COMPUTER SCIENCE

Unit 1 Introduction to Systems

Long Question Answers:

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

System:

A system is a group of different parts or components that work together in an organized way to complete a specific task or achieve a goal. Systems can be found everywhere — in nature, in machines, in our bodies, in schools, and especially in technology like computers. Each system has parts that depend on each other, and they must work together smoothly to keep the system working properly.

Basic Concepts of Systems

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

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1 Objective

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

Types of System Objectives

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

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

- A car engine system aims to convert fuel into mechanical energy efficiently.

2 Components

Components are the **building blocks** of any system. Each has a specific role and contributes to the system's overall functionality.

Understanding each component's role is essential to:

- Understand how the system works
- Identify problems
- Improve performance
- Refine system design

Smooth and proper working of components ensures the system meets its objectives.

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3 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.

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4 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.
- In a biological system: the **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.
  - In a **biological system**, animals interact with plants and other animals, forming a **food chain**.

4. Methods of Communication in a System:

Communication in a system refers to how different parts of the system share data, signals, or information with each other. Without proper communication, a system cannot function correctly.

In a computer system, the CPU communicates with memory and input/output devices using buses (data bus, control bus, and address bus).

In a school system, the teachers communicate with students, the principal communicates with teachers, and so on.

The better communication among components, the more efficient and reliable the system becomes.

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

A system is a set of connected parts that work together to achieve a goal. Systems can be natural (created by nature) or artificial (created by humans). Both types of systems are important in our world, but they are different in how they are formed, how they work, and what they are used for.

Let’s explore the difference between natural and artificial systems in detail.

1. Natural Systems:

Definition:

Natural systems are systems that are not made by humans. They occur naturally in the environment and usually operate according to the laws of nature. These systems have evolved over time without human intervention.

Characteristics of Natural Systems:

They are formed naturally without human effort.

They are usually complex and self-regulated. They work according to natural rules or biological laws.

They are mostly stable and balanced when left undisturbed.

Functions and Purposes of Natural Systems:

To maintain balance in the environment.

To support life and natural processes.

To allow survival and reproduction in nature.

Examples:

Physical Systems: Composed of physical components and governed by the laws of physics.

Chemical System: Involve substances and their interactions, transformation, and reactions. They are governed by the laws of chemistry.

Biological Systems: Consists of living organisms and their interactions. They are governed by Biological processes such as growth, reproduction, and metabolism.

Human Body: Different organs work together (like the brain, heart, and lungs) to keep a person alive and healthy.

Solar System: The sun, planets, and moons follow natural laws like gravity and rotation.

Water Cycle: The process of evaporation, condensation, and rainfall keeps water moving and supporting life.

3. Artificial Systems:

Definition:

Artificial systems are systems that are designed and built by humans to solve problems, perform tasks, or make life easier.

Characteristics of Artificial Systems:

Made and controlled by humans.

It can be simple or complex.

Usually require energy or human input to function.

Can be changed, upgraded, or improved over time.

Functions and Purposes of Artificial Systems:

To help in solving everyday problems.

To increase comfort, speed, and productivity.

To complete tasks that may be difficult or impossible for humans to do alone.

Examples:

Computer System: It processes data and performs calculations with the help of hardware and software.

Transportation System: Cars, trains, and airplanes move people and goods from one place to another.

School System: A planned structure where teachers, students, and staff work together to provide education.

Engineering Systems: Products developed by engineers are complex framework or devices that apply engineering concepts to perform certain tasks.

4. Comparison Table:

Feature	**Natural System**	**Artificial System**
Created by	Nature	Humans
Examples	Human body, plants, rivers	Computers, schools, machines
Control	Natural laws	Human designed rules
Purpose	Maintain natural balance	Solve specific human problems
Modification	Cannot be easily changed	Can be updated or changed
Energy Sources	Sunlight, internal body energy	Electricity, fuel, human effort

Conclusion:

Natural and artificial systems are both essential parts of our world. Natural systems exist to support life and the environment, while artificial systems are created by humans to improve life and perform tasks efficiently. Understanding their differences helps us appreciate how nature works and how technology supports our daily lives. Both types of systems can be studied to learn more about how things function, how they can be improved, and how they affect the world around us.

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.

The concept of a system is very important in science. All scientific fields study systems in one way or another. A system is made up of different parts that work together to complete a function or solve a problem. Scientists and engineers use system theory to understand how these parts interact and how they can be improved.

System theory is the study of how systems work — how input becomes output, how parts are connected, and how systems adapt and respond to change.

There are many different branches of science that use system theory. Let's look at three important ones:

1. Natural Science and Systems:

Natural science includes fields like biology, chemistry, physics, and environmental science. These fields study the systems that occur in nature.

How system theory is used:

Scientists use system theory to study how natural things function, survive, and interact. They observe how different parts of nature work together.

Examples:

Human Body System: The human body is a biological system made up of organs like the heart, brain, lungs, and stomach. Doctors and biologists study how these organs work together to keep a person healthy. If one part fails, the whole body can be affected.

Ecosystems: An ecosystem includes living things (like animals and plants) and non-living things (like air and water). Scientists use system theory to study how energy flows through food chains and how pollution affects all parts of the system.

Water Cycle: This is a natural system where water moves between oceans, clouds, and land through processes like evaporation and rain.

In each example, system theory helps scientists understand how natural processes work and how to protect or improve them.

2. Design Science and Systems:

Design science includes engineering, architecture, and technology design. It focuses on creating new systems to solve problems.

How system theory is used:

Engineers use system theory when building machines, structures, or transportation systems. They need to know how every part of the design will work with other parts.

Examples:

Car System: A car is made up of many parts like the engine, brakes, wheels, and steering system. Engineers must design each part carefully and test how they work together to make the car safe and efficient.

Bridge Design: When building a bridge, engineers consider materials, weight, weather, and traffic. System theory helps them make sure all parts of the bridge work together for strength and safety.

Power Supply Systems: Engineers use system theory to design electricity systems for cities, ensuring that all power stations, wires, and homes are connected and working properly.

In design science, system theory helps in making new inventions that are reliable, safe, and efficient.

3. Computer Science and Systems:

Computer science is the study of computers, software, and information systems.

How system theory is used:

In computer science, system theory is used to understand how computers operate — from how software works to how networks are connected.

Examples:

Computer System: A computer has input devices (keyboard, mouse), processing units (CPU), memory (RAM), and output devices (monitor, printer). All parts must work together as a system.

Software Systems: Programs like MS Word or games are built using system theory. Programmers plan how the software will handle user input and give the correct output.

Computer Networks: The internet is a system of many computers connected together. Engineers use system theory to design how data flows between devices safely and quickly.

In computer science, system theory is necessary for designing systems that are fast, secure, and user-friendly.

Conclusion:

System theory connects all branches of science by helping experts understand how different parts of a system interact. In natural science, it helps explain nature. In design science, it helps build safe and effective machines. In computer science, it helps in creating smart software and networks.

By using system theory, scientists and engineers can solve problems, make better designs, and understand the world more deeply. It is a powerful tool for improving both natural and man-made systems.

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

Computing systems:

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

Hardware software and electric power are three basic requisites that are needed to run a computing system that can be described in following simple terms.

Hardware: components of the system

Software: programs run on those components

Electric power: that enables hardware components to run.

Types of computing system

- Computer
- software system
- computer network
- internet

1 Network as a system

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

Objectives

Resource sharing: allows multiple users to share resources like files printers and internet access within an office or other setting.

Communication: enables efficient communication between devices and users

Data management: facilitates easy data management and collaborates.

Components:

Networking hardware

Routers: Routers are devices that transmit data packets between their

Switches: Which is to connect devices in a network and facilitate communication.

Network software

Protocols: rules and conventions for data exchange such as TCP IP.

Network operating system: software that manages network resources such as Windows servers.

Environment:

A computer networks operate in various environment such as office buildings data centers or across the globe via the internet the environment influences network designs security and performance.

Types of computer networks

Local area network LAN

Connect computers and specific area such as a single building or school.

For example: An office network that connects everyone. employee PC'S and printers.

Wide area network WAN

Connect computers across larger geographic regions such as cities Nations and continents.

For example: Consider the internet which links computers worldwide

2 Internet as a system

The internet is fast and complex system designed to connect multiple networks worldwide including private public academy business and government networks.

Internet protocols:

The TCP IP: the core protocols that govern that are 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 task.

For example, when are user request a web page through a web browser several components of Internet work together to display its content on the user screen.

Environment

The internet operates in diverse and dynamic environment connecting various type of network across different locations including home office data centers and mobile networks this environment influences design security and performance of internet.

3 Computer as a system

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

Objective

the main objective of Computer is to perform computation process data and execute different tasks.

For example: A personal computer objective is to run software application such as word processor web browser and games through various computational processes.

Components

A computer composed of many components that operate in conjunction these components include:

Interface components:

Interface components refer to fundamental part of Computer System including input devices such as keyboard mouse which allow users to interact with computer.

Processing component:

The processing components of a computer consists of CPU which at the central processing Unit responsible for computation and executing commands the operating system is responsible for receiving information from interface components and determining the appropriate action to take.

Communication components:

Communication components in computers refer to physical element that provide communication between different components of computer

in computer the motherboard serves as the primary circuit board that interconnects all components by using cables and circuit.

A system bus is a collection of electricity conductivity cables that transmit data between CPU and all other interconnected components.

Environment:

The computer system environment includes any external devices that interact with computers.

For example,

Power supply: provide electrical power to allow computers to work.

Network: connects computers to other systems and internet.

Peripheral: include printer scanner and external disc expand computer capability.

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

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 is 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 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.

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's 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 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.

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 hoe the architecture operates.**

The architecture of Von Newman computers:

Von Newman 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, input mechanism and output mechanism.

This model is called the John von neumann model the Newman model named in honor of mathematician and physicist who contributed to its development during the 1940s.

Components:

The key parts that constitute the architecture of the Von Neumann computer are:

1. **Memory:**

Contains both input data and the instructions or program required for CPU processing. For instance, consider the RAM of your computer when a program starts it is loaded in to 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 command provided by the memory. The system has two main components the arithmetic logic Unit ALU and control unit CU.

The arithmetic logic Unit performs mathematical computations and logical operations.

A control unit 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.

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 task 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: transport control electrical signals

How does Von Neumann architecture work?

The Von Neumann architecture encompasses 3 essential stages for a CPU to carry out instructions, namely retrieval, interpretation, execution and storage.

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.

Decoding:

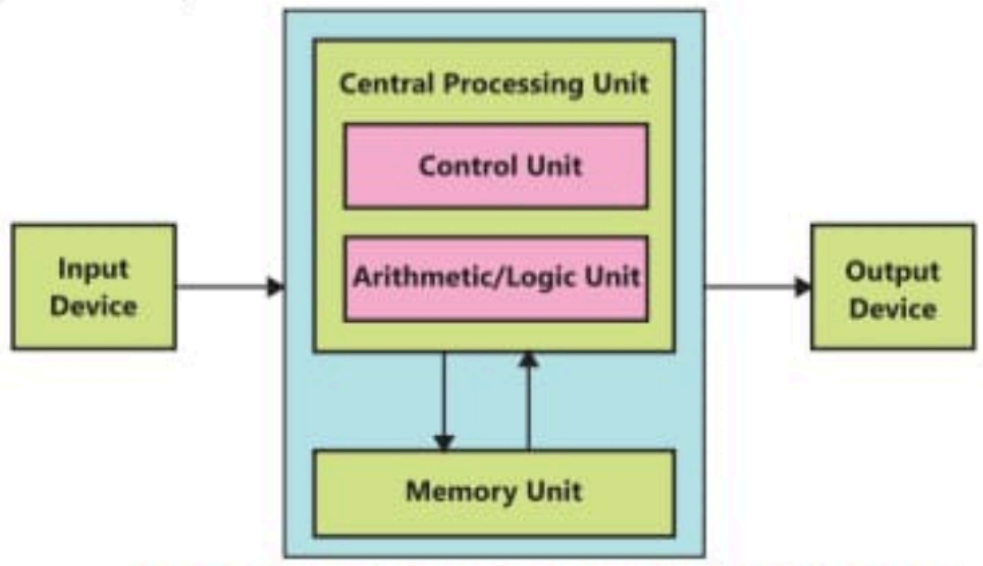
Description:
In order to determine the necessary action the control unit decodes the instruction.

Execution:

Description: the CPU processes the instruction. When the instruction involves a computation it is executed by ALU. Any task that requires transferring data between several locations is managed by the CU.

Storing:

the outcome of the computation is either returned to memory or sent to an output device.



7. **Provide a detailed explanation of how computers interact with their environment. Include examples of user input, network communication, and power supply?**

Computers interact with their environment through **three main channels**:

1. **User Input**
2. **Network Communication**
3. **Power Supply**

Each of these channels involves both hardware and software components that allow the computer to **receive, process, and respond** to external stimuli.

🔹 1. User Input

Computers receive **direct input from users** through various input devices. This interaction forms the core of how users communicate instructions and data to the system.

Examples:

- **Keyboard**: Typing a document, entering passwords, or using command-line interfaces.
- **Mouse/Touchpad**: Navigating a graphical user interface (GUI), clicking icons, or dragging files.
- **Touchscreen**: Tapping and swiping on tablets or smartphones.
- **Microphone**: Capturing voice commands (e.g., "Hey Siri" or "OK Google").
- **Webcam**: Feeding visual data for video calls or facial recognition.
- **Game controller**: Providing directional input or button presses in games.

Software Involvement:

- **Drivers** interpret raw input data into recognizable signals.
- **Operating Systems (OS)** manage and route input to the correct applications.

🔹 2. Network Communication

Computers interact with other systems via **network interfaces**—allowing data to be exchanged locally or over the internet.

Examples:

- **Web Browsing**: A user visits a website (e.g., www.google.com). The browser sends a request through the internet to a web server, which responds with HTML content.
- **Cloud Storage**: Files uploaded to Google Drive or Dropbox are transmitted through network protocols.

- **Email**: Sent using SMTP (Simple Mail Transfer Protocol), received via POP or IMAP.
- **Gaming**: Online multiplayer games communicate in real-time using low-latency protocols.

Networking Tools:

- **NIC (Network Interface Card)**: Enables wired or wireless communication.
- **Protocols**: TCP/IP, HTTP, FTP etc., define the rules for data exchange.

🔹 3. Power Supply

All computing devices require electrical power to function. The **power supply system** converts and regulates this power to prevent damage and ensure stable operation.

Examples:

- **Laptops**: Use internal rechargeable batteries, charged via AC adapters.
- **Desktops**: Use internal power supply units (PSUs) that convert AC from wall outlets to regulated DC power for internal components.
- **Smartphones/Tablets**: Charged through USB-C, Lightning, or wireless charging pads.
- **Servers**: Use redundant PSUs to prevent downtime in case of failure.

Power Management Features:

- **Power-saving modes**: Sleep, Hibernate, or Hybrid Sleep.
- **Battery management**: Monitors charge cycles, health, and temperature.
- **Uninterruptible Power Supply (UPS)**: Provides backup power in case of outages.

Summary Table

Interaction Type	Description	Example
User Input	Physical or sensory data from users to the computer	Typing, clicking, speaking
Network Communication	Exchanging data with other systems over a network	Sending emails, video streaming
Power Supply	Electrical power input to run hardware components	Plugging in a laptop charger

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.

How a Computer Opens and Shows a File — Step by Step

🔹 **Step 1: You Give a Command**

- You use the **mouse** or **keyboard** to open a file (like clicking on a picture or a document).
- The computer **gets your input** and starts the process.

🔹 **Step 2: Computer Understands What You Want**

- The **Operating System (OS)** (like Windows) understands that you want to open a file.
- It finds **where the file is saved** and what program is needed to open it (like Photos for pictures, Word for documents).

🔹 **Step 3: Finding the File**

- The computer looks for the file on its **hard drive or SSD** (these are parts that store your files).
- It **reads the file data** from there.

🔹 **Step 4: Loading the File**

- The file is **sent into RAM** (the computer's memory), so it can work with it quickly.
- The **CPU (main brain of the computer)** starts to read the file.

🔹 **Step 5: Opening the File**

- The program you use (like a photo viewer or Word) **opens the file** and gets it ready to show.
- It **turns the file into something you can see** on the screen.

🔹 **Step 6: Showing the File on the Screen**

- The **graphics system** (GPU or part of the CPU) sends the picture of the file to the **monitor**.
- Now you can **see the file on the screen** and work with it.

Example:

You double-click a photo → Computer finds it → Opens it in the Photos app → Shows it on your screen.

In Short:

Step	What Happens	Part of the Computer Used
1	You click to open a file	Mouse/Keyboard
2	Computer understands your command	Operating System

Step	What Happens	Part of the Computer Used
3	It looks for the file	Hard Drive / SSD
4	Loads the file into memory	RAM and CPU
5	Opens the file using a program	Software like Word or Photos
6	Shows the file on screen	Graphics and Monitor