
67. Which type of software is responsible for managing the computer's resources?
- Application Software
 - System Software
 - Utility Software
 - Both b and c
68. What is the essential power source for a computing system to function?
- Internet
 - Software
 - Electricity
 - Hardware
69. Which of the following is NOT a type of computer network?
- Local Area Network (LAN)
 - Wide Area Network (WAN)
 - Metropolitan Area Network (MAN)
 - Wireless Local Area Network (WLAN)
70. Which of the following is NOT a core protocol that governs data transmission over the internet?
- TCP/IP
 - UDP
 - HTTP
 - FTP

Answers

- | | | | | | | |
|---------|---------|---------|---------|---------|---------|---------|
| 1. (c) | 2. (c) | 3. (b) | 4. (d) | 5. (b) | 6. (a) | 7. (a) |
| 8. (d) | 9. (a) | 10. (d) | 11. (b) | 12. (c) | 13. (c) | 14. (b) |
| 15. (b) | 16. (d) | 17. (d) | 18. (b) | 19. (b) | 20. (a) | 21. (b) |
| 22. (a) | 23. (c) | 24. (a) | 25. (c) | 26. (b) | 27. (a) | 28. (c) |
| 29. (c) | 30. (d) | 31. (c) | 32. (a) | 33. (d) | 34. (d) | 35. (b) |
| 36. (a) | 37. (a) | 38. (b) | 39. (d) | 40. (d) | 41. (b) | 42. (c) |
| 43. (d) | 44. (d) | 45. (a) | 46. (c) | 47. (b) | 48. (d) | 49. (b) |
| 50. (b) | 51. (d) | 52. (a) | 53. (d) | 54. (a) | 55. (b) | 56. (b) |
| 57. (a) | 58. (b) | 59. (b) | 60. (c) | 61. (b) | 62. (b) | 63. (c) |
| 64. (c) | 65. (c) | 66. (c) | 67. (b) | 68. (c) | 69. (d) | 70. (c) |

Conceptual MCQs

1. What is the relationship between the components of a system?
- They are independent of each other.
 - They are interdependent and interact with each other.

- (c) They are only connected by a single common element.
(d) They are unrelated and do not affect each other.
2. **What is the key characteristic that differentiates a "simple system" from a "complex system"?**
(a) The number of components involved
(b) The level of interaction between components
(c) The ability to adapt to changes
(d) The clarity of objectives
3. **The human brain is an incredible example of:**
(a) A communication network. (b) A power supply.
(c) A sensory organ. (d) A storage device.
4. **The information traveling through your brain moves at approximately:**
(a) 100 miles per hour. (b) 268 miles per hour.
(c) 500 miles per hour. (d) 1000 miles per hour.
5. **The approximate number of neurons in the human brain is:**
(a) 8.6 million. (b) 86 million.
(c) 8.6 billion. (d) 86 billion.
6. **During the design of a simple system, what is the purpose of outlining the system's environment?**
(a) To determine the cost of building the system.
(b) To identify the materials needed for the system.
(c) To understand the context in which the system will operate.
(d) To create a detailed blueprint of the system.
7. **Which engineering system is involved in creating devices that utilize external forces?**
(a) Civil Engineering (b) Mechanical Engineering
(c) Chemical Engineering (d) Electrical Engineering
8. **The Edhi Foundation is an example of:**
(a) Artificial engineering system.
(b) Academic institution.
(c) Government organization.
(d) Non-profit organization.
9. **How do artificial engineering systems contribute to the betterment of society?**
(a) By simplifying complex tasks.
(b) By improving efficiency and productivity.
(c) By enhancing safety and security.
(d) All of the above
10. **The "recipe" analogy used to describe how a computer works refers to:**
(a) The Von Neumann bottleneck
(b) The CPU's processing power
(c) The instructions stored in memory
(d) The hardware components of the computer

11. The statement "Data on the Internet travels at nearly the speed of light" implies that:
- (a) Data travels at the exact speed of light.
 - (b) Data transfer is near instantaneous.
 - (c) Data transmission is very slow.
 - (d) The speed of light is variable for internet data.
12. How does a computer system ensure that different components can communicate and work together?
- (a) By using a single, dedicated cable for each component.
 - (b) By relying on a central control unit that directs all communication.
 - (c) By using a system bus to transmit data, addresses, and control signals.
 - (d) By assigning each component a unique frequency for communication.
13. The Von Neumann bottleneck arises due to:
- (a) The speed of the CPU
 - (b) The limitations of the operating system
 - (c) The slow speed of data transfer between memory and CPU
 - (d) The single memory area for both data and instructions
14. The Internet's environment influences which of the following aspects?
- (a) Security
 - (b) Performance
 - (c) Design
 - (d) All of the above
15. In the context of the weather monitoring system, what serves as the input from the environment?
- (a) The weather forecast.
 - (b) Data from environmental sensors.
 - (c) The user's request for a forecast.
 - (d) The display showing the weather information.

Answers

1. (b) 2. (b) 3. (a) 4. (b) 5. (b) 6. (c) 7. (b)
8. (d) 9. (c) 10. (c) 11. (b) 12. (b) 13. (c) 14. (d)
15. (b)

Additional Short Questions

1. Define System.

Ans: System: A system is a set of interrelated components working together towards a common goal. Think of it like a team: each member plays a specific role, but they all collaborate to achieve a shared objective.

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.

2. Define Systems Theory.

Ans: Systems Theory: A branch of a science that deals with complicated structures in living organisms, that relate the human with society and the science is known as Systems Theory. It gives a way of interpreting the existing world with different varied perspectives, how the different systems and sub-systems operate, how they are integrated, how they grow and how they change with time.

3. What are the building blocks of any system?

Ans: 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.

4. What is the environment of a system?

Ans: 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 environment 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.

5. What is the difference between static and dynamic environments?

Ans: 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.

6. What are the two main categories of environment properties?

Ans: Two of environment 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.

7. **What is the difference between deterministic and non-deterministic systems?**

Ans: 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.

8. **How do systems interact with their environment?**

Ans: 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.

9. **What are the two types of systems? OR What are the main types of systems?**

Ans: Systems can be broadly categorized into two types:

(i) Natural systems

(ii) Artificial systems.

Understanding the differences and similarities between these types helps us apply system theory across various fields.

(i) Natural systems are naturally built and occur in nature without human intervention.

(ii) Artificial systems are created by humans to fulfill specific needs or purposes.

10. **What is the main difference between natural and artificial systems?**

Ans: Natural Systems:

Natural systems are those that exist in nature and operate independently of human involvement. They are governed by natural laws and processes. Natural systems are of various forms and sizes, from very tiny objects like atoms and cells in our body to very huge like forests, oceans and the cosmos. Following are examples of some natural systems that exist in nature.

1. Physical systems

2. Chemical systems

3. Biological Systems

4. Psychological systems

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

1. Knowledge Systems

2. Engineering Systems

3. Social systems

11. What are the characteristics of biological systems?

Ans: 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.

12. What do psychological systems involve?

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

13. What is unique about a 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.

14. What is the purpose of knowledge systems?

Ans: Purpose: 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.

15. What are some examples of structures that Civil Engineers design and maintain?

Ans: 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.

16. How do Mechanical Engineering systems utilize forces?

Ans: Mechanical Engineering Systems: Engage in planning and creating devices that make utilization of forces from outside to accomplish work. For instance, a robotic arm applied in assembly line for packaging of products in factories.

17. What is the main goal of Chemical Engineering Systems?

Ans: 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.

18. What are some examples of how electrical engineering systems are used in homes?

Ans: 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 smart phone app. This system uses electric signals and power to operate various home appliances and systems remotely.

19. What is the main task of Software Engineering Systems?

Ans: 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 stocks in their possession.

20. What is the goal of 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 order, provide services, and facilitate social connections.

21. What are examples of educational institutions?

Ans: 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.

22. What are the two types of governments?

Ans: 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.

23. What type of system is the Edhi Foundation?

Ans: Edhi Foundation is the social system of artificial systems.

41. What are the two main types of science?

Ans: Science is a systematic way to validate this understanding. Science can be divided into two main types:

1. Natural science.
2. Design science.

Both natural and design sciences study systems, but they approach them differently. In natural science, scientists study existing natural systems to understand their workings.

In design science, scientists create new systems (artifacts) to solve problems or achieve specific goals. Each type of science addresses different systems and questions.

24. What is the objective of natural science?

Ans: Objective: Natural science is meant to uncover the objectivity and functionality of natural descriptive, meaning that the scientists systems in the natural world. Its nature is seeks to understand and describe natural phenomena. To achieve this, natural scientists follow the empirical cycle of natural science.

1. Conclusion
2. Observation

3. Question
4. Hypothesis
5. Experiment
6. Analysis

25. What is the empirical cycle of natural science?

Ans: Natural scientists follow the empirical cycle of natural science, which consists of:

1. Conclusion
2. Observation
3. Question
4. Hypothesis
5. Experiment
6. Analysis

26. What is the main focus of Design Science?

Ans: Design Science is focused on designing and creating artifacts (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 (prescriptive).

27. What are the essential components by a computer composed of?

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

1. Interface Components
2. Processing Components
3. Communication Components

28. Why are the interface components used in a computer?

Ans: 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 present or generate results from the computer's operations.

29. What are the processing components used in a computer?

Ans: Processing Components: The processing components of a computer consist of the CPU, which acts as the Central Processing Unit responsible for computations and executing commands.

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.

30. What is the difference between RAM and storage?

Ans: 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.

31. What is the function of the operating system?

Ans: The operating system is responsible for receiving information from interface components and determining the appropriate actions to take.

32. What are the three distinct types of buses in a system bus?

Ans: 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:

1. Data bus
2. Address bus
3. Control bus

These buses provide the flow of data, the address of data or instructions, and control signals from the CPU to other components concurrently.

33. Write step by step process of how components of your computer interact seamlessly?

Ans: Here is a step-by-step explanation of the process:

i. **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.

iii. **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.

34. What are the main components of a computer system environment?

Ans: 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.

35. How does a computer interact with its environment?

Ans: Interaction with the Environment: A computer interacts with its environment to perform its functions.

For example:

● **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.

36. Define the architecture of Von Neumann computers.

Ans: The Architecture of Von Neumann Computers: 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. It works on the cycle (Fetching, decoding, execution, storing)

37. What are the four primary components of the Von Neumann architecture?

Ans: The computer has four primary components: the memory, the Central Processing Unit (CPU), input mechanisms, and output mechanisms.

38. What are the main components of the Central Processing Unit?

Ans: 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) and the Control Unit (CU). 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 instructions. 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.

39. What are the two key characteristics of the Von Neumann architecture?

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

- i. **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 positions) are stored in the same RAM.
- ii. **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.
- iii. **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 instructions replace the old ones in memory.

40. Define the term Hardware and Software in Computer systems. OR What is meant by 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. There exist two primary categories. System software

and application software. Differentiate between system 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.

41. What are the two main advantages 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.

42. What is the main drawbacks of the Von Neumann architecture?

Ans: 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 a 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 evaluation of computing technology, despite its limitation.

43. Write the types of computer networks.

Ans: Types of Computer Networks: Local Area Network (LAN): Connects computers in a specific area, such as a single building or school. For example, an office network that connects everyone. Employee PCs and printers.

Wide Area Network (WAN): connects computers across larger geographic regions, such as cities, nations, and even continents. For example, consider the Internet which links computers worldwide.

44. What is the Internet's main purpose?

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

45. What are the core protocols that govern data transmission over the Internet?

Ans: 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.

46. What does the environment of the Internet refer to?

Ans: 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.

Conceptual Short Questions

1. What do engineers focus on when developing engineering systems?

Ans: Engineers focus on designing and building systems that are efficient, reliable, safe, and cost-effective, while also meeting specific needs and solving problems. They consider factors like functionality, performance, materials, and environmental impact.

2. Which system is the Attock Bridge an example of?

Ans: The Attock Bridge is an example of a structural engineering system, and more broadly, a civil engineering system.

3. When were the first electric traffic lights built?

Ans: The first electric traffic lights were built in the early 20th century.

4. What technology enables exploration and interaction as if you were physically present?

Ans: Virtual Reality (VR) technology enables exploration and interaction as if you were physically present.

5. How does a chemical system emerge from a physical system?

Ans: A chemical system emerges from a physical system when the physical components interact in ways that involve chemical reactions or changes in the composition of matter. It involves the organization and interaction of physical components at a molecular level.

6. What is the nature of Design Science and what does it aim to do?

Ans: Design Science is a problem-solving paradigm that aims to create and evaluate innovative artifacts (e.g., systems, products, processes) to address practical problems and advance knowledge. It's about "making things" to improve situations.

7. What is the cycle that Design Science researchers follow?

Ans: Design Science research typically follows a cycle involving problem identification and motivation, objectives of a solution, design and development, demonstration, evaluation, and communication.

8. Which component is responsible for computations and executing commands?

Ans: The Central Processing Unit (CPU) is responsible for computations and executing commands in a computing system.

9. What are the two ways the outcome of a computation can be handled?

Ans: The outcome of a computation can be either stored (in memory or storage devices) or displayed / output (e.g., on a screen, printer, or other output device).

10. **What is the most important component needed for a computing system to operate?**

Ans: While many components are essential, the CPU is often considered the "brain" and is crucial for the system to operate.

11. **Why are multiple components of the Internet needed?**

Ans: The Internet requires multiple components (routers, servers, cables, protocols, etc.) to function because it is a complex network of interconnected networks. These components work together to transmit data across vast distances, ensuring that information can be shared globally. Each component plays a specific role in routing, storing, and delivering data packets.

Exercise Questions

☆ 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 price

3. **What is an example of a simple system?**

- (a) A human body (b) A 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, environments, communication
(c) Inputs, 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?
- Separate memory for data and instructions
 - Parallel execution of instructions
 - Single memory store for both program instructions and data
 - Multiple CPUs for different tasks
9. What is a disadvantage of the Von Neumann architecture?
- Complex design due to separate memory spaces
 - Difficult to modify programs stored in memory
 - Bottleneck due to single memory space for instructions and data
 - 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

Answers

- | | | | | |
|--------|--------|--------|--------|---------|
| 1. (b) | 2. (b) | 3. (c) | 4. (b) | 5. (b) |
| 6. (b) | 7. (c) | 8. (c) | 9. (c) | 10. (b) |

B. Write short answers.

1. Define a system. What are its basic components?

Ans. System: A system is a set of interrelated components working together towards a common goal. Think of it like a team: each member plays a specific role, but they all collaborate to achieve a shared objective.

Basic Components:

The basic components of a system are:

- Input:** The resources or information that enter the system to be processed.
- Process:** The mechanism or method used to convert inputs into outputs.
- Output:** The final products, services, or information that result from the processing.
- Feedback:** Information about the output that can be used to make adjustments to the input or process for better performance.
- Control:** Procedures and mechanisms that guide and direct the functioning of the system.

2. Differentiate between natural and artificial systems.

Ans. Natural Systems: Natural systems are those that exist in nature and operate independently of human involvement. They are governed by natural laws and processes. Natural systems are of various forms and sizes, from very tiny objects like atoms and cells in our body to very huge like forests, oceans and the cosmos. Following are examples of some natural systems that exist in nature.

- i. Physical systems
- ii. Chemical systems
- iii. Biological systems
- iv. Psychological systems

Artificial Systems:

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

- i. Knowledge Systems
- ii. Engineering systems
- iii. Social systems

3. Describe the main components of a computer system.

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

- i. Interface Components
- ii. Processing Components
- iii. Communication Components

4. List and describe the types of computing systems.

Ans. Types of Computing Systems:

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

- i. Computer,
- ii. Software Systems,
- iii. Computer Networks,
- iv. Internet.

5. What are the main components of the Von Neumann architecture?

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

1. Memory: Contains 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.

2. 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) and the Control Unit (CU). 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 instructions. 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.

3. 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

4. Output Devices: Present or communicate the outcomes of the tasks executed by

the computer. Executed by the computer. Consider, for instance, a monitor and printer. Upon completion of data processing, the CPU transmits the outcome 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.

6. What is the Von Neumann computer architecture? List its key components.

Ans. The Architecture of von Neumann Computers: 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:

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It comprises:

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Address Bus: Maintains data destination information.

Control Bus: Transports control electrical signals.

7. **What are the four main steps in the Von Neumann architecture's instruction cycle?**

Ans. Working: The Von Neumann architecture encompasses four essential stages for a CPU to carry out instructions, namely retrieval, interpretation, execution, and storage. To demonstrate this procedure, we will use the example two-digit addition with abasic 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).

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 executed by the Arithmetic Logic Unit (ALU). Any task that requires transferring data between several locations is managed by the CU.

Involved Components: ALU, CU.

Detail: The Arithmetic and Logic Unit (ALU) carries out mathematical and logical calculations, while the 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.

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.

9. **What is a 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.

10. What are the three main requirements for a computing system to function?

Ans. Hardware, software, and electric power are the three basic requisites that are needed to run a computing system.

C. Long Question.

1. Define and describe the concept of a system. Explain the fundamental components, objectives, environment, and methods of communication within a system.

Ans. For Answer See Q.1

2. Differentiate between natural and artificial systems. Discuss their characteristics, functions, and purposes with relevant examples.

Ans. For Answer See Q.2

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 respective fields? Provide specific examples to support your analysis.

Ans. For Answer See Q.3

4. Explore the different types of computing systems such as computers, software systems, computer networks, and the internet.

Ans. For Answer See Q.4

5. Describe the main characteristics of a computer as a system, including its objectives, components, and interactions among these components.

Ans. For Answer See Q.5

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. For Answer See Q.6

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

Ans. For Answer See Q.7

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. For Answer See Q.8

