20IT605/JO-02

Hall Ticket Number:

III/IV B.Tech (Regular/Supplementary) DEGREE EXAMINATION

May/June, 2025 — **Information Technology**

Sixth Semester — **Industrial IOT**

Time: Three Hours — **Maximum:**70 Marks

Answer question 1 compulsorily. **(14X1 = 14Marks)**

Answer one question from each unit. **(4X14=56Marks)**

			CO	BL	M
1	a)	Define IOT.	CO1	L1	1M
	b)	List out the characteristics of IOT	CO1	L2	1M
	c)	List out any four IOT Applications	CO1	L2	1M
	d)	What is the use of control Services in IOT?	CO1	L1	1M
	e)	Define sensor? List out sensor types.	CO2	L1	1M
	f)	Differentiate between Zigbee and LORA protocols	CO2	L2	1M
	g)	Differentiate between Pneumatic and Electric actuators	CO2	L2	1M
	h)	List out the applications of MQTT protocol.	CO2	L2	1M
	i)	Differentiate M2M and IOT	CO3	L2	1M
	j)	Write key elements of Software Defined Network (SDN).	CO3	L1	1M
	k)	List out the advantages of Network Function Virtualization(NFV)	CO3	L2	1M
	l)	What is Map-Reduce?	CO4	L1	1M
	m)	Define Cloud, Write any Four AWS services	CO4	L1	1M
	n)	What are the Advantages of AWS?	CO4	L1	1M
		Unit-I			
2	a)	Explain about Logical design of IOT with neat sketch.	CO1	L1	7M
	b)	Discuss in detail about Industrial IOT Applications.	CO1	L2	7M
		(OR)			
3	a)	Discuss in detail about different IOT enabling Technologies.	CO1	L2	7M
	b)	Describe Level-5 and Level-6 deployment templates for IOT with neat sketch.	CO1	L2	7M
		Unit-II			
4	a)	Explain the features of Arduino Uno compare with Raspberry Pi.	CO2	L1	7M
	b)	Design and Sketch for Analog Temperature Sensor (LM36) if Sensor value greater than 35 degrees than switch on the DC Motor.	CO2	L3	7M
		(OR)			
5	a)	Explain about Bluetooth Protocol stack with neat sketch.	CO2	L1	7M
	b)	Discuss about MQTT Protocols with neat sketch	CO2	L2	7M
		Unit-III			
6	a)	Difference between IOT and M2M Technology with example.	CO3	L2	7M
	b)	Write a short note on i) SDN ii) NFV	CO3	L1	7M
		(OR)			
7		Explain in detail about IOT design Methodologies with example.	CO3	L1	14M
		Unit-IV			
8	a)	Explain about WAMP Server in detail with neat sketch.	CO4	L1	7M
	b)	Discuss about Xively cloud storage model.	CO4	L2	7M
		(OR)			
9		Explain in detail about Air Pollution Monitoring System Case study based on IOT design methodology.	CO4	L1	14M

a) Define IOT. 1M

IoT is a network of interconnected physical objects or 'things' embedded with sensors, software, and other technologies to collect, exchange, and act on data with minimal human intervention.

b) List out the characteristics of IOT 1M

i. Dynamic and Self-Adaptive
ii. Self Configuring
iii. Inter operable Communication Protocols
iv. Unique Identity
v. Integrated into Information Networks

c) List out any four IOT Applications 1M

i. Smart Home Automation
ii. Healthcare Monitoring
iii. Smart Agriculture
iv. Industrial Automation**.**

d) What is the use of control Services in IOT? 1M

Control services in IoT (Internet of Things) play a vital role in managing and coordinating the behaviour of IoT devices and systems.

e) Define sensor? List out sensor types. 1M

A **sensor** is a device that detects and measures physical properties from the environment (such as temperature, pressure, motion, light, etc.) and converts them into signals that can be read and interpreted by humans or machines (typically into electrical signals for processing).

i. Digital Sensors
ii. Analog Sensors

f) Differentiate between Zigbee and LORA protocols 1M

Zigbee:

A short-range, low-power wireless standard built on the IEEE 802.15.4 specification, Zigbee is widely used in personal area networks (PANs) for applications like home and industrial automation. It emphasizes low power consumption with reliable mesh networking capability.

LoRa(LongRange):

LoRa is designed for long-range communication with low power consumption, typically used in wide-area networks for IoT devices. Often paired with the LoRaWAN protocol for network management, LoRa is optimized for infrequent, small data packets over extended distances.

g) Differentiate between Pneumatic and Electric actuators 1M

Pneumatic actuators are ideal for **fast, powerful, low-cost** operations, especially in industrial Environments. **Electric actuators** are best for **precise, quiet, and energy-efficient** applications requiring accurate control.

h) List out the applications of MQTT protocol. 1M

i. Healthcare
ii. Building Automation
iii. Agriculture
iv. Energy and Utilities
v. Logistics and Supply Chain
vi. Mobile Applications

i) Differentiate M2M and IOT 1M

M2M is mainly about *device-to-device communication*, often using private networks.
IoT is a broader concept that connects devices over the *internet*, often involving cloud computing, Analytics and remote access.

j) Write key elements of Software Defined Network (SDN). 1M

i. Control Plane and Data Plane Separation
ii. Centralized Controller
iii. Programmability
iv. Open Interfaces (APIs)
v. Abstraction
vi. Policy Enforcement
vii. Network Virtualization

k) List out the advantages of Network Function Virtualization(NFV) 1M

i. Reduced Hardware Costs
ii. Increased Flexibility and Agility
iii. Faster Deployment of Services
iv. Improved Scalability
v. Centralized Management and Automation
vi. Energy and Space Efficiency
vii. Vendor Independence
viii. Supports Innovation and Experimentation

l) What is Map-Reduce? 1M

Map-Reduce is a **programming model** and **processing technique** used in **data analytics** to handle and analyze large datasets in a **distributed computing environment**.

m) Define Cloud, Write any Four AWS services 1M

The **cloud** refers to the delivery of computing services—such as servers, storage, databases, networking, software, and more—**over the Internet** ("the cloud") to offer faster innovation, flexible resources, and economies of scale. Instead of owning physical hardware, users can access and pay for cloud services on a **pay-as-you-go** basis.

i. Amazon EC2 (Elastic Compute Cloud)
ii. Amazon S3 (Simple Storage Service)
iii. Amazon RDS (Relational Database Service)
iv. AWS Lambda:

n) What are the Advantages of AWS? 1M

The **main advantages of Amazon Web Services (AWS):**

i. Scalability
ii. Cost-Effective (Pay-as-you-go)
iii. Reliability and Performance
iv. Security
v. Global Reach
vi. Flexibility and Customization

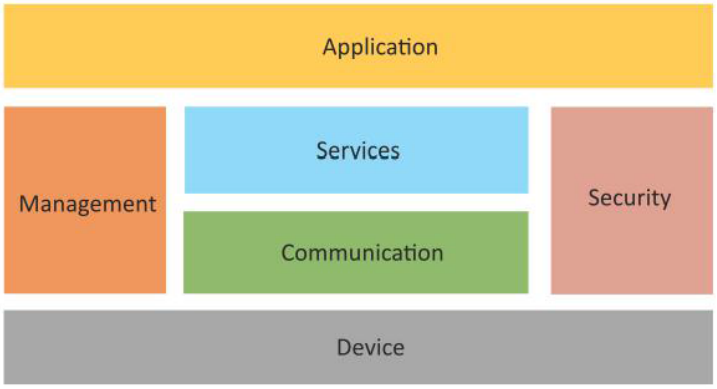
2a) Explain about Logical design of IOT with neat sketch. **7M**

Description-3m

Diagram-4m

Logical Design of IoT

- Logical design of an IoT system refers to an abstract representation of the entities and processes without going into the low-level specifics of the implementation.
- An IoT system comprises of a number of functional blocks that provide the system the capabilities for identification, sensing, actuation, communication, and management.



b) Discuss in detail about Industrial IOT Applications. **7M**

Description-4m

Explantion-3m

Industrial IoT (IIoT) refers to the application of Internet of Things (IoT) technologies in industrial sectors such as manufacturing, energy, logistics, oil and gas, agriculture, and more. It involves connecting sensors, instruments, and other devices to industrial applications, enabling real-time data collection, monitoring, control, and analysis to optimize performance and productivity.

Major Applications of Industrial IoT

1. Predictive Maintenance

- **Function**: Sensors monitor machine performance in real-time to predict failures before they happen.
- **Benefits**: Reduces downtime, extends equipment life, lowers maintenance costs.
- **Use Case**: Vibration sensors on motors detect anomalies that indicate potential failure.

2. Smart Manufacturing (Industry 4.0)

- **Function**: Automation and real-time visibility into production lines.
- **Benefits**: Enhances productivity, quality control, and customization.
- **Use Case**: Real-time tracking of production KPIs, automatic quality checks using vision systems.

3. Asset Tracking and Management

- **Function**: Monitor location, condition, and usage of physical assets.
- **Benefits**: Prevents asset loss, optimizes usage, ensures compliance.
- **Use Case**: RFID and GPS systems track parts in warehouses and during transportation.

4. Energy Management

- **Function**: Track and optimize energy usage across operations.
- **Benefits**: Reduces energy costs and carbon footprint.

- **Use Case**: Smart meters and load monitoring systems in factories.

5. Supply Chain and Logistics

- **Function**: Real-time monitoring of goods during transit.
- **Benefits**: Improves delivery efficiency, reduces spoilage and theft.
- **Use Case**: Cold chain monitoring in pharmaceutical and food industries.

6. Remote Monitoring and Operations

- **Function**: Enables control of industrial systems from remote locations.
- **Benefits**: Increases safety, reduces on-site workforce needs.
- **Use Case**: Remote control of oil rigs or mining operations.

7. Worker Safety and Health Monitoring

- **Function**: Wearable devices monitor worker health and environmental conditions.
- **Benefits**: Enhances worker safety, reduces accidents.
- **Use Case**: Gas leak detectors, smart helmets, and wearables tracking vital signs.

8. Quality Control and Assurance

- **Function**: Use of real-time data for quality monitoring.
- **Benefits**: Reduces defects, improves product reliability.
- **Use Case**: Vision systems inspect items on conveyor belts for defects.

9. Agriculture and Farming

- **Function**: Precision farming using sensors and analytics.
- **Benefits**: Increases yield, optimizes resource usage.
- **Use Case**: Soil moisture sensors and GPS-enabled equipment for precision sowing.

10. Oil and Gas Monitoring

- **Function**: Monitor pipelines, refinery equipment, and drilling systems.
- **Benefits**: Prevents leaks, improves safety, and reduces downtime.
- **Use Case**: Smart sensors for pressure, temperature, and corrosion in pipelines.

3a) Discuss in detail about different IOT enabling Technologies. 7M

Description-4M

Explantion-3M

IoT (Internet of Things) enabling technologies are foundational technologies that facilitate the implementation, deployment, and operation of IoT systems. These technologies support connectivity, data processing, device integration, and analytics, making it possible to monitor, control, and automate physical objects through the internet.

Here's a detailed discussion of the **major IoT enabling technologies**:

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1. Sensor Technology

- **Role**: Sensors are the eyes and ears of IoT. They detect and measure physical parameters such as temperature, humidity, motion, light, pressure, etc.
- **Types**:
  - Temperature sensors
  - Proximity sensors

    - Motion detectors
    - Accelerometers
    - Gas sensors
- **Importance**: They provide real-time data from the physical world which is processed and used for decision-making.

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2. RFID (Radio Frequency Identification)

- **Role**: Enables automatic identification and tracking of objects using electromagnetic fields.
- **Components**: RFID tags and RFID readers.
- **Use Cases**:
    - Inventory management
    - Asset tracking
    - Smart logistics

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3. Wireless Sensor Networks (WSNs)

- **Role**: A group of distributed sensors that communicate wirelessly to monitor and report environmental conditions.
- **Characteristics**:
    - Self-organizing and energy-efficient
    - Can be deployed in inaccessible environments
- **Applications**:
    - Environmental monitoring
    - Industrial automation
    - Smart agriculture

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4. Connectivity Technologies

IoT devices need communication channels to share data. The choice of connectivity depends on range, power consumption, data rate, and cost.

a) Short-Range Communication

- **Bluetooth / BLE (Low Energy)**: Used in wearables, smart home devices.
- **Wi-Fi**: High data rate, used in home automation.
- **Zigbee / Z-Wave**: Low power, used in smart lighting and security.

b) Medium to Long-Range Communication

- **LoRaWAN (Long Range Wide Area Network)**: Suitable for rural, wide-area applications.
- **NB-IoT (Narrowband IoT)**: Operates over cellular networks with low power.
- **5G**: High bandwidth and ultra-low latency, supports massive IoT deployments.

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5. Cloud Computing

- **Role**: Offers scalable storage, data processing, analytics, and management platforms for IoT data.
- **Benefits**:
    - On-demand scalability

    - Data backup and recovery
    - Integration with AI and machine learning
- **Examples**: AWS IoT Core, Microsoft Azure IoT Hub, Google Cloud IoT.

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6. Edge and Fog Computing

- **Edge Computing**: Processing data near the source (on the device or local gateway) to reduce latency.
- **Fog Computing**: Extends cloud capabilities closer to the edge network, offering more processing between device and cloud.
- **Use Cases**:
    - Industrial IoT
    - Autonomous vehicles
    - Smart cities

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7. Big Data Analytics

- **Role**: Analyzing large volumes of IoT-generated data to extract insights.
- **Techniques**:
    - Descriptive, predictive, and prescriptive analytics
    - Machine learning and AI integration
- **Applications**:
    - Predictive maintenance
    - Smart healthcare diagnostics
    - Energy consumption optimization

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8. Artificial Intelligence (AI) and Machine Learning (ML)

- **Role**: Enables intelligent decision-making in IoT systems by recognizing patterns and automating responses.
- **Functions**:
    - Anomaly detection
    - Predictive analytics
    - Automated control systems

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9. Middleware

- **Role**: Acts as a bridge between hardware (devices/sensors) and applications, providing services like device discovery, data management, and security.
- **Examples**:
    - FIWARE
    - Kaa IoT Platform
    - ThingsBoard

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10. Cyber security Technologies

- **Role**: Protects IoT systems from threats and unauthorized access.

- **Key Technologies**:
  - End-to-end encryption
  - Device authentication and identity management
  - Secure firmware updates
  - Blockchain (for decentralized trust and transparency)

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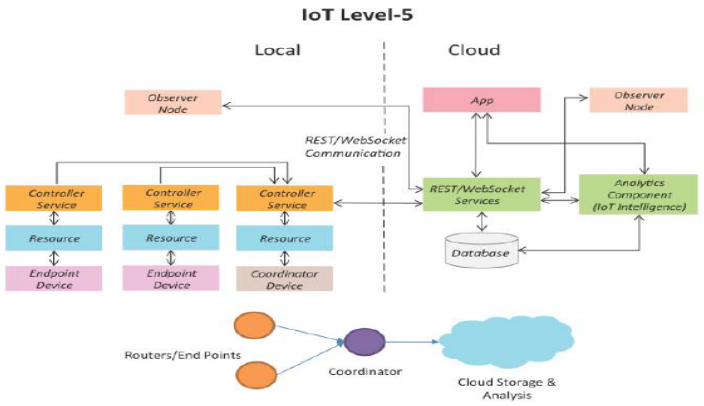
11. Actuators

- **Role**: Convert digital signals into physical action (opposite of sensors).
- **Examples**:
  - Motors
  - Valves
  - Lights
- **Use**: Enable automation based on sensor data and control signals.

b) Describe Level-5 and Level-6 deployment templates for IOT with neat sketch. 7M
Description-3m
Diagram-4m

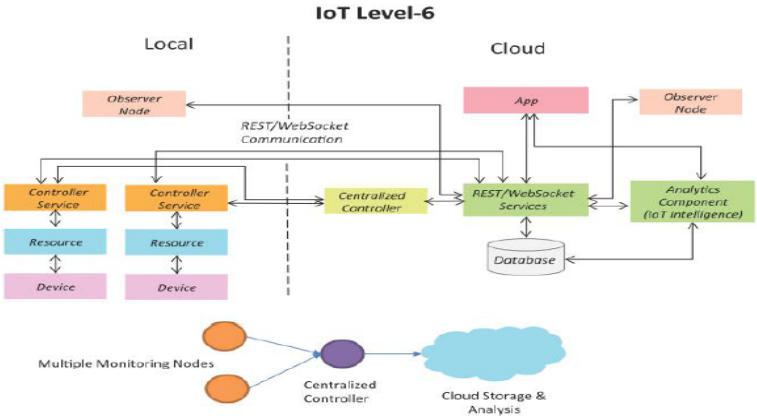
IoT Level-5

- A level-5 IoT system has multiple end nodes and one coordinator node.
- The end nodes that perform sensing and/or actuation.
- Coordinator node collects data from the end nodes and sends to the cloud.
- Data is stored and analyzed in the cloud and application is cloud-based.
- Level-5 IoT systems are suitable for solutions based on wireless sensor networks, in which the data involved is big and the analysis requirements are computationally intensive.



IoT Level-6

- A level-6 IoT system has multiple independent end nodes that perform sensing and/or actuation and send data to the cloud.
- Data is stored in the cloud and application is cloud-based.
- The analytics component analyzes the data and stores the results in the cloud database.
- The results are visualized with the cloud-based application.
- The centralized controller is aware of the status of all the end nodes and sends control commands to the nodes.



4a) Explain the features of Arduino Uno compare with Raspberry Pi. 7M
Differences-4m
Example-3m

Here's a clear comparison between **Arduino Uno** and **Raspberry Pi**, highlighting their features and differences:

□ Arduino Uno – Microcontroller Board

Main Purpose: Designed for hardware-level control like reading sensors, controlling motors, and managing real-time systems.

Feature	Description
Processor	ATmega328P microcontroller (8-bit, 16 MHz)
RAM	2 KB
Storage	32 KB flash memory (program storage)
Operating System	None (runs a single program repeatedly)
Power Consumption	Very low (runs on 5V and a few milliamps)
GPIO Pins	14 Digital I/O (6 can do PWM), 6 Analog inputs
Programming Language	C/C++ (Arduino IDE)
Connectivity	USB, I2C, SPI, UART (no built-in Wi-Fi or Ethernet)
Best For	Real-time control, sensor interfacing, simple electronics projects

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□ Raspberry Pi – Single Board Computer

Main Purpose: Designed as a full computer that runs Linux, suitable for complex tasks like web browsing, media processing, and networking.

Feature	Description
Processor	Quad-core ARM Cortex-A (varies by model, up to 1.8 GHz)
RAM	1 GB to 8 GB (depending on model)
Storage	microSD card (up to hundreds of GBs)
Operating System	Linux-based (Raspberry Pi OS, Ubuntu, etc.)
Power Consumption	Higher (5V, 2.5A or more)
GPIO Pins	40 GPIO pins (digital only, no native analog input)
Programming Language	Python, C/C++, Java, many more
Connectivity	Built-in Wi-Fi, Bluetooth, HDMI, USB, Ethernet
Best For	Computer vision, web servers, IoT gateways, robotics control, media centers

b) Design and Sketch for Analog Temperature Sensor (LM36) if Sensor value greater than 35 degrees than switch on the DC Motor. 7M

Description-4m

Source Code & Diagram-3m

Components Required:

- LM35 temperature sensor
- Arduino UNO (or any microcontroller)
- NPN Transistor (e.g., 2N2222 or BC547)
- DC Motor
- Diode (e.g., 1N4007) — for back EMF protection
- 10kΩ Resistor (for transistor base)
- External Power Supply (for motor if needed)
- Breadboard and jumper wires

Working Principle:

- **LM35** outputs **10 mV/°C** → 35°C = **0.35V output**
- Arduino reads analog voltage via **analog pin**
- Converts voltage to temperature
- If temperature > 35°C, **digital pin goes HIGH**
- This turns on the **transistor**, which powers the **DC motor**

Source Code:

```
const int sensorPin = A0;
const int motorPin = 8;
void setup() {
pinMode(motorPin, OUTPUT);
Serial.begin(9600);
}
void loop() {
 int sensorValue = analogRead(sensorPin);
 float voltage = sensorValue * (5.0 / 1023.0); // Convert to voltage
 float temperatureC = voltage * 100.0; // LM35 = 10mV/°C
Serial.print("Temperature: ");
Serial.print(temperatureC);
Serial.println(" °C");
if (temperatureC > 35.0) {
digitalWrite(motorPin, HIGH); // Turn on motor
} else {
digitalWrite(motorPin, LOW); // Turn off motor
}
 delay(1000); // Wait for 1 second
}
```

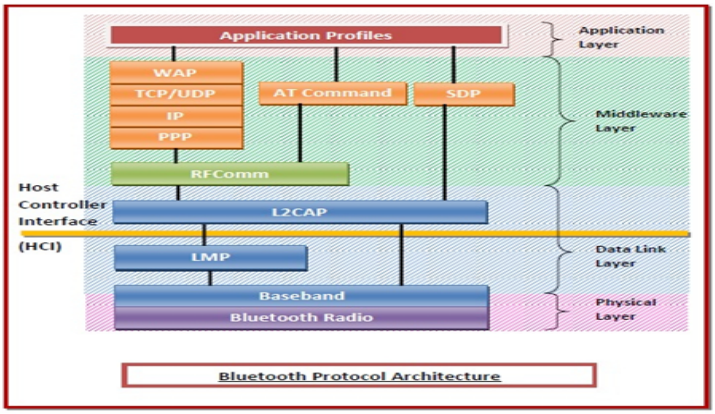
5a) Explain about Bluetooth Protocol stack with neat sketch. 7M

Desription-3m

Diagram-4m

- Bluetooth is a network technology that connects mobile devices wirelessly over a short-range to form a personal area network (PAN).
- A cable replacement technology.
- Developed by Ericsson-1994.
- Operates in the unlicensed industrial, scientific and medical (*ISM*) band at 2.4 GHz
- Frequency Hopping scheme (1600 hops/sec)
- 1 Mb/s symbol rate
- Range 10+ meters
- Single chip radio + baseband
- Key features:
    - Robustness
    - low complexity
    - low power, and
    - low cost.
- It is a significant protocol for IoT applications.

- **Physical Layer** – This includes Bluetooth radio and Baseband (also in the data link layer.
    - **Radio** – This is a physical layer equivalent protocol that lays down the physical structure and specifications for transmission of radio waves. It defines air interface, frequency bands, frequency hopping specifications, and modulation techniques.
    - **Baseband** – This protocol takes the services of radio protocol. It defines the addressing scheme, packet frame format, timing, and power control algorithms.



- **Data Link Layer** − This includes Baseband, Link Manager Protocol (LMP), and Logical Link Control and Adaptation Protocol (L2CAP).
- **Link Manager Protocol (LMP)** − LMP establishes logical links between Bluetooth devices and maintains the links for enabling communications. The other main functions of LMP are device authentication, message encryption, and negotiation of packet sizes.
- **Logical Link Control and Adaptation Protocol (L2CAP)** − L2CAP provides adaption between upper layer frame and baseband layer frame format. L2CAP provides support for both connection-oriented as well as connectionless services.
- **Middleware Layer**
- **RFComm** − It is short for Radio Frontend Component. It provides a serial interface with WAP.
- **Adopted Protocols** − These are the protocols that are adopted from standard models. The commonly adopted protocols used in Bluetooth are Point-to-Point Protocol (PPP), Internet Protocol (IP), User Datagram Protocol (UDP), Transmission Control Protocol (TCP), and Wireless Application Protocol (WAP).
- **Service Discovery Protocol (SDP)**− SDP takes care of service-related queries like device information so as to establish a connection between contending Bluetooth devices.
- **AT Commands** − ATtention command set.
- **Applications Layer** − This includes the application profiles that allow the user to interact with the Bluetooth applications.

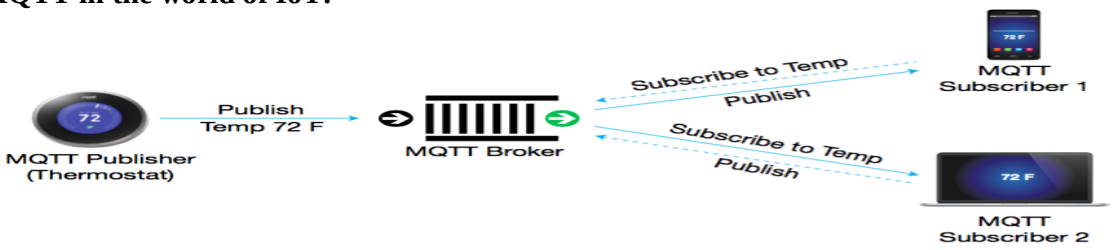
b) Discuss about MQTT Protocols with neat sketch **7M**

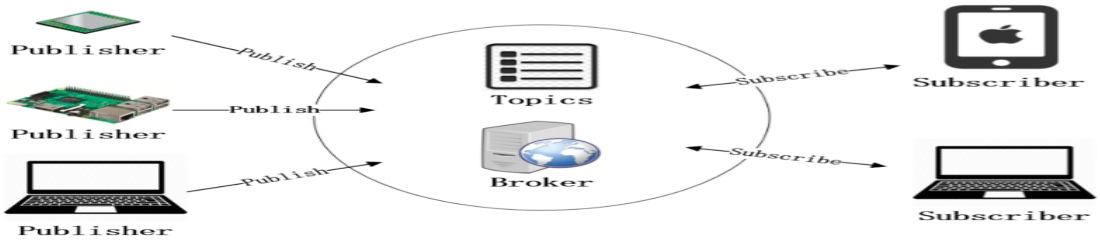
Description-3m

Diagram-4m

- MQTT is a publish/subscribe messaging protocol designed for lightweight M2M communications. It was originally developed by IBM and is now an open standard. MQTT has a client/server model, where every sensor is a client and connects to a server, known as a broker, over TCP.
- MQTT is message oriented. Every message is a discrete chunk of data, opaque to the broker.
- Every message is published to an address, known as a topic. Clients may subscribe to multiple topics. Every client subscribed to a topic receives every message published to the topic.

MQTT in the world of IoT:





6a) Difference between IOT and M2M Technology with example. **7M**

Differences-4m

Example-3m

Feature	IoT	M2M
Network Type	Internet-based	Point-to-point / Local
Intelligence	Smart with cloud/AI	Basic automation
Scalability	High	Limited
Communication	Device to cloud to device	Device to device
Data Usage	Analyzed, stored, visualized	Minimal, mostly real-time

Examples

Use Case	IoT Example	M2M Example
Home	Smart thermostat adjusting temperature via app/cloud	Remote water meter sending readings to utility company
Industry	Predictive maintenance using IoT sensors and analytics	Industrial robot arm sending status to control system
Healthcare	Wearable health tracker syncing with phone and cloud	ECG machine sending data to local monitoring station

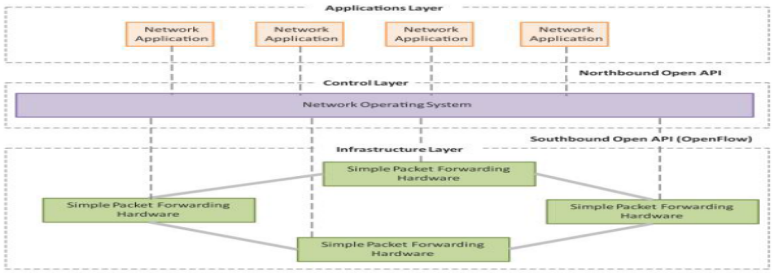
b) Write a short note on i) SDN ii) NFV **7M**

Description-3m

Diagrams-4m

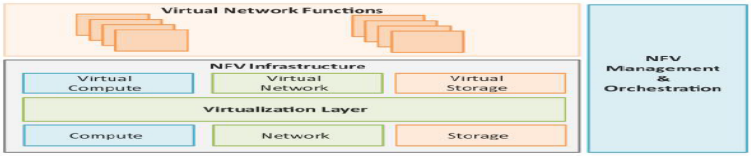
SDN:

- Software-Defined Networking (SDN) is a networking architecture that separates the control plane from the data plane and centralizes the network controller.
- Software-based SDN controllers maintain a unified view of the network and make confi guration, management and provisioning simpler.
- The underlying infrastructure in SDN uses simple packet forwarding hardware as opposed to specialized hardware in conventional networks.



NFV:

- Network Function Virtualization (NFV) is a technology that leverages virtualization to consolidate the heterogeneous network devices onto industry standard high volume servers, switches and storage.
- NFV is complementary to SDN as NFV can provide the infrastructure on which SDN can run.



7) Explain in detail about IOT design Methodologies with example. **14M**

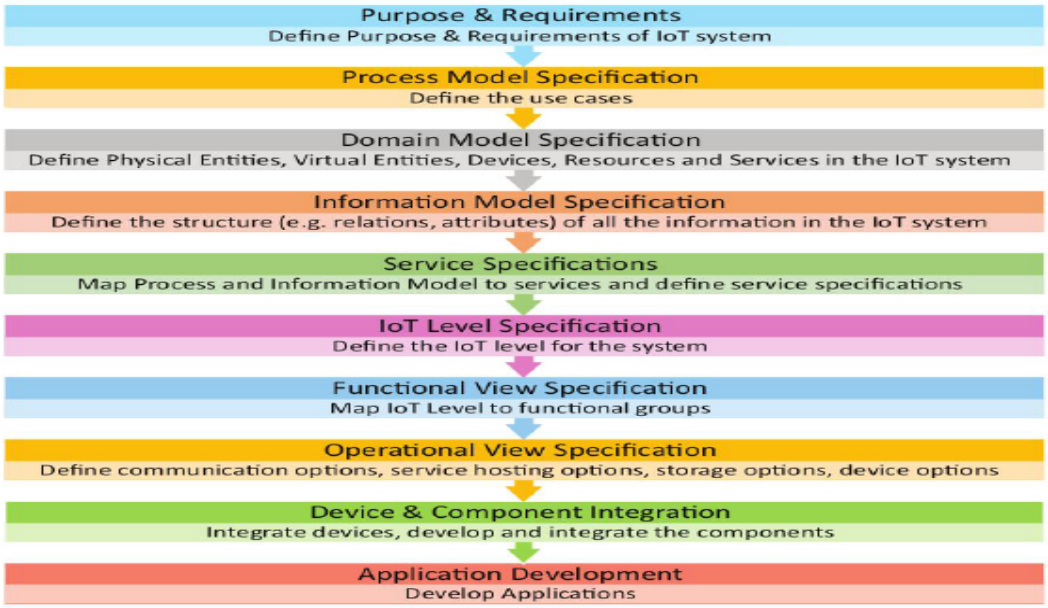
Design steps-4

Example-3m

Example: Smart Home Automation System

Design Phase	Implementation
Requirement Analysis	Automate lighting and fan based on motion and temperature
Device Design	Use PIR sensor (for motion), DHT11 sensor (temperature), ESP32 controller
Network Design	Use Wi-Fi and MQTT protocol to send sensor data
Data Processing	ESP32 processes temperature; fan switches on above 30°C
Application Design	Mobile app shows room status and manual control buttons
Security Design	Use encrypted MQTT communication and app login
Testing & Deployment	Test in multiple rooms; deploy with backup battery and Wi-Fi router

IoT Design Methodology – Steps:



8a) Explain about WAMP Server in detail with neat sketch. 7M

Description-3m

Key Terminology-4m

WAMP: **W**eb **A**pplication **M**essaging **P**rotocol

•Mainly used in cloud storage model for IoT& other messaging services

•WAMP is a routed protocol, with all components connecting to a *WAMP Router*, where the WAMP Router performs message routing between the component

•It is protocol for Web Socket (PUBSUB based protocol) : uses RPC Messaging Pattern

Some Important Key Terminologies

•Transport

•Session

•Clients (Publisher & Subscriber)

•Router

•Broker

•Dealer

•Application Code

Transport: Transport is a channel that connects two peers.

•**Session**: Session is a conversation between two peers that runs over a transport.

•**Client**: Clients are peers that can have one or more roles.

•In the publish–subscribe model, the Client can have the following roles:

Publisher: Publisher publishes events (including payload) to the topic maintained by the Broker.

Subscriber: Subscriber subscribes to the topics and receives the events including the payload.

•In the RPC model, the Client can have the following roles:

Caller: Caller issues calls to the remote procedures along with call arguments.

Callee: Callee executes the procedures to which the calls are issued by the Caller and returns the results to the Caller.

•**Router**: Routers are peers that perform generic call and event routing.

•In the publish–subscribe model, the Router has the role of a Broker.

Broker: Broker acts as a Router and routes messages published to a topic to all the subscribers subscribed to the topic.

•In the RPC model, the Router has the role of a Dealer.

Dealer: Dealer acts a router and routes RPC calls from the Caller to the Calleeand routes results from the Callee to the Caller.

•**Application code**: Application code runs on the Clients (Publisher, Subscriber, Calleeor Caller).

b) Discuss about Xively cloud storage model. 7M

Description-3m

Diagram-4m

Xivelyis an IoTCloud Platform

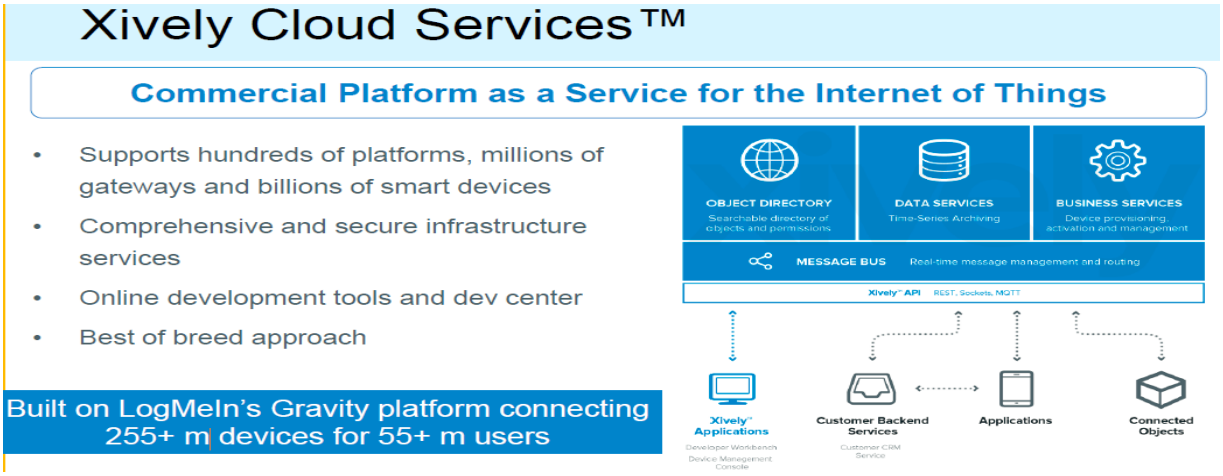
•It is an enterprise platform for building, managing, and deriving business value from connected products.

•It also provides the cloud base API with an SDK

•It supports platforms and technologies like Android, Arduino, C etc.

•Xively is a PaaS(Platform as a Service) which exposes its service via Restful API

•It supports messaging service based on MQTT



9) Explain in detail about Air Pollution Monitoring System Case study based on IOT design. 14M
Description-3m
Example-4m

Objective:

To design and implement an IoT-based system that monitors air quality in real-time by collecting pollutant data (e.g., CO_2, NO_2, PM2.5, PM10), analyzing it, and alerting authorities and citizens when air pollution exceeds safe levels.

IoT Design Methodology Applied

This case study follows a standard **7-step IoT Design Methodology**:

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1. Define the Purpose and Scope

- **Purpose**: Monitor and analyze air pollution levels in urban areas.
- **Scope**:
  - Measure pollutants like CO_2, NO_2, PM2.5, temperature, and humidity.
  - Collect real-time data from multiple locations.
  - Provide alerts via mobile app or web dashboard.
  - Store data for analysis and reporting.

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2. Model the Domain

- **Entities**:
  - **Sensors**: Gas sensors (e.g., MQ135), dust sensors (e.g., PMS5003), temperature & humidity sensors (DHT11/22).
  - **Devices**: Microcontrollers (NodeMCU, Raspberry Pi).
  - **Users**: Government agencies, environmental researchers, general public.
- **Location**: Urban regions, near traffic intersections, industrial zones.

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3. Design the Domain Model

- **Hardware Layer**:
  - NodeMCU or Raspberry Pi (controller)
  - Sensors (PM2.5/PM10, CO_2, NO_2, temperature/humidity)
  - Power Supply (solar or grid)
- **Communication Layer**:
  - Wi-Fi, LoRa, or GSM to send data to the cloud
- **Cloud Platform**:
  - AWS, Google Cloud IoT, or Thingspeak for data storage and processing
- **Application Layer**:
  - Web dashboard and mobile app for live monitoring, alerts, and analysis

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4. Define the Functional Requirements

- Sensing and data acquisition of pollution levels
- Data transmission to cloud
- Data processing and analytics (threshold alerts, trends)
- Visual representation through dashboards
- Alert notifications (SMS, app alerts)

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5. Define the Non-Functional Requirements

- **Scalability**: Ability to support many devices and locations
- **Real-time**: Quick data transmission and alert generation
- **Accuracy**: High-quality sensors for reliable data
- **Energy-efficient**: Low power usage (esp. in remote areas)
- **Security**: Encrypted data transmission

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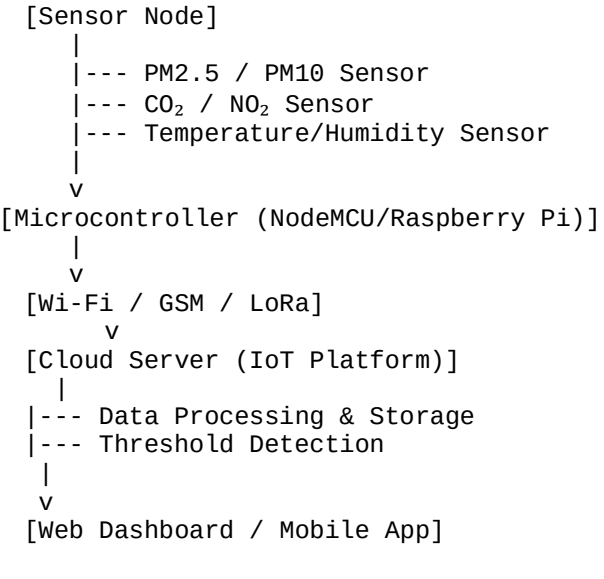
6. Define the System Architecture



```
  |
 |--- Data Visualization
 |--- Notifications / Alerts
```

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7. Build the IoT Application

- **Prototype**:
  - Setup a NodeMCU with MQ135 and PMS5003 sensors.
  - Send data to Thingspeak/MQTT broker using Wi-Fi.
- **Data Collection**:
  - Collect air quality data every 30 seconds.
- **Dashboard**:
  - Use Grafana, Thingspeak, or Blynk for visual display.
- **Notification**:
  - Use IFTTT or custom backend to send alerts via SMS/email.

Expected Output and Benefits

- Real-time pollution maps
- Alerts to reduce exposure to polluted air
- Historical pollution trends and analytics
- Government insights for policy decisions

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