CMR
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## Internal Assessment Test – III

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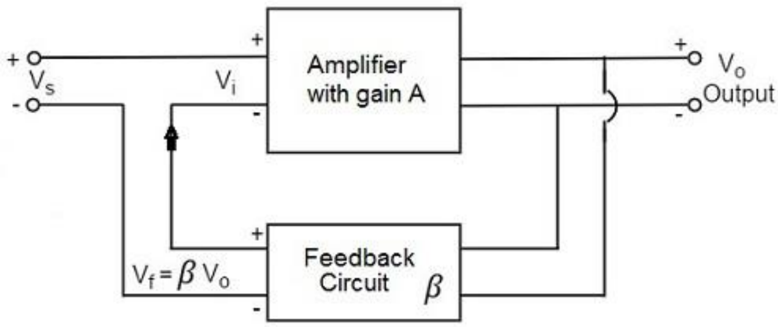
|---|---|---|---|---|---|---|---|---|---|---|
| **Sub:** | **Introduction to Electronics Engineering** | | | | | | | **Code:** | **BESCK204C** | |
| **Date:** | **26/ 06 / 2024** | **Duration:** | **90 mins** | **Max Marks:** | **50** | **Sem:** | **II** | **Sec:** | **Sec K & L** | |

| **Answer Any FIVE FULL Questions** | | **Marks** | **OBE CO** | **OBE RBT** |
|---|---|---|---|---|
| 1. | Draw the circuit diargam of (i) Ladder network oscillator (ii)Wein bridge oscillator (iii) Crystal controlled oscillator. | [4+4+2] | CO2 | L2 |
| 2. | What is an Embedded System? Describe the Classification of Embedded Systems with applications. | [4+4+2] | CO4 | L2 |
| 3. | Differentiate Between following : (i) Microprocessor and Microcontroller (ii) RISC and CISC | [15+5] | CO4 | L2 |
| 4. | Define and differentiate between General Purposes Computing System and Embedded System. | 10 | CO4 | L2 |
| 5. | Write note on followings: (i) Actuator (ii) LED (iii) 7-Segment Display | [3+3+4] | CO4 | L2 |

| | | | | |
|---|---|---|---|---|
| 6. | Explain positive feedback and derive the feedback loop gain under positive   feedback. | [10] | CO2 | L4 |
| 7. | Explain the block diagram and elements of modern communication system on basis of source, transducer, transmitter, and channel, Noise, Receiver and Multiplexing. | [10] | CO5 | L2 |
| 8. | What is modulation? List out the types of modulation. what is the need of modulation? | [2+4+5] | CO5 | L2 |

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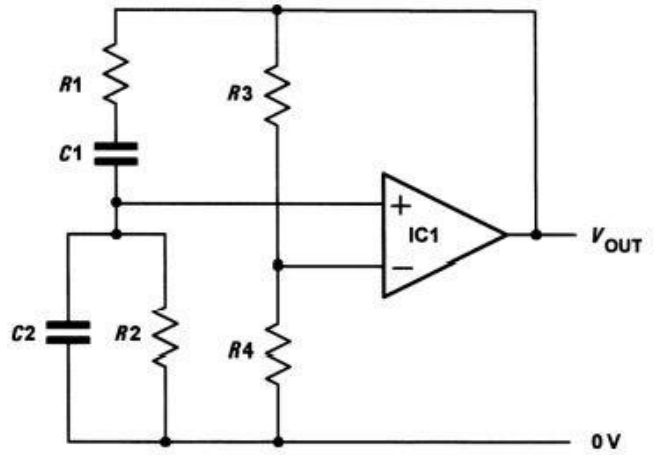
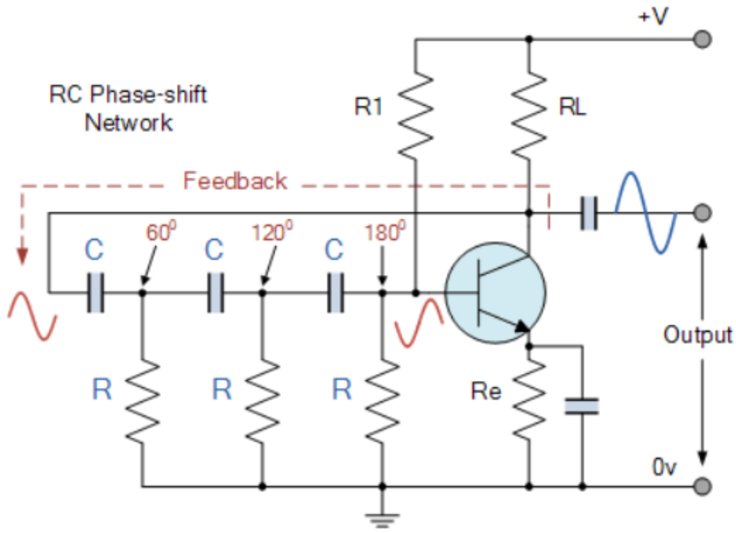
# Solution

## Answer 1.

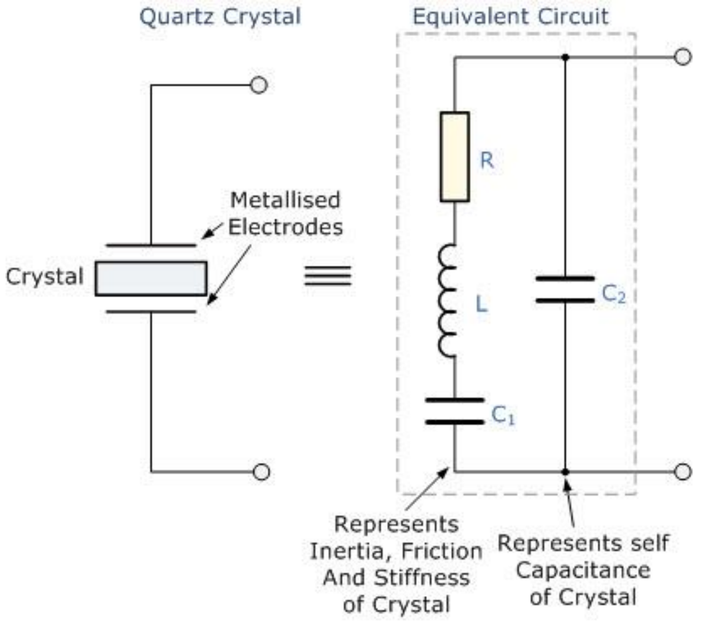
Wein bridge oscillator




Ladder network oscillator




Crystal controlled oscillator



**Answer 2.** What is an Embedded System?

An embedded system is a specialized computer system designed to perform dedicated functions or tasks, often within a larger device or system. It combines hardware and software to perform real-time operations. Unlike general-purpose computers, embedded systems are optimized for specific applications and are typically resource-constrained in terms of memory, processing power, and energy consumption.

Examples include microcontrollers in appliances, sensors in automobiles, and systems within medical devices.

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Classification of Embedded Systems

Embedded systems can be classified based on several parameters, such as performance, complexity, functional requirements, and real-time constraints. Below are the main categories:

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1. Classification Based on Performance and Functionality
   1. Small-scale Embedded Systems
      - Use 8-bit or 16-bit microcontrollers with limited resources (RAM, ROM).
      - Perform simple tasks like controlling lights, monitoring sensors, or managing basic appliances.
      - Examples: Microwave ovens, electronic toys, smart thermostats.
   2. Medium-scale Embedded Systems
      - Use 32-bit microcontrollers or DSPs (Digital Signal Processors) with more complex hardware and software requirements.
      - May include RTOS (Real-Time Operating System) for efficient task scheduling.
      - Examples: Washing machines, digital cameras, printers.
   3. Large-scale Embedded Systems
      - Feature powerful processors, FPGAs (Field Programmable Gate Arrays), or multi-core systems.
      - Require extensive hardware and software development with sophisticated algorithms.
      - Examples: Smart TVs, advanced robotics, automotive systems.

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2. Classification Based on Real-time Operation
   1. Hard Real-time Systems
      - Systems where meeting the deadline is crucial; missing a deadline can cause catastrophic failure.
      - Examples: Airbag control systems in cars, pacemakers, industrial control systems.
   2. Soft Real-time Systems
      - Deadlines are important but not critical; occasional delays may be tolerated without significant impact.
      - Examples: Multimedia streaming devices, gaming consoles, smart home systems.

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3. Classification Based on Application Specific Requirements
   1. Standalone Embedded Systems
      - Operate independently without needing a host system or network connection.
      - Examples: Digital watches, calculators, automatic door locks.
   2. Networked Embedded Systems
      - Communicate with other systems over wired or wireless networks to perform tasks collaboratively.
      - Examples: Smart grid systems, IoT devices, and smart security cameras.
   3. Mobile Embedded Systems
      - Designed for portability and low-power operation.
      - Examples: Smartphones, tablets, portable medical equipment.

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4. Classification Based on Microcontroller/Processor Architecture
   1. RISC-based Systems (Reduced Instruction Set Computing)
      - Use simplified instructions for faster execution, commonly found in ARM-based processors.
      - Examples: Smartphones, embedded Linux systems.
   2. CISC-based Systems (Complex Instruction Set Computing)

- Use complex instructions that reduce the number of operations but require more cycles per instruction.
- Examples: Traditional computers, some automotive control units.

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Applications of Embedded Systems

- Consumer Electronics: Smartphones, smartwatches, home appliances like refrigerators, washing machines, and air conditioners.
- Automotive: Engine control units (ECU), airbags, anti-lock braking systems (ABS), infotainment systems.
- Healthcare: Pacemakers, blood glucose monitors, medical imaging equipment.
- Telecommunications: Routers, modems, signal processors.
- Industrial: Process automation controllers, robotics, and CNC machines.
- Aerospace: Flight control systems, navigation units, and satellite controllers.

Embedded systems are becoming increasingly prevalent in the modern world, with the rise of IoT and smart technologies leading to even more advanced applications in multiple fields

# Answer 3. (i)

## (i) Microprocessor vs Microcontroller

| Aspect | Microprocessor | Microcontroller |
|---|---|---|
| **Definition** | A **microprocessor** is the central processing unit (CPU) of a computer, performing only processing tasks. It needs external components like memory, input/output ports, etc., to function. | A **microcontroller** is a compact integrated circuit that contains a CPU, memory (RAM/ROM), input/output ports, and other peripherals on a single chip. |
| **Architecture** | CPU only; requires external RAM, ROM, and peripherals. | All components (CPU, memory, I/O) are integrated on the same chip. |
| **Application Focus** | Used for **complex tasks** requiring high processing power. | Used for **specific control-oriented tasks** such as switching, automation, and sensing. |
| **Examples** | Intel 8086, Pentium, AMD Ryzen. | ARM Cortex-M, PIC, AVR, Arduino. |
| **Power Consumption** | High, as multiple components are required externally. | Low, optimized for energy-efficient applications. |
| **Cost and Complexity** | More expensive and complex to design due to external components. | Less expensive with simpler design since everything is on-chip. |
| **Usage** | PCs, laptops, and high-end servers. | Home appliances, IoT devices, and embedded systems. |

# Answer 3(ii)

## (ii) RISC vs CISC Architecture

| Aspect | RISC (Reduced Instruction Set Computing) | CISC (Complex Instruction Set Computing) |
|---|---|---|
| **Instruction Set** | Uses a **small, simple set of instructions** that execute in one clock cycle. | Uses a **large set of complex instructions**, which may take multiple clock cycles to execute. |
| **Design Complexity** | Simple design with a focus on fast execution. | More complex design due to larger instruction sets. |
| **Code Size** | Requires **more lines of code** for complex tasks. | Requires **fewer lines of code** as one complex instruction can replace multiple simpler ones. |
| **Performance** | Faster execution per instruction. Best for applications requiring **high speed** and **efficiency** (e.g., mobile devices). | Slower due to multiple cycles per instruction but efficient for complex operations. |
| **Power Consumption** | **Lower power consumption** due to simpler instructions and fewer transistors. | **Higher power consumption** due to the complexity of the instructions. |
| **Examples** | ARM, MIPS, RISC-V processors. | Intel x86, AMD, Motorola 68k. |
| **Applications** | Used in **embedded systems**, smartphones, IoT devices, and some servers. | Used in **personal computers**, laptops, and general-purpose computing. |

# Answer 4. Definition of General-Purpose Computing System (GPCS)

A General-Purpose Computing System is a computer designed to perform a variety of tasks. It can run multiple applications and handle different types of workloads, making it flexible and versatile. These systems prioritize computational power, multitasking, and user interaction.

Examples: Personal computers (PCs), laptops, servers, and workstations.

Definition of Embedded System

An Embedded System is a specialized computer system designed to perform specific, pre-defined tasks. It is usually optimized for real-time operations with dedicated hardware and software components. Embedded systems are often part of a larger system or device and focus on efficiency, reliability, and low power consumption.

Examples: Washing machine controllers, automotive engine control units, and pacemakers.

### Differences between General-Purpose Computing System and Embedded System

| Aspect | General-Purpose Computing System (GPCS) | Embedded System |
| --- | --- | --- |
| **Purpose** | Designed to handle **multiple tasks** and applications. | Optimized to perform **specific tasks** or functions. |
| **Flexibility** | Highly flexible, capable of running various software applications. | Limited flexibility, usually performs only predefined tasks. |
| **Performance Requirements** | Focuses on **high computational power** and multitasking. | Prioritizes **efficiency, reliability, and low power consumption**. |
| **Hardware Components** | Includes general-purpose processors, RAM, storage, etc. | Uses **microcontrollers or specialized processors** with integrated memory and peripherals. |
| **Operating System** | Runs **complex operating systems** like Windows, Linux, or macOS. | May use **RTOS (Real-Time Operating System)** or firmware; some run without an OS. |
| **User Interaction** | Designed for direct user interaction through interfaces (keyboard, mouse, etc.). | Limited or no direct user interaction; often operates autonomously. |
| **Energy Consumption** | **Higher** power consumption due to powerful components and multitasking. | **Low** power consumption, optimized for specific tasks. |
| **Examples** | PCs, laptops, gaming consoles, and servers. | Digital cameras, microwave ovens, IoT devices, automotive systems. |

# Answer 5.

i) Actuator

An actuator is a device that converts electrical energy into mechanical movement. It is typically used in control systems to perform physical tasks, such as opening a valve, rotating a motor, or moving a robotic arm. Actuators play a key role in automation by providing the motion or force needed to execute tasks based on control signals from embedded systems.

Types:

Electrical actuators (motors, solenoids)

Hydraulic actuators (fluid-powered movement)

Pneumatic actuators (air-powered movement)

Applications:

Robotics (motor-driven joints)

Automotive (electric windows, throttle control)

Industrial automation (valve operations)

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(ii) LED (Light Emitting Diode)

An LED is a semiconductor device that emits light when an electrical current flows through it. LEDs are energy-efficient, compact, and long-lasting, making them a popular choice for a wide range of applications. The color of light emitted depends on the material used in the LED's construction.

Features:

Low power consumption
Longer lifespan compared to traditional light bulbs
Available in various colors (Red, Green, Blue, White, etc.)
Applications:
Indicator lights on electronic devices
Displays in TVs, smartphones, and wearables
Automotive lights (headlights, taillights)

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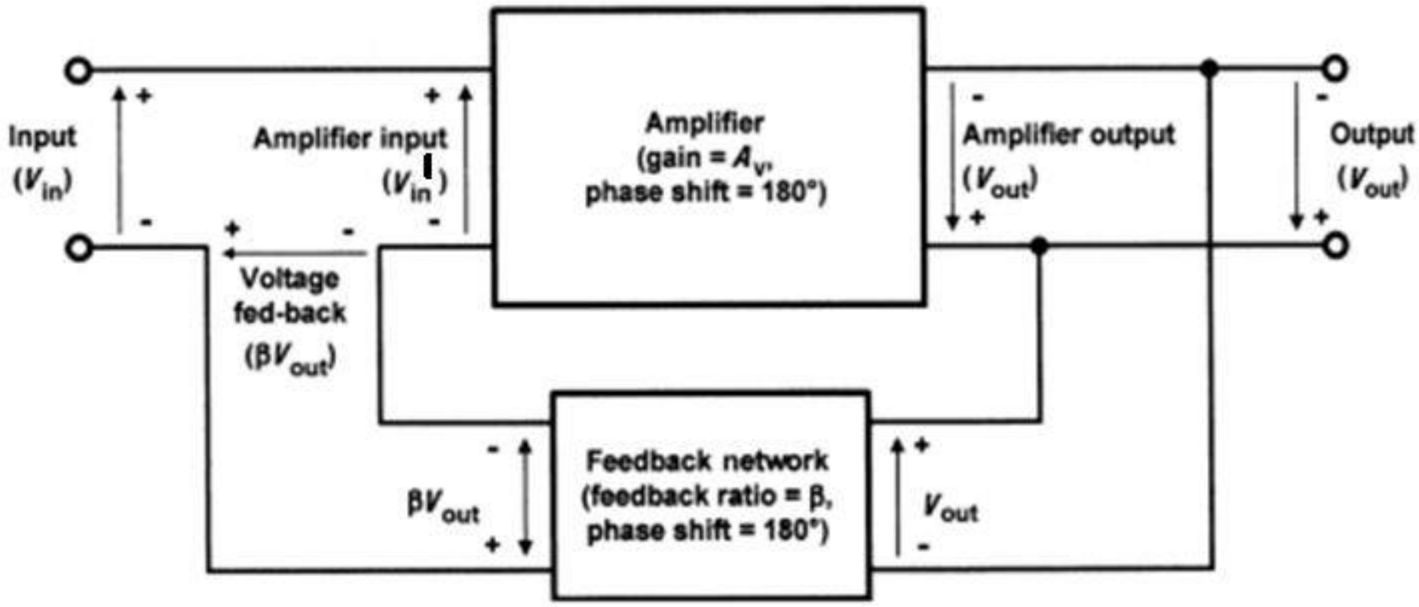
(iii) 7-Segment Display
A 7-segment display is a form of electronic display used to represent decimal numbers. It consists of seven LEDs (segments) arranged in the shape of the number "8". By selectively illuminating specific segments, the display can show digits from 0 to 9. Some variants also have an additional decimal point (DP) for displaying fractional values.
Configuration:
Common anode or cathode connections.
Each segment is labeled from 'a' to 'g', corresponding to individual LEDs.
Applications:
Digital clocks and timers
Calculators and measurement devices
Elevator floor indicators
The simplicity and ease of use make the 7-segment display a popular choice for numerical displays in embedded systems.

# Answer 6.

**Positive Feedback in Control Systems**

**Positive feedback** occurs when the output of a system is fed back into the input **in phase**, reinforcing or amplifying the original signal. In contrast to negative feedback, which stabilizes the system by opposing the input signal, positive feedback enhances the input signal and can lead to increased gain or instability if not controlled properly. Positive feedback is useful in systems like oscillators and triggers, where signal amplification or regeneration is required.



$$\text{Overall gain, } G = \frac{V_{out}}{V_{in}}$$

By applying Kirchhoff's Voltage Law

$$V_{in}' = V_{in} + \beta V_{out}$$

thus

$$V_{in} = V_{in}' - \beta V_{out}$$

and

$$V_{out} = A_v \times V_{in}$$

where *Av* is the internal gain of the amplifier.
Hence:

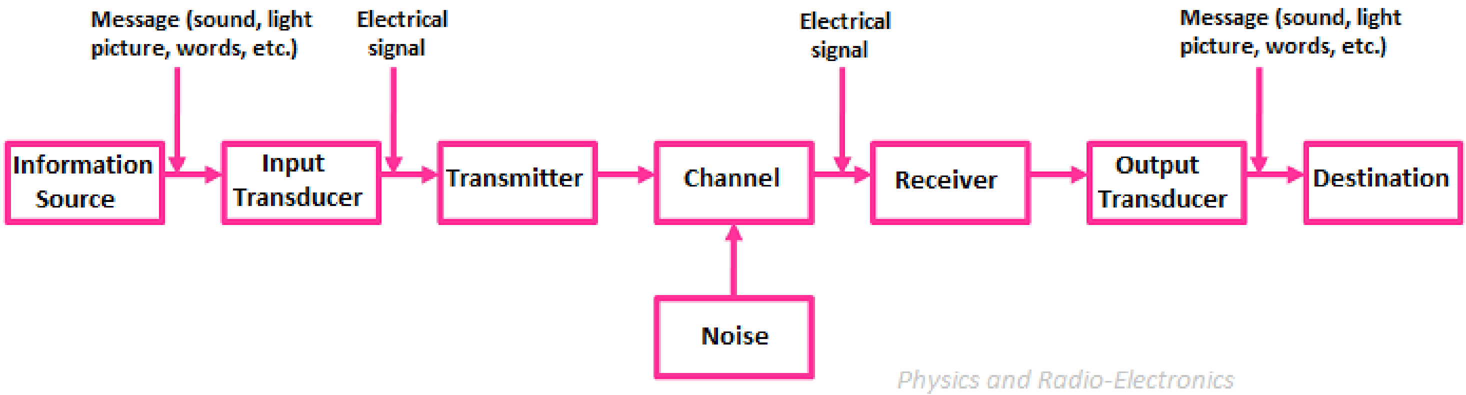
$$\text{Overall gain, } G = \frac{A_v \times V_{in}'}{V_{in}' - \beta V_{out}} = \frac{A_v \times V_{in}'}{V_{in}' - \beta(A_v \times V_{in}')}$$

$$\text{Thus, } G = \frac{A_v}{1 - \beta A_v}$$

# Answer 7.

**Modern Communication System: Block Diagram and Elements**

A **communication system** transmits information from a source to a destination. Modern systems consist of multiple components to efficiently encode, transmit, and decode data over various channels. Below is the block diagram and an explanation of the elements involved.




**Key Elements of a Communication System**

1. **Source**
   - The **source** is the origin of the message or data that needs to be communicated. The information could be in the form of **speech, audio, video, text**, or **data** from sensors.
   - **Example**: A person speaking on a phone, a video feed, or sensor readings from IoT devices.

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2. **Transducer**
   - A **transducer** converts the message from one form of energy into another for transmission. For example, **microphones convert sound into electrical signals**, and cameras convert images into digital data.
   - **Types of Transducers**: Microphones, cameras, temperature sensors, etc.

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3. **Transmitter**
    - The **transmitter** processes the signal for transmission over the channel. It performs functions like **amplification, modulation, and encoding** to ensure the signal is transmitted efficiently.
    - **Modulation**: The message signal is modulated to a higher frequency carrier to allow effective propagation.
    - **Example**: A radio transmitter modulates sound into radio waves, while a Wi-Fi transmitter encodes and modulates data into RF signals.

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4. **Channel**
    - The **channel** is the medium through which the signal travels from the transmitter to the receiver. It can be **wired** (cables, fiber optics) or **wireless** (radio waves, satellite links).
    - **Types**: Copper cables, fiber optics, air (for radio waves), etc.
    - **Characteristics**: The channel can introduce attenuation, distortion, and interference.

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5. **Noise**
    - **Noise** is any unwanted signal that interferes with the transmitted signal, causing distortion or degradation in quality.
    - **Sources of Noise**: Electrical interference, thermal noise, atmospheric noise, and human-made noise.
    - **Impact**: Noise reduces the **Signal-to-Noise Ratio (SNR)**, leading to poor signal quality and potential data loss.

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6. **Receiver**
    - The **receiver** extracts the message from the transmitted signal. It performs functions such as **demodulation, filtering, and decoding**. The goal is to accurately reconstruct the original message with minimal distortion.
    - **Example**: A radio receiver demodulates the radio waves into sound, and a modem demodulates digital data sent over a phone line.

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7. **Multiplexing** (Optional Element)
    - **Multiplexing** allows multiple signals to be transmitted over a single channel simultaneously, improving efficiency. It separates signals either in **time, frequency, or code domains**.
    - **Types**:
        - **Time-Division Multiplexing (TDM)**: Multiple signals share the same channel in different time slots.
        - **Frequency-Division Multiplexing (FDM)**: Signals occupy different frequency bands.
        - **Code-Division Multiplexing (CDM)**: Unique codes are assigned to each signal.

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8. **Destination**
    - The **destination** is the end point where the transmitted message is received and interpreted by the user or device. It could be a speaker, display screen, computer, or any other interface that presents the information.
    - **Example**: A phone speaker that plays sound, or a monitor that displays video content.

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**Summary of Signal Flow in a Communication System**

- **Source** generates the information.
- **Transducer** converts the message into an electrical or digital signal.
- **Transmitter** modulates and sends the signal through the **channel**.
- The signal is affected by **noise** as it propagates through the channel.
- **Receiver** demodulates and recovers the original signal.
- **Multiplexing** ensures efficient use of channels when multiple signals are transmitted.

- Finally, the signal reaches the **destination** for interpretation or use.

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**Applications of Modern Communication Systems**

- **Telecommunication**: Mobile networks, internet, and satellite communication.
- **Broadcasting**: Radio, television, and streaming services.
- **IoT and Automation**: Sensors transmitting data to cloud systems.
- **Data Networks**: Fiber optic communication, Ethernet networks, and wireless communication (Wi-Fi, 5G).

This structured approach ensures that the transmitted information reaches the intended destination with minimal loss and interference, providing the foundation for modern communications

# Answer 8.

**What is Modulation?**

**Modulation** is the process of altering a **carrier signal's properties** (like amplitude, frequency, or phase) based on the **information signal** (message) to be transmitted. The information signal (which could be voice, data, or video) is typically of low frequency, and modulation helps it travel efficiently over long distances by shifting it to a higher frequency.

- **Carrier Signal**: A high-frequency signal that carries the information.
- **Message Signal**: The original information signal (low frequency).

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**Types of Modulation**

1. **Analog Modulation**
    - Modulating the carrier with **analog information** (like voice or video signals).
    - **Types of Analog Modulation**:
        - **Amplitude Modulation (AM)**: The amplitude of the carrier varies according to the message signal.
        - **Frequency Modulation (FM)**: The frequency of the carrier varies according to the message signal.
        - **Phase Modulation (PM)**: The phase of the carrier signal changes with the message signal.
2. **Digital Modulation**
    - Used when the **message signal is digital data** (binary data: 0s and 1s).
    - **Types of Digital Modulation**:
        - **Amplitude Shift Keying (ASK)**: Carrier amplitude varies with digital data.
        - **Frequency Shift Keying (FSK)**: Carrier frequency varies with binary data.
        - **Phase Shift Keying (PSK)**: Carrier phase changes according to the digital data.
        - **Quadrature Amplitude Modulation (QAM)**: Combines both amplitude and phase modulation.
3. **Pulse Modulation**
    - Deals with **sampling analog signals** into discrete-time pulses.
    - **Types**:
        - **Pulse Amplitude Modulation (PAM)**: Amplitude of pulses varies.
        - **Pulse Width Modulation (PWM)**: Width of pulses varies.
        - **Pulse Position Modulation (PPM)**: Position of pulses changes.
        - **Pulse Code Modulation (PCM)**: Analog signals are converted into a binary stream.

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**Need for Modulation**

1. **Efficient Transmission over Long Distances**
    - Low-frequency signals (like audio signals) cannot travel far due to energy loss. Modulation shifts the signal to **higher frequencies**, enabling long-distance transmission.
2. **Antenna Size Reduction**

- To efficiently transmit a signal, the antenna size must be proportional to the signal's wavelength. Higher frequency signals (from modulation) require **smaller antennas**, making communication equipment more practical.

3. **Multiplexing Capability**
    - Modulation allows **multiple signals** to share the same medium by assigning different frequencies to each signal (through **Frequency Division Multiplexing**), ensuring efficient use of the available bandwidth.
4. **Noise Reduction and Signal Quality**
    - Higher frequency signals are **less prone to noise** and interference compared to low-frequency signals, improving signal quality during transmission.
5. **Spectrum Utilization**
    - Modulation helps **organize and manage spectrum allocation**, preventing interference among different communication channels.
6. **Compatibility with Transmission Media**
    - Modulation helps adapt signals to different types of **media** like optical fibers, coaxial cables, or radio waves, ensuring efficient communication.