

2(a) Outline the characteristics of IoT.

Characteristics of IoT

The Internet of Things (IoT) is a system in which devices are connected through the internet to share data and perform tasks automatically. The main characteristics of IoT are given below.

1. Connectivity

IoT devices are connected to the internet or network for communication and data sharing.

2. Sensing

Sensors collect information such as temperature, humidity, motion and light from the environment.

3. Intelligence

IoT systems analyze data and make smart decisions automatically.

4. Automation

Devices can perform tasks automatically without human involvement.

5. Real-Time Communication

IoT devices exchange data instantly for quick monitoring and control.

6. Heterogeneity

Different devices and technologies can work together in one IoT system.

7. Scalability

More devices can be added easily to the IoT network.

8. Security

IoT systems require security to protect data and devices from unauthorized access.

2(b) Differentiate between Consumer IoT and Industrial IoT.

Consumer IoT	Industrial IoT
Used by normal users at home	Used in industries and factories
Focuses on comfort and convenience	Focuses on productivity and efficiency
Devices are low cost	Devices are expensive and powerful
Security requirement is lower	High security is required

Consumer IoT	Industrial IoT
Used on a small scale	Used on a large scale
Examples: Smart TV, smart watch, smart speaker	Examples: Smart machines, industrial robots, sensors
Failure causes minor problems	Failure may cause heavy loss

2(c) Define multihoming. Classify between classical multihoming and multihoming with multiple addresses.

Multihoming

Multihoming is a technique in which a device or network is connected to more than one internet connection or network at the same time. It improves reliability, communication and network performance. If one connection fails, another connection can continue the communication.

Types of Multihoming

1. Classical Multihoming

In classical multihoming, a network is connected to multiple Internet Service Providers (ISPs) using one address range. It is mainly used for backup and reliability. When one network connection fails, the other connection keeps the network active.

Features:

- Provides network reliability
- Used for backup connection
- Reduces network failure problems

Example:

A company connected to two different ISPs.

2. Multihoming with Multiple Addresses

In this type, a device or network uses multiple IP addresses for communication. Different addresses can be used for different network paths. It improves load sharing and communication efficiency.

Features:

- Uses multiple IP addresses

- Supports better data transfer
- Improves network performance

Example:

A smartphone using both Wi-Fi and mobile data together.

2(d) Portray the architecture of IEEE 802.15.4.

IEEE 802.15.4 Architecture

IEEE 802.15.4 is a wireless communication standard used in IoT and sensor networks. It supports low power, low cost and short-range communication between devices. It is mainly used in technologies like ZigBee and wireless sensor networks.

The architecture of IEEE 802.15.4 consists of the following layers:

1. Physical Layer (PHY)

The physical layer is responsible for transmitting and receiving data signals. It controls frequency selection, modulation and data transmission.

Functions:

- Data transmission and reception
- Channel selection
- Signal detection

2. MAC Layer (Medium Access Control)

The MAC layer controls communication between devices and manages access to the wireless channel. It helps avoid data collision.

Functions:

- Data transfer control
- Error checking
- Channel access management

3. Network Layer

The network layer manages routing and communication between devices in the network.

Functions:

- Routing of data

- Network formation
- Device communication

4. Application Layer

This layer provides services to the user and supports IoT applications.

Functions:

- User interaction
- Smart applications support
- Data processing

Features of IEEE 802.15.4

- Low power consumption
- Low cost
- Short-range communication
- Simple network structure

2(e) Illustrate the four modes by which sensors detect the objects.

Modes of Object Detection by Sensors

Sensors are devices used to detect objects and collect information from the environment. Sensors can detect objects in different ways depending on their working principle. The four modes of object detection are given below.

1. Active Mode

In active mode, the sensor sends energy or signals towards the object and receives the reflected signal to detect the object.

Example:

Radar sensor and ultrasonic sensor.

Features:

- Works by transmitting signals
- Detects distance and movement
- Accurate detection

2. Passive Mode

In passive mode, the sensor does not send any signal. It only detects natural energy or radiation coming from the object.

Example:

Temperature sensor and infrared sensor.

Features:

- Does not generate signals
- Uses natural energy from objects
- Consumes less power

3. Contact Mode

In contact mode, the sensor must touch the object for detection and measurement.

Example:

Touch sensor and pressure sensor.

Features:

- Physical contact is necessary
- Simple and reliable
- Used for direct measurement

4. Non-Contact Mode

In non-contact mode, the sensor detects objects without touching them.

Example:

Infrared sensor and proximity sensor.

Features:

- No physical contact needed
- Fast detection
- Used in automation systems

2(f) What do you mean by smart home? Give four examples of smart homes in brief.

Smart Home

A smart home is a house in which electronic devices and appliances are connected through the internet and can be controlled automatically or remotely using smartphones or computers. Smart homes improve comfort, security, energy saving and convenience for users.

Examples of Smart Home

1. Smart Lighting System

Smart lights can be controlled using mobile apps or voice commands. Lights can automatically switch ON or OFF when needed.

2. Smart Security System

Smart security systems use CCTV cameras, smart locks and alarms to improve home safety. Users can monitor their homes remotely.

3. Smart Air Conditioner

Smart AC systems can automatically control room temperature and can be operated through smartphones.

4. Smart Refrigerator

A smart refrigerator monitors food items, temperature and energy usage. It can also send notifications to users.

2(g) Outline the benefits and challenges of IIoT.

Benefits and Challenges of IIoT

Industrial Internet of Things (IIoT) refers to the use of IoT technology in industries and manufacturing systems. IIoT connects machines, sensors and devices to improve industrial operations and productivity.

Benefits of IIoT

1. Increased Productivity

IIoT helps machines work efficiently and increases production speed.

2. Real-Time Monitoring

Industries can monitor machines and systems continuously in real time.

3. Reduced Human Effort

Automation reduces manual work and improves accuracy.

4. Predictive Maintenance

IIoT helps detect machine problems early, reducing maintenance cost and downtime.

5. Better Decision Making

Collected data helps industries make better and faster decisions.

6. Improved Safety

IIoT systems help monitor dangerous areas and improve worker safety.

Challenges of IIoT

1. Security Issues

Connected devices may face hacking and cyber attacks.

2. High Installation Cost

Setting up IIoT systems requires expensive devices and infrastructure.

3. Data Management

Large amounts of data are difficult to store and manage.

4. Network Dependency

IIoT systems depend heavily on internet and network connectivity.

5. Compatibility Problems

Different devices and technologies may not work properly together.

6. Privacy Issues

Industrial data must be protected from unauthorized access.

2(a) Discuss about different components of IoT.

Components of IoT

Internet of Things (IoT) is a system where different devices communicate through the internet to collect and exchange data. IoT consists of several important components that help the system work properly.

1. Sensors and Devices

Sensors are used to collect data from the environment such as temperature, humidity, motion and pressure. Devices use this data to perform operations.

2. Connectivity

Connectivity helps IoT devices communicate with each other through networks like Wi-Fi, Bluetooth, ZigBee and mobile networks.

3. Data Processing

The collected data is processed using software or cloud systems. Processing helps convert raw data into useful information.

4. User Interface

The user interface allows users to monitor and control IoT devices using mobile apps, computers or websites.

5. Cloud Storage

Cloud platforms store large amounts of IoT data and help users access data from anywhere.

6. Actuators

Actuators perform physical actions based on received commands, such as switching ON lights or controlling motors.

2(c) Portray the architecture of ZigBee.

ZigBee Architecture

ZigBee is a wireless communication technology used in IoT, sensor networks and home automation systems. It is based on IEEE 802.15.4 standard and supports low power and short-range communication.

The ZigBee architecture consists of different layers which work together for communication between devices.

Layers of ZigBee Architecture

1. Physical Layer

The physical layer handles transmission and reception of wireless signals.

Functions:

- Signal transmission
- Frequency selection
- Data communication

2. MAC Layer (Medium Access Control)

The MAC layer controls access to the communication channel and manages data transfer between devices.

Functions:

- Error checking
- Channel access control
- Data frame management

3. Network Layer

The network layer manages routing and communication among ZigBee devices.

Functions:

- Network formation
- Device addressing
- Routing of data packets

4. Application Support Layer

This layer provides communication services between network and application layers.

Functions:

- Message handling
- Device management
- Security support

5. Application Layer

The application layer is responsible for user applications and smart device control.

Functions:

- Smart home applications
- Industrial automation
- Sensor monitoring

Features of ZigBee

- Low power consumption
- Low cost
- Secure communication

- Supports many devices
- Short-range wireless communication

2(d) Define HAN. Write the advantages & disadvantages of HAN.

HAN (Home Area Network)

HAN stands for Home Area Network. It is a network that connects different electronic devices within a home for communication and data sharing. HAN is mainly used in smart homes to control appliances such as lights, fans, televisions, air conditioners and security systems through the internet.

HAN uses technologies like Wi-Fi, Bluetooth and ZigBee for communication between devices.

Advantages of HAN

1. Easy Device Control

Users can control home appliances remotely using smartphones or computers.

2. Energy Saving

HAN helps reduce electricity usage through smart control of devices.

3. Improved Security

Smart cameras, alarms and locks improve home security.

4. Automation

Devices can work automatically based on user settings and sensor data.

5. Convenience

HAN makes daily life easier and more comfortable for users.

Disadvantages of HAN

1. High Installation Cost

Setting up smart home devices and networks can be expensive.

2. Security Risks

Connected devices may face hacking and privacy problems.

3. Internet Dependency

HAN systems depend on proper internet connectivity.

4. Technical Complexity

Some users may find installation and maintenance difficult.

5. Compatibility Issues

Different devices may not work properly together.

2(e) What is IDE? Explain the various basic components of Arduino Board.

IDE

IDE stands for Integrated Development Environment. It is a software application used to write, edit, compile and upload programs into Arduino boards. Arduino IDE provides a simple platform for developing IoT and embedded system projects.

The Arduino IDE supports programming languages like C and C++ and helps users communicate with the Arduino board easily.

Basic Components of Arduino Board

1. Microcontroller

The microcontroller is the main part of the Arduino board. It processes data and controls all operations of the board.

Function:

- Executes program instructions
- Controls input and output devices

2. Digital Input/Output Pins

These pins are used to connect sensors, LEDs, switches and other devices.

Function:

- Send or receive digital signals

3. Analog Input Pins

Analog pins are used to read analog signals from sensors.

Function:

- Read variable voltage values

4. USB Port

The USB port is used to connect the Arduino board to a computer.

Function:

- Upload programs
- Provide power supply

5. Power Supply Pins

These pins provide power to external devices connected to the Arduino board.

Function:

- Supply voltage and ground connection

6. Reset Button

The reset button restarts the Arduino program from the beginning.

Function:

- Resets the microcontroller

7. Crystal Oscillator

It controls the clock speed of the Arduino board.

Function:

- Maintains timing and synchronization

8. LED Indicators

LEDs indicate power status and data transmission activity.

Function:

- Show board operation status

2(f) Define smart city. Give four examples of smart city applications.

Smart City

A smart city is a modern city that uses Internet of Things (IoT), sensors and communication technologies to improve the quality of life of people. Smart cities use technology for better management of transportation, electricity, water supply, healthcare and security systems.

The main aim of a smart city is to provide efficient services, reduce resource wastage and improve public safety.

Examples of Smart City Applications

1. Smart Traffic Management

Smart traffic systems use sensors and cameras to control traffic flow and reduce traffic congestion.

Benefits:

- Reduces traffic jams
- Saves travel time
- Improves road safety

2. Smart Street Lighting

Street lights automatically turn ON or OFF based on movement and daylight conditions.

Benefits:

- Saves electricity
- Reduces maintenance cost

3. Smart Waste Management

Sensors in dustbins monitor garbage levels and help in efficient waste collection.

Benefits:

- Cleaner environment
- Better waste management

4. Smart Healthcare System

Hospitals and healthcare centers use IoT devices for patient monitoring and health services.

Benefits:

- Fast medical support
- Improved healthcare services

2(g) Explain briefly about smart transportation.**Smart Transportation**

Smart transportation is an advanced transport system that uses Internet of Things (IoT), sensors, communication networks and automation technologies to improve traffic management, safety and transportation services.

It helps in reducing traffic congestion, saving fuel and improving travel efficiency. Smart transportation systems collect real-time data from vehicles, roads and traffic signals to manage transportation effectively.

Features of Smart Transportation

1. Real-Time Traffic Monitoring

Sensors and cameras monitor traffic conditions continuously.

2. Smart Traffic Signals

Traffic lights automatically adjust according to traffic flow.

3. GPS and Navigation

Vehicles use GPS systems for route guidance and location tracking.

4. Smart Parking System

Sensors help drivers find available parking spaces easily.

5. Public Transport Management

IoT helps monitor buses, trains and transport schedules in real time.

Advantages of Smart Transportation

1. Reduces Traffic Congestion

Efficient traffic management decreases road congestion.

2. Saves Time and Fuel

Better route planning reduces travel time and fuel consumption.

3. Improves Road Safety

Smart monitoring systems help prevent accidents.

4. Reduces Pollution

Less traffic congestion lowers air pollution.

5. Better Public Transport Services

Passengers can track public transport easily.

2(a) Compare between Piconet and Scatternet in Bluetooth. (Any Five)

Piconet	Scatternet
A small Bluetooth network formed by one master and slave devices	Combination of two or more connected piconets
Contains one master device	Contains multiple master devices

Piconet	Scatternet
Supports up to 7 active slave devices	Supports many devices through multiple piconets
Simple network structure	Complex network structure
Communication happens within one piconet only	Communication occurs between multiple piconets
Limited network coverage	Larger network coverage
Easier to manage	More difficult to manage

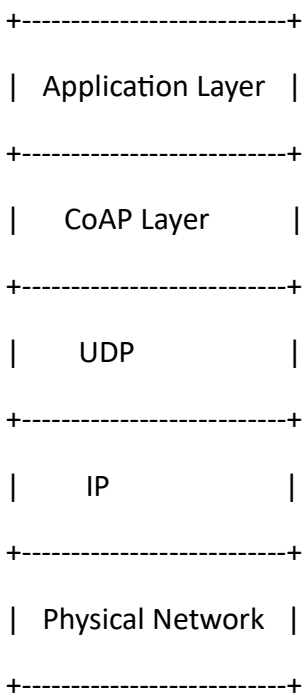
2(b) Explain the architecture of CoAP with a neat diagram.

CoAP Architecture

CoAP stands for Constrained Application Protocol. It is a lightweight communication protocol used in IoT devices and sensor networks. CoAP is designed for low power and low memory devices that work through the internet.

CoAP follows a client-server architecture where the client sends requests and the server provides responses.

Architecture of CoAP



Layers of CoAP Architecture

1. Application Layer

This layer contains IoT applications and smart services.

Functions:

- User interaction
- Smart device control
- Data processing

2. CoAP Layer

This is the main communication layer of CoAP.

Functions:

- Request and response handling
- Resource management
- Reliable message transfer

3. UDP Layer

CoAP uses UDP protocol for fast and lightweight communication.

Functions:

- Low overhead communication
- Fast data transmission

4. IP Layer

The IP layer handles addressing and routing of data packets.

Functions:

- Device addressing
- Packet routing

5. Physical Network Layer

This layer provides physical communication between IoT devices.

Examples:

- Wi-Fi

- ZigBee
- Bluetooth

Features of CoAP

- Lightweight protocol
- Low power consumption
- Fast communication
- Suitable for IoT devices
- Supports REST architecture

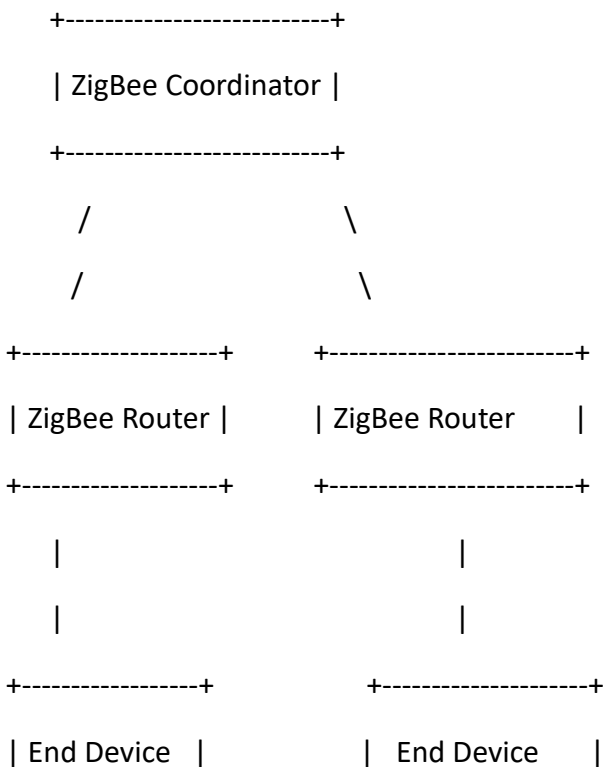
2(c) Illustrate the working principle of ZigBee with proper diagram.

Working Principle of ZigBee

ZigBee is a low power wireless communication technology used in IoT, home automation and sensor networks. It is based on IEEE 802.15.4 standard and supports short-range communication between devices.

ZigBee works by transmitting data wirelessly between devices such as sensors, controllers and smart appliances.

Diagram of ZigBee Communication



+-----+ +-----+

Working of ZigBee

1. ZigBee Coordinator

The coordinator is the main device in the network. It starts the network and manages communication between devices.

Functions:

- Creates the network
- Controls data communication
- Connects devices

2. ZigBee Router

Routers help in forwarding data from one device to another and increase communication range.

Functions:

- Route data packets
- Extend network coverage

3. End Devices

End devices are sensors or smart devices that collect and send data.

Functions:

- Sense environmental data
- Communicate with coordinator or router

Features of ZigBee

- Low power consumption
- Low cost
- Secure communication
- Supports many devices
- Suitable for IoT applications

Applications of ZigBee

- Smart home systems
- Industrial automation

- Wireless sensor networks
- Smart lighting systems

2(d) Define Software Defined Network. Explain the modes by which sensors detect the object.

Software Defined Network (SDN)

Software Defined Network (SDN) is a modern networking technology in which the control of the network is managed through software instead of traditional hardware devices. SDN separates the control plane from the data plane, making network management easier and more flexible.

SDN helps administrators control, monitor and configure the network centrally.

Advantages of SDN

- Easy network management
- Better flexibility
- Faster network control
- Improved performance
- Simplified configuration

Modes by which Sensors Detect the Object

Sensors detect objects in different ways depending on their working principle. The main detection modes are given below.

1. Active Mode

In active mode, the sensor sends signals or energy towards the object and receives the reflected signal.

Example:

Radar sensor, ultrasonic sensor

Features:

- Uses transmitted signals
- Accurate object detection

2. Passive Mode

In passive mode, the sensor only detects natural energy coming from the object and does not send any signal.

Example:

Infrared sensor, temperature sensor

Features:

- Low power consumption
- Detects natural radiation

3. Contact Mode

In contact mode, the sensor must physically touch the object for detection.

Example:

Touch sensor, pressure sensor

Features:

- Direct measurement
- Simple operation

4. Non-Contact Mode

In non-contact mode, the sensor detects objects without physical contact.

Example:

Proximity sensor, infrared sensor

Features:

- Fast detection
- Used in automation systems

2(e) Explain about M2M Ecosystem.**M2M Ecosystem**

M2M stands for Machine-to-Machine communication. It is a system in which devices communicate with each other automatically without human involvement. M2M technology is widely used in IoT, smart homes, industries, healthcare and transportation systems.

The M2M ecosystem consists of different components that work together for data collection, communication and processing.

Components of M2M Ecosystem**1. M2M Devices**

These are smart devices or machines equipped with sensors and communication modules.

Functions:

- Collect data from the environment
- Send and receive information

Examples:

- Smart meters
- Sensors
- Smart appliances

2. Communication Network

The communication network transfers data between devices and servers.

Technologies Used:

- Wi-Fi
- Bluetooth
- ZigBee
- Cellular networks

3. M2M Gateway

The gateway acts as an intermediate device between sensors and cloud systems.

Functions:

- Data collection
- Data conversion
- Protocol management

4. Data Processing System

Collected data is processed and analyzed using software or cloud platforms.

Functions:

- Data analysis
- Monitoring
- Decision making

5. Application Layer

This layer provides services to users through applications and dashboards.

Functions:

- User interaction
- Device control
- System monitoring

Applications of M2M

- Smart homes
- Healthcare monitoring
- Industrial automation
- Smart transportation
- Smart agriculture

2(f) Discuss about smart healthcare in IoT.

Smart Healthcare in IoT

Smart healthcare is an application of Internet of Things (IoT) used to improve medical services and patient care. In smart healthcare systems, medical devices, sensors and healthcare applications are connected through the internet for monitoring and communication.

IoT helps doctors and hospitals collect real-time patient data and provide better treatment.

Working of Smart Healthcare

Sensors and medical devices collect patient information such as heart rate, temperature, blood pressure and oxygen level. This data is sent through the internet to doctors or healthcare centers for monitoring and analysis.

Components of Smart Healthcare

1. Medical Sensors

Sensors monitor patient health conditions continuously.

Examples:

- Heartbeat sensor
- Temperature sensor

- Blood pressure monitor

2. Communication Network

Networks transfer medical data between devices and hospitals.

Technologies:

- Wi-Fi
- Bluetooth
- Mobile networks

3. Cloud Storage

Patient data is stored securely in cloud systems for future use.

4. Healthcare Applications

Applications help doctors and patients monitor health information remotely.

Advantages of Smart Healthcare

1. Remote Patient Monitoring

Doctors can monitor patients from distant locations.

2. Fast Medical Support

Emergency alerts can be sent quickly.

3. Better Patient Care

Continuous monitoring improves treatment quality.

4. Reduced Hospital Visits

Patients can receive healthcare services from home.

5. Accurate Data Collection

IoT devices provide real-time and accurate health information.

Applications of Smart Healthcare

- Remote health monitoring
- Smart hospitals
- Elderly patient care

- Fitness monitoring systems

2(g) Explain briefly about smart governance.

Smart Governance

Smart governance is the use of Internet of Things (IoT), information technology and communication systems to improve government services and public administration. It helps governments provide faster, transparent and efficient services to citizens.

Smart governance improves communication between the government and the public through digital systems and online services.

Features of Smart Governance

1. Digital Services

Government services are provided online through websites and mobile applications.

Examples:

- Online bill payment
- Online certificates
- E-governance portals

2. Transparency

Smart governance increases transparency in government operations and reduces corruption.

3. Real-Time Monitoring

IoT devices and sensors help monitor public services and city operations in real time.

4. Public Participation

Citizens can give feedback and communicate easily with government departments

5. Efficient Resource Management

Smart systems help manage water supply, electricity and public services efficiently.

Advantages of Smart Governance

1. Faster Public Services

Citizens can access services quickly through online systems.

2. Reduced Paperwork

Digital systems reduce manual documentation.

3. Improved Transparency

Government activities become more open and accountable.

4. Better Decision Making

Real-time data helps governments make better decisions.

5. Cost Saving

Automation reduces administrative costs.

Applications of Smart Governance

- E-governance systems
- Smart city management
- Online public services
- Smart utility management