18CSD43

Hall Ticket Number:

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

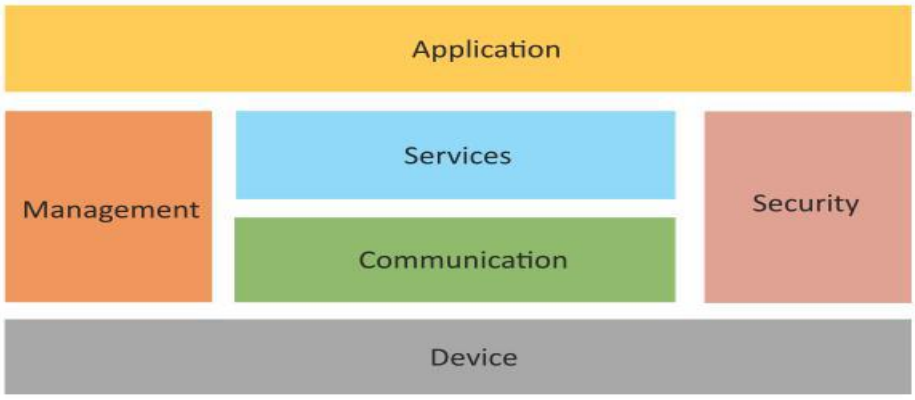
November, 2022 — **Computer Science and Engineering**

Seventh Semester — **Internet of Things**

Time: Three Hours — **Maximum :** 50 Marks

Answer Question No.1 compulsorily. (1X10 = 10 Marks)

Answer ONE question from each unit. (4X10=40Marks)

1.	a)	List the applications of IoT Smart Homes. Smart City. Self-driven Cars. IoT Retail Shops. Farming. Wearables. Smart Grids. Industrial Internet	CO1	L2	1M
	b)	What is REST? Representational State Transfer (REST) is a set of architectural principles by which you can design web services and web APIs that focus on a system's resources and how resource states are addressed and transferred.	CO1	L1	1M
	c)	List the protocols used in the physical design of IoT. Application Layer Transport Layer Network Layer Link Layer	CO1	L2	1M
	d)	Write the communication protocols used in IoT? 	CO2	L1	1M
	e)	Differentiate sensor and actuator. When input is a physical quantity and output electrical → Sensor When input is electrical and output a physical quantity → Actuator	CO2	L1	1M
	f)	Define M2M. M2M stands for **Machine to Machine** communication. It is a direct communication system between the devices using wired or wireless communications channels without any human interaction.	CO2	L1	1M
	g)	What type of communication will be provided in M2M architecture? Point to point communication	CO3	L1	1M
	h)	Write the history of Fog Computing. The term fog computing was coined by Cisco in January 2014. This was because fog	CO3	L1	1M

		is referred to as clouds that are close to the ground in the same way fog computing was related to the nodes which are present near the nodes somewhere in between the host and the cloud. It was intended to bring the computational capabilities of the system close to the host machine. After this gained a little popularity, IBM, in 2015, coined a similar term called "Edge Computing"			
	i)	Write the significance of cloud in IoT applications. IoT means massive data generation. And when we need to deal with data, an obvious question of data security and privacy comes into the picture. Additionally, IoT harnesses mobility. Hence, with cloud intervention, we can expect more preventive, corrective, and detective measures. With effective authentication and encryption protocols, the cloud enables users with strong security measures.	CO4	L2	1M
	j)	List various cloud service providers 1. Amazon Web Service (AWS) 2. ServerSpace 3. Microsoft Azure 4. Google Cloud Platform 5. IBM Cloud Services 6. Adobe Creative Cloud 7. Kamatera 8. VMware 9. Rackspace 10. Red Hat 11. Salesforce 12. Oracle Cloud 13. SAP 14. Verizon Cloud 15. Navisite 16. Dropbox	CO4	L2	1M

		Unit - I			
2	a)	List and explain various IoT enabling technologies. **IoT Enabling Technologies:** IoT is enabled by several technologies including wireless sensor networks, Cloud Computing, Big Data Analytics, Embedded systems, security protocols and architectures, communication protocols, web services, mobile internet, and semantic search engines, etc., **1. Wireless Sensor Network(WSN):** A WSN comprises distributed devices with sensors which are used to monitor the environmental and physical conditions. A wireless sensor network consists of end nodes, routers and coordinators. End nodes have several sensors attached to them where the data is passed to a coordinator with the help of routers. The coordinator also acts as the gateway that connects WSN to the internet. Example – 1. Weather monitoring system 2. Indoor air quality monitoring system 3. Soil moisture monitoring system 4. Surveillance system 5. Health monitoring system **2. Cloud Computing :** It provides us the means by which we can access applications as utilities over the internet. Cloud means something which is present in remote locations. With Cloud computing, users can access any resources from anywhere like databases, webservers, storage, any device, and any software over the internet. **Characteristics –** Broad network access On demand self-services Rapid scalability Measured service Pay-per-use	CO1	L1	5M

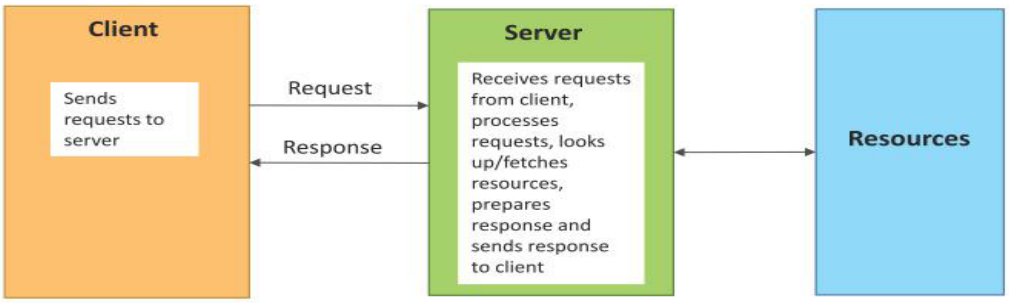
3. Big Data Analytics :
It refers to the method of studying massive volumes of data or big data. Collection of data whose volume, velocity or variety is simply too massive and tough to store, control, process and examine the data using traditional databases.
Big data is gathered from a variety of sources including social network videos, digital images, sensors and sales transaction records.
Several steps involved in analyzing big data –
Data cleaning
Munging
Processing
Visualization

4. Communications Protocols :
They are the backbone of IoT systems and enable network connectivity and linking to applications. Communication protocols allow devices to exchange data over the network. Multiple protocols often describe different aspects of a single communication.
A group of protocols designed to work together is known as a protocol suite; when implemented in software they are a protocol stack.
They are used in Data encoding and Addressing schemes.

5. Embedded Systems :
It is a combination of hardware and software used to perform special tasks.
It includes microcontroller and microprocessor memory, networking units (Ethernet Wi-Fi adapters), input output units (display keyword etc.) and storage devices (flash memory).
It collects the data and sends it to the internet.
Embedded systems used in
Examples –
Digital camera
DVD player, music player
Industrial robots
Wireless Routers etc.

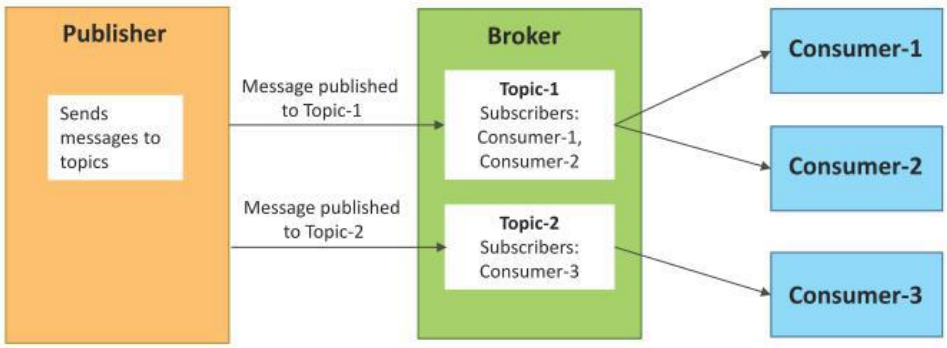
b) Explain the IoT communication protocols used in logical design of IoT. — CO1 — L1 — 5M

1. Request-Response communication model:
Request-Response is a communication model in which the client sends requests to the server and the server responds to the requests.
• When the server receives a request, it decides how to respond, fetches the data, retrieves resource representations, prepares the response, and then sends the response to the client.

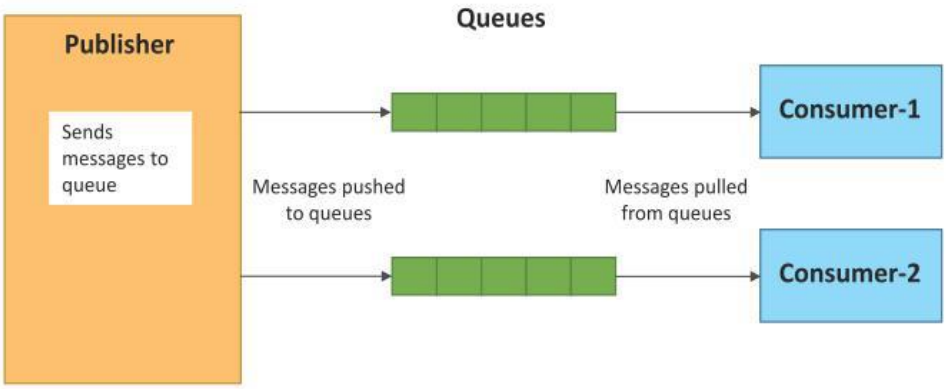


2. Publish-Subscribe communication model:
Publish-Subscribe is a communication model that involves publishers, brokers and

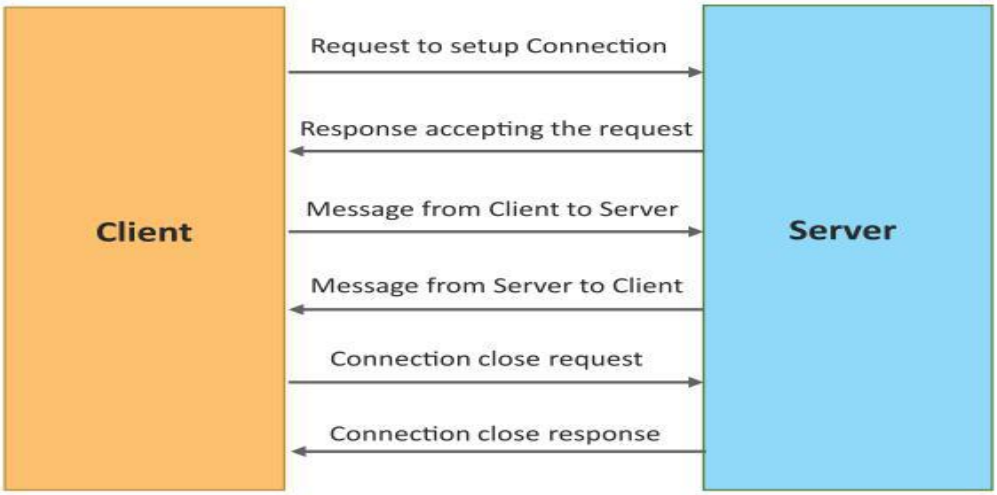
consumers.
• Publishers are the source of data. Publishers send the data to the topics which are managed by the broker. Publishers are not aware of the consumers.
• Consumers subscribe to the topics which are managed by the broker.
• When the broker receives data for a topic from the publisher, it sends the data to all the subscribed consumers.



3. Push-Pull communication model:
Push-Pull is a communication model in which the data producers push the data to queues and the consumers pull the data from the queues. Producers do not need to be aware of the consumers.
• Queues help in decoupling the messaging between the producers and consumers.
• Queues also act as a buffer which helps in situations when there is a mismatch between the rate at which the producers push data and the rate rate at which the consumers pull data.



4. Exclusive Pair communication model:
Exclusive Pair is a bidirectional, fully duplex communication model that uses a persistent connection between the client and server.
• Once the connection is setup it remains open until the client sends a request to close the connection.
• Client and server can send messages to each other after connection setup.

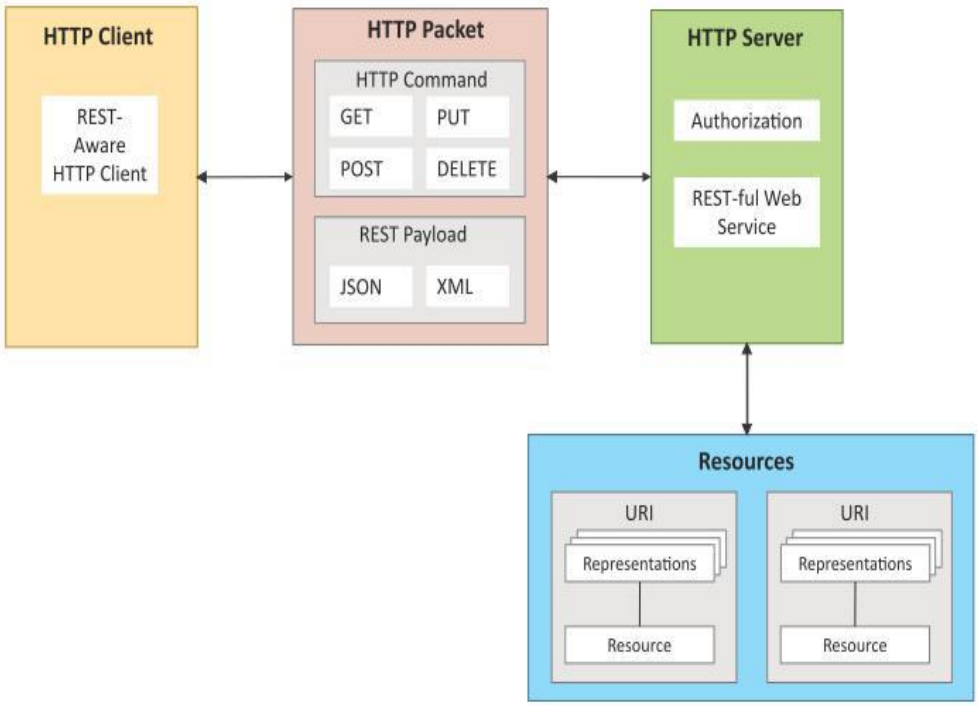


5. REST-based Communication APIs:

Representational State Transfer (REST) is a set of architectural principles by which you can design web services and web APIs that focus on a system's resources and how resource states are addressed and transferred.

• REST APIs follow the request response communication model.

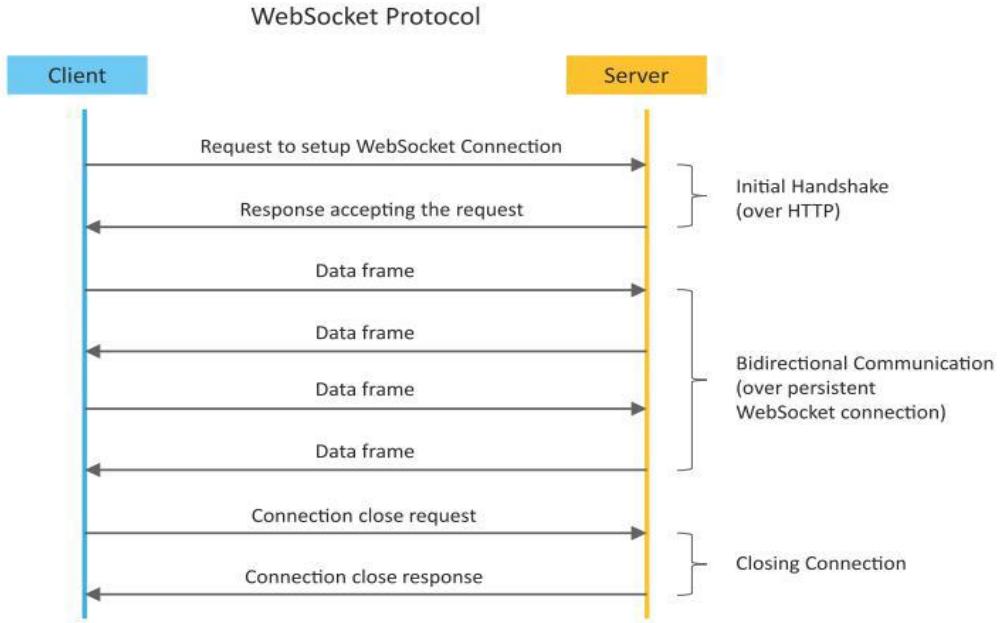
• The REST architectural constraints apply to the components, connectors, and data elements, within a distributed hypermedia system.



5. WebSocket-based Communication APIs:

WebSocket APIs allow bidirectional, full duplex communication between clients and servers.

• WebSocket APIs follow the exclusive pair communication model



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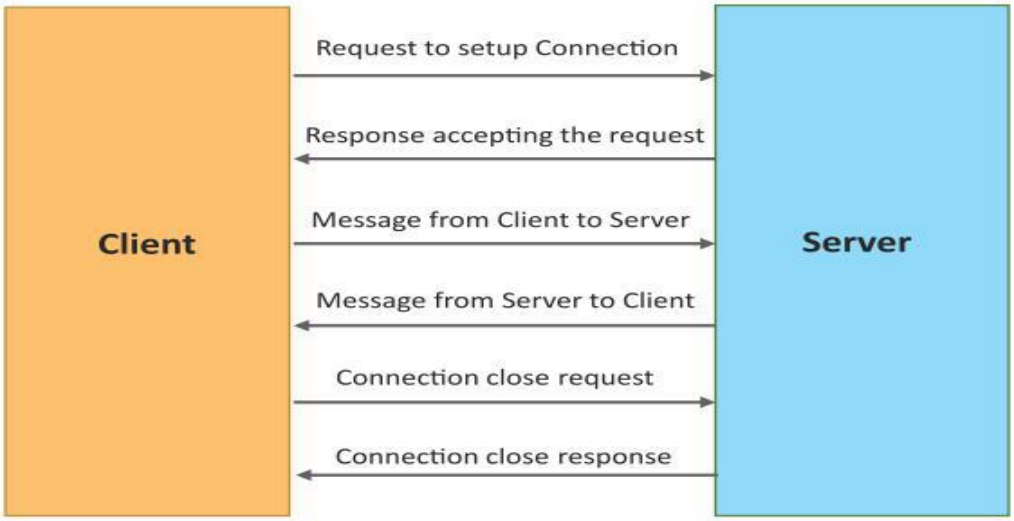


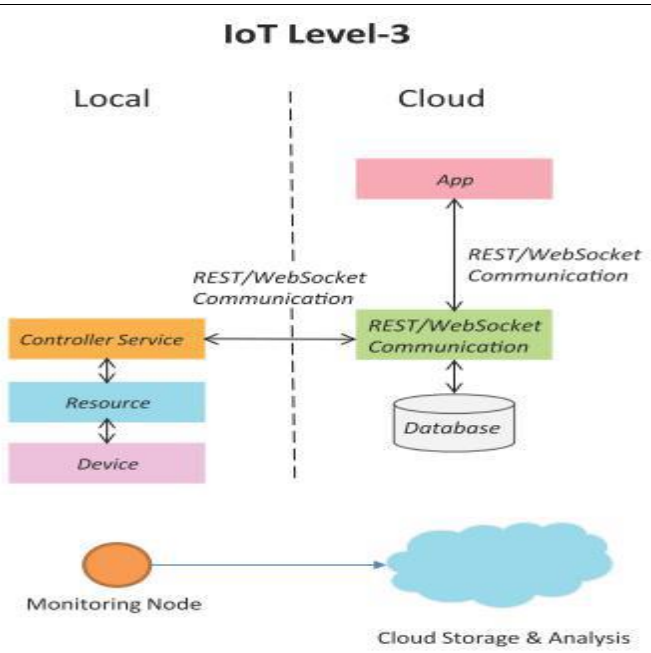
OR

3	a)	Explain level 3 and level 4 deployment models with a neat sketch.	CO1	L3	6M

IoT Level-3

• A level-3 IoT system has a single node. Data is stored and analyzed in the cloud and application is cloudbased.

• Level-3 IoT systems are suitable for solutions where the data involved is big and the analysis requirements are computationally intensive.

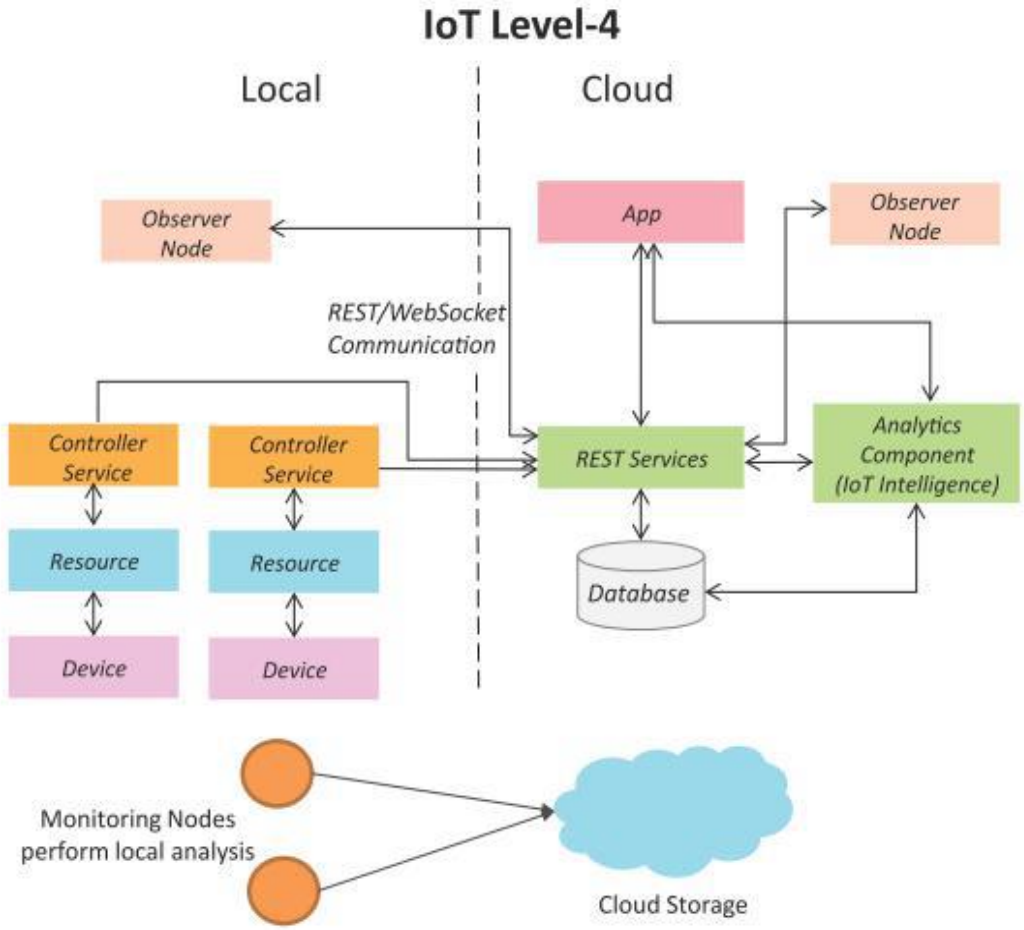


IoT Level-4:

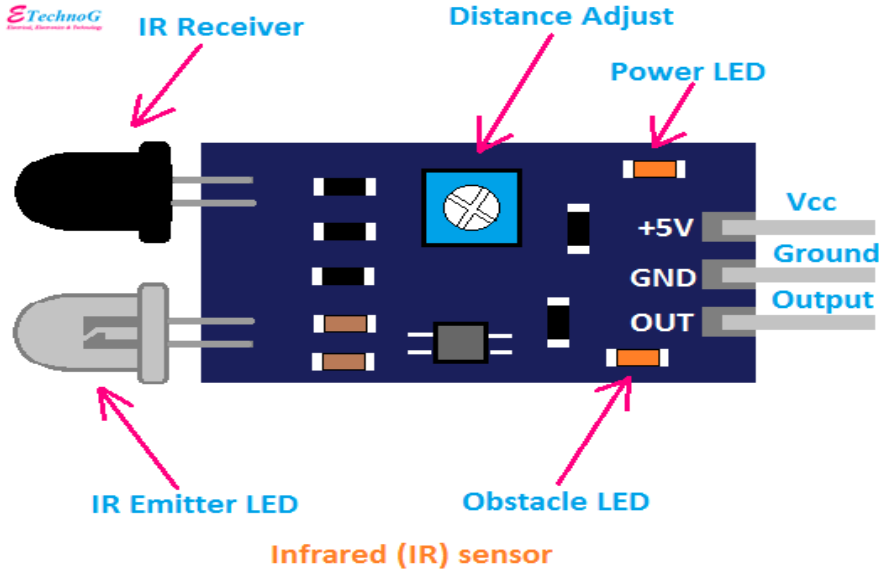
• A level-4 IoT system has multiple nodes that perform local analysis. Data is stored in the cloud and application is cloud-based.

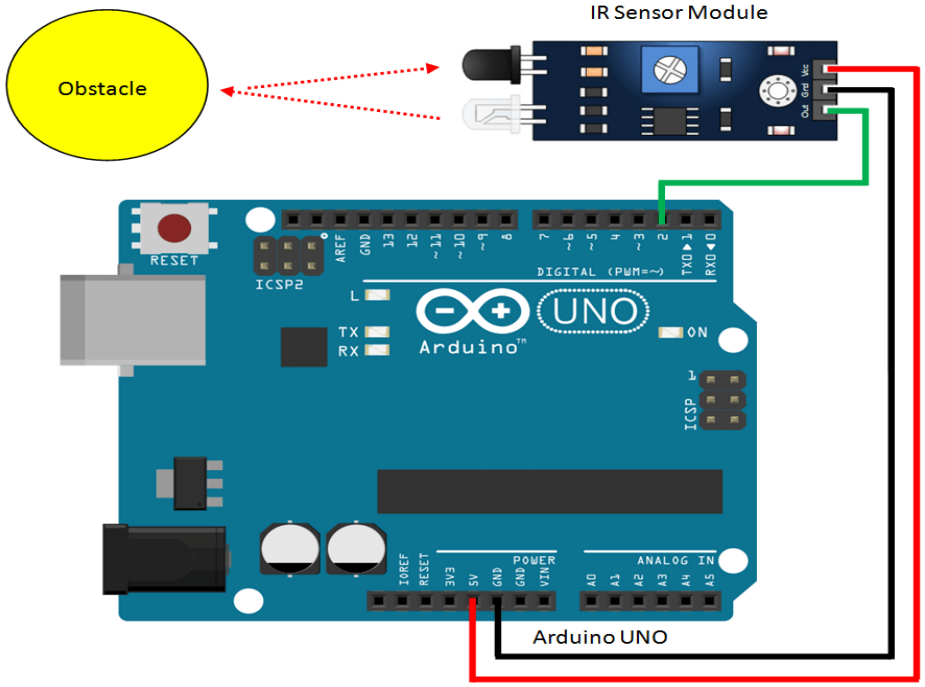
• Level-4 contains local and cloud based observer nodes which cansubscribe to and receive information collected in the cloud from IoT devices.

• Level-4 IoT systems are suitable for solutions where multiple nodes are required, the data involved is big and the analysis requirements are computationally intensive.



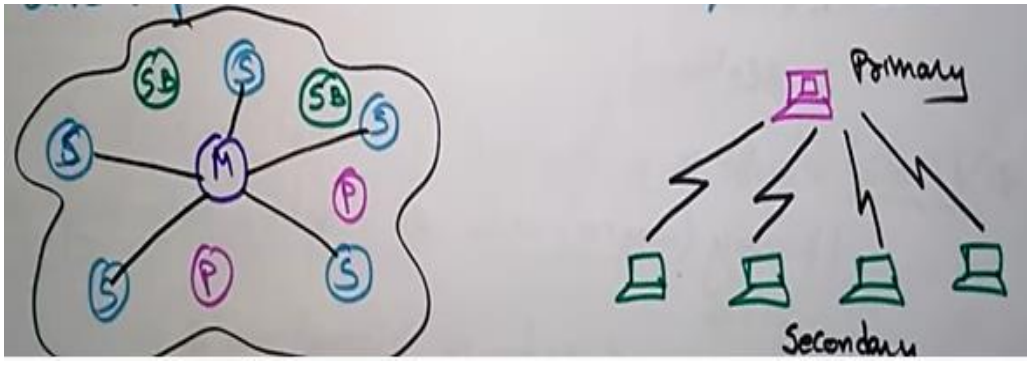
	b)	Write the characteristics of IoT. • Dynamic & Self-Adapting • Self-Configuring • Interoperable Communication Protocols • Unique Identity • Integrated into Information Network	CO1	L2	4M

		Unit – II			
4	a)	What is a Sensor? Explain the working of IR sensor with an example. Sensor is a device that when exposed to a physical phenomenon (temperature, displacement, force, etc.) produces a proportional output signal (electrical, mechanical, magnetic, etc.). Sensor is a device that detects and responds to some type of input from the physical environment. Input could be light, heat, motion, moisture, force, pressure, displacement, etc. It produces a proportional output signal (electrical, mechanical, magnetic, etc.). Human beings are equipped with 5 different types of sensors. Eyes detect light energy, ears detect acoustic energy, a tongue and a nose detect certain chemicals, and skin detects pressures and temperatures. The eyes, ears, tongue, nose, and skin receive these signals then send messages to the brain which outputs a response. **IR SENSOR** The IR sensor or infrared sensor is one kind of electronic component, used to detect specific characteristics in its surroundings through emitting or detecting IR radiation. These sensors can also be used to detect or measure the heat of a target and its motion. In many electronic devices, the IR sensor circuit is a very essential module. This kind of sensor is similar to human's visionary senses to detect obstacles.  Infrared (IR) sensor The sensor which simply measures IR radiation instead of emitting is called PIR or passive infrared. Generally in the IR spectrum, the radiation of all the targets radiation and some kind of thermal radiation are not visible to the eyes but can be sensed through IR sensors. In this sensor, an IR LED is used as an emitter whereas the photodiode is used as a detector. Once an infrared light drops on the photodiode, the output voltage & resistance will be changed in proportion to the received IR light magnitude.	CO2	L3	6M



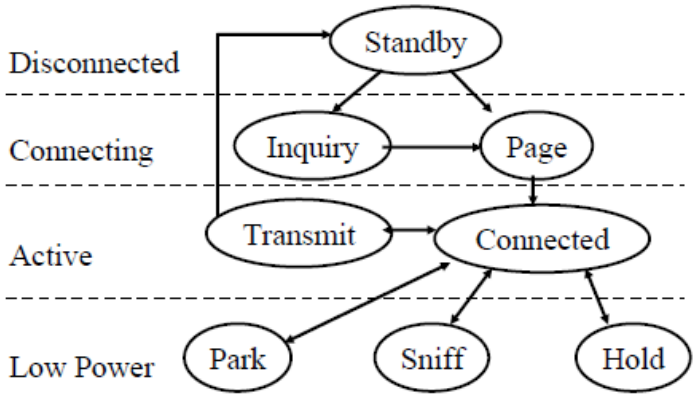

```
int IRSensor = 2; // connect ir sensor to arduino pin 2
int LED = 13; // conect Led to arduino pin 13
void setup()
{
  pinMode (IRSensor, INPUT); // sensor pin INPUT
  pinMode (LED, OUTPUT); // Led pin OUTPUT
}
void loop()
{
  int statusSensor = digitalRead (IRSensor);

  if (statusSensor == 1)
    digitalWrite(LED, LOW); // LED LOW
  }

  else
  {
    digitalWrite(LED, HIGH); // LED High
  }
  }
```

b)	Explain the features of Raspberry Pi. **Features:** • Superior software implementation. • 64-bit Quad-core processor. • Large RAM (latest Raspberry Pi 4 Model B Board has up to 8G of RAM). • Processor speed- 700MHz- 1.5GHz. • Raspberry Pi has 40 input/output pins. • It can be connected to the Internet. • It can run all kinds of applications (including MS Office and Email). • It contains everything- CPU (Central Processing Unit), GPU (Graphics Processing Unit), Ethernet port, GPIO (General-purpose Input/Output) pins, and power source connector.	CO2	L1	4M

		OR			
5	a)	Explain the communication protocol(Bluetooth) used in IoT. Bluetooth is a network technology that connects mobile devices wirelessly over a short-range to form a personal area network (PAN). It is a wireless technology based on mobile computing technology. A cable replacement technology. Developed by Ericsson-1994. Range 10+ meters It is also known as IEEE 802.15 Standard. The data can send or receive at a certain distance i.e., it uses a band of 2.4 to 2.485GHz. • It is a significant protocol for IoT applications. • The developing unit of this technology is a group of 5 companies called a special interest group which was formed in 1998. The companies are Ericson, Intel, IBM, Nokia, and Toshiba. • The range of bluetooth technology over which data can be exchanged is lessthan 10mts, but the latest version Bluetooth 5.0 can exchange data in a range of 40 – 400mtrs. • The speed at which data transmission occurs is around 1MBPS. **Key features: (Advantages)** • Robustness • low complexity • low power, and • low cost. **Disadvantages:** • Low bandwidth • Data transmission range is very less **Applications:** • Wireless Keyboard and Mouse. • Bluetooth earphones and speakers **Bluetooth Architecture:** Bluetooth architecture defines two types of networks. 1. Piconet 2. Scatternet **Pickonet:** > It is a bluetooth network that consists of 1 primary (master) node and 7 Secondary(slave) nodes. > Maximum it consists of 8nodes(1Master + 7 Slave nodes) > Maximum no.of devices can be paired are $2^8 - 1 = 255$ > No.of devices can be parked are infinite. ➢ A parked node is a node which is ready to connect and standby node is a node which can either became a slave or parked or either remains idle/disconnected. 	CO2	L2	7M

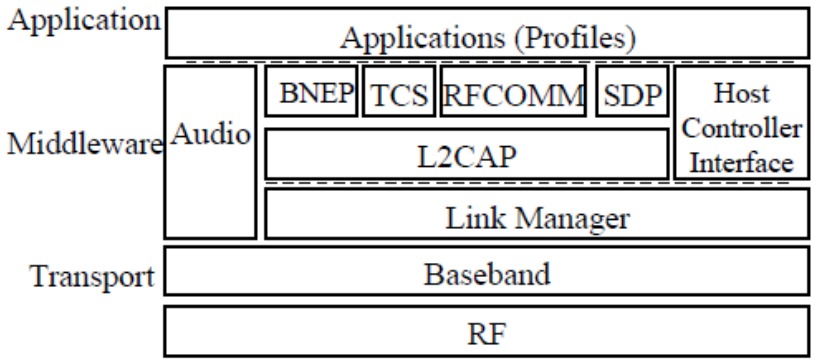
Data transmission can only occur between master and slave but not vice-versa.

Bluetooth Operational States

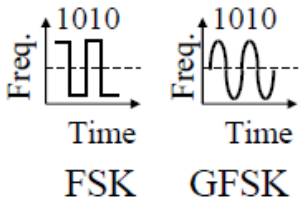


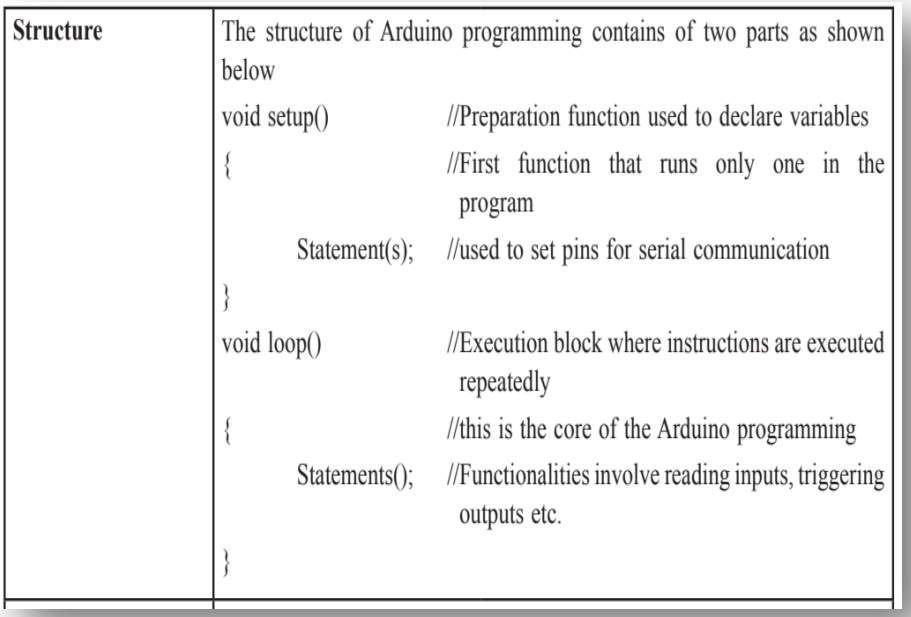
- **Standby**: Initial state
- **Inquiry**: Master sends an inquiry packet. Slaves scan for inquiries and respond with their address and clock after a random delay (CSMA/CA)

Bluetooth Protocol Stack

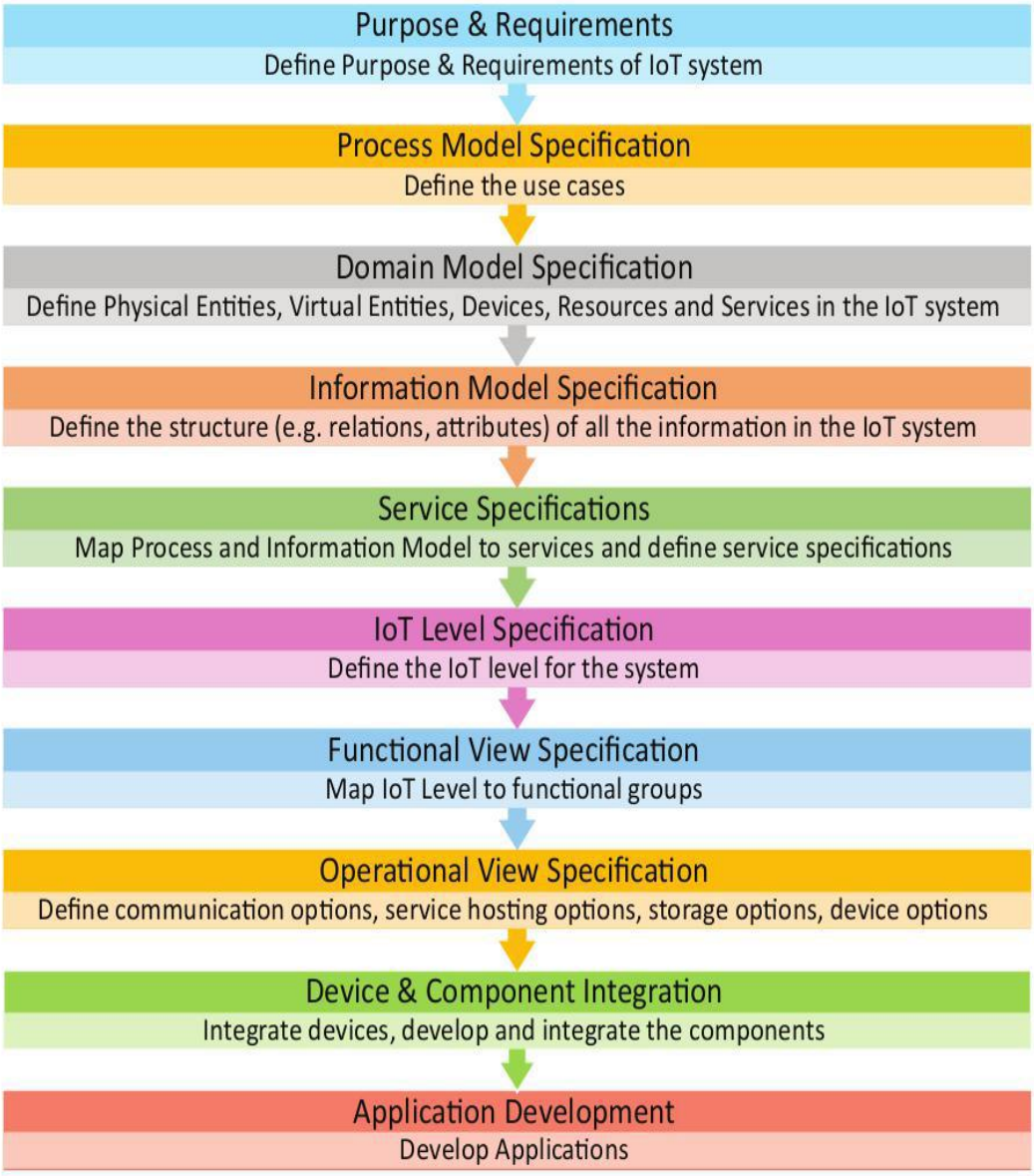


- **RF**: Frequency hopping Gaussian Frequency Shift Keying (GFSK) modulation
- **Baseband**: Frequency hop selection, connection, MAC



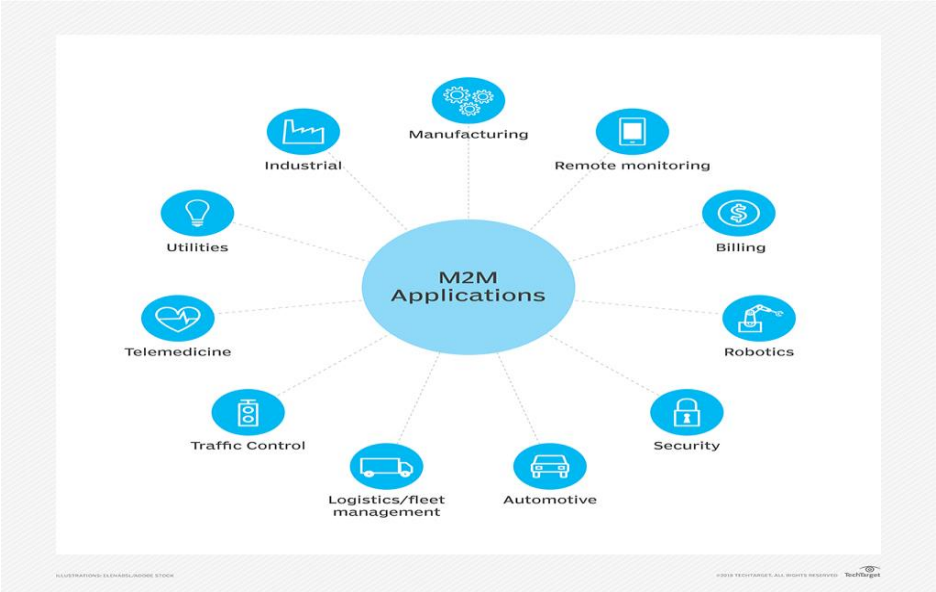
	b)	Write the Aurdino basic programming structure. 	CO2	L1	3M

Unit – III					
6	a)	Describe the steps in IoT design methodology in detail. Designing IoT systems can be a complex and challenging task as these systems involve interactions between various components such as IoT devices and network resources, web services, analytics components, application and database servers. IoT system designers often tend to design IoT systems keeping specific products/services in mind. So that designs are tied to specific product/service choices made. But it make updating the system design to add new features or replacing a particular product/service choice for a component becomes very complex, and in many cases may require complete re- design of the system.	CO3	L1	6M



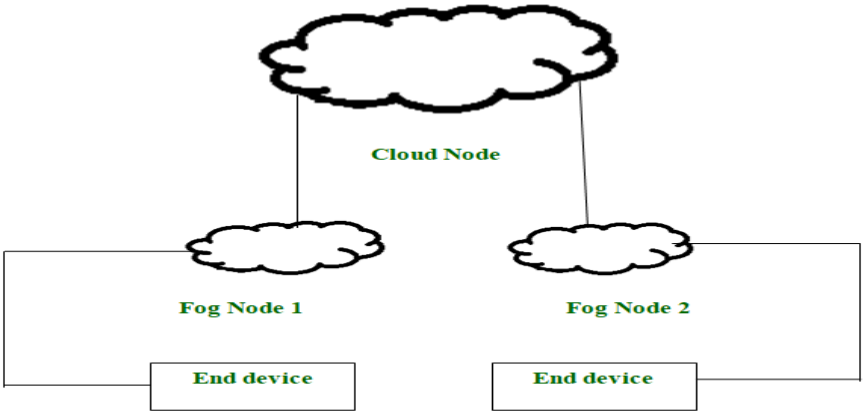
	b)	Write the steps in IoT design methodology for Smart Parking application. Steps involved in this project: 1. Making three devices in Artik Cloud Platform 2. Making one application in Artik Cloud 3. Making one rule in Artik Cloud 4. Preparing & Programming Arduino 5. Connecting the Sensors to Arduino 6. Preparing Raspberry Pi 7. Preparing Intel Edison 8. Developing Web Application 9. Developing Android Application 10. Completing the Project.	CO3	L3	4M

OR

7	a)	Write the applications of M2M architecture.  	CO3	L1	5M
	b)	Write the differences between M2M and IoT.	CO3	L2	5M

Features	IoT	M2M
Abbreviation	IoT stands for the Internet of Things.	M2M stands for Machine-to-Machine communication.
Intelligence	Devices include objects that are responsible for decision-making processes.	In M2M, there is a limited amount of intelligence observed.
Communication Protocol Used	IoT has used internet protocols like FTP, Telnet, and HTTP.	Communication technology and Traditional protocols are uses in M2M technology.
Connection Type Used	The connection of IoT is through the network and using various types of communication.	M2M uses a point to point connection.
Scope	It has a wide range of devices, yet the scope is large.	It has a limited Scope for devices.

Data Sharing	In IoT, data sharing depends on the Internet protocol network.	In M2M, devices may be connected through mobile or any other network.
Open API Support	IoT technology supports Open API integrations.	In M2M technology, there is no Open API support.

		Unit – IV			
8	a)	Explain the architecture of Fog computing with a neat diagram. **Fog Computing** Fog Computing is the term coined by Cisco that refers to extending cloud computing to an edge of the enterprise's network. Thus, it is also known as Edge Computing or Fogging. It facilitates the operation of computing, storage, and networking services between end devices and computing data centers.  **Fog Computing Architecture** 1. The devices comprising the fog infrastructure are known as fog nodes. 2. In fog computing, all the storage capabilities, computation capabilities, data along with the applications are placed between the cloud and the physical host. 3. All these functionalities are placed more towards the host. This makes processing faster as it is done almost at the place where data is created. 4. It improves the efficiency of the system and is also used to ensure increased security. **History of fog computing** The term fog computing was coined by Cisco in January 2014. This was because fog is referred to as clouds that are close to the ground in the same way fog computing was related to the nodes which are present near the nodes somewhere in between the host and the cloud. It was intended to bring the computational capabilities of the system close to the host machine. After this gained a little popularity, IBM, in 2015, coined a similar term called "Edge Computing". **Advantages of fog computing** 1. This approach reduces the amount of data that needs to be sent to the cloud. 2. Since the distance to be traveled by the data is reduced, it results in saving	CO4	L1	6M

		network bandwidth. 3. Reduces the response time of the system. 4. It improves the overall security of the system as the data resides close to the host. 5. It provides better privacy as industries can perform analysis on their data locally. **Disadvantages of fog computing** 1. Congestion may occur between the host and the fog node due to increased traffic (heavy data flow). 2. Power consumption increases when another layer is placed between the host and the cloud. 3. Scheduling tasks between host and fog nodes along with fog nodes and the cloud is difficult. 4. Data management becomes tedious as along with the data stored and computed, the transmission of data involves encryption-decryption too which in turn release data. **Applications of fog computing** 1. It can be used to monitor and analyze the patients' condition. In case of emergency, doctors can be alerted. 2. It can be used for real-time rail monitoring as for high-speed trains we want as little latency as possible. 3. It can be used for gas and oils pipeline optimization. It generates a huge amount of data and it is inefficient to store all data into the cloud for analysis.			
	b)	Write a short note on various IoT Cloud platforms. **IaaS (Infrastructure-as-a-Service)**: It was provided by the Cloud Service providers which help the customer to access and monitor things like computer, networking, and other services. In IaaS, the customer can purchase resources on demand rather than buying hardware which is costly and hard to maintain. Amazon Web Services (AWS) is an example of IaaS, allowing businesses to use its storage space, computing tools, and analytical functionalities on a pay-as-you-go basis. **PaaS (Platform-as-a-Service)**: It is a framework for the developer where they can create an application for customizing the previously built application. This service also provided through the means of internet and here all the management is done by the enterprise or any third party provider. Oracle Cloud is an examples of PaaS, where it allows developers to customize the functionalities for their already-existing application through JavaScript language. **SaaS (Software-as-a-Service)**: Software as a service, a cloud service provided by the cloud company. In SaaS, a customer provides software which can be either for a particular amount of time or for the lifetime. SaaS utilizes the internet and delivers the application to the customer. Google Cloud is an example of SaaS, where, through subscriptions, it allows enterprises to link their IoT devices and store their data on its cloud.	CO4	L2	4M
		OR			
9	a)	List and explain various challenges to select a Cloud Service provider for IoT applications. The main challenges of adopting an IoT cloud are as follows:	CO4	L2	3M

		Data breaches and security: Security challenges and data breaches are estimated to be the topmost concern with cloud computing. If there is a bug within the cloud computing provider's network, there is the possibility of hackers getting access not only to your data, but to all other subscribers' information. **Internet connectivity:** You need internet connectivity to have access to the cloud. If there is an internet outage, you will not be able to access your data. **Migration:** Whether you are transitioning toward cloud computing, or you are migrating from one cloud provider to another, transferring huge amount of data can be time-consuming, and prone to human error. However, businesses can leverage automation solutions such as RPA bots or workload automation to automate data migration processes and avoid human intervention and errors.			
	b)	Explain the case studies on Smart Lighting and Weather Monitoring System. In general, IoT architecture can be structured into three-layered model: perception (sensing), network, and applications layer **1st layer—perception layer** Internet-enabled devices from wireless sensors, Radio-frequency identification (RFID), Global Positioning System (GPS), to mobile devices and automobiles are what makes up the perception layer. It is essentially an eco-system of devices that can collect, detect, and exchange information with other devices through different communication networks. **2nd layer—network layer** The role of the network layer acts as an intermediary between the perception layer and the application layer. It transports the raw information gathered, via a combination of short-range (ZigBee and Bluetooth) and long-range communication technologies (PLC, Wi-Fi, 3G, 4G, 5G), all dependent on the device's network capability, otherwise known as middleware technology. **3rd layer—application layer** Finally, the application layer is the most important for the user as this is where the raw data is received, analyzed and processed to display real time feedback (Talari et al. 2017). Depending on the design of the system, artificial intelligence can provide automated services based on the information given. These systems play an important role in smart cities, to enhance standards of living by incorporating it into services such as, transportation, traffic management and streetlights. 1st stage—perception layer: Wireless Sensor Networks (WSNs) to monitor data on the environment • Light sensors to monitor the light level • Rain gauge to measure precipitation • Wind direction vane and anemometer to measure the wind speed and direction • Water level to measure ground water level for flooding • Environmental air pollution detector measures traffic pollution	CO4	L3	7M

2nd stage—network layer	WSN's able to receive and retransmit data from gateways, ZigBee/WLAN based communication protocol used to communicate between neighboring WSN's, creating a mesh network WSN communicates to other gateways creating a larger network The use of Wi-Fi and GPS to transmit data from a base station to the cloud which can be accessed by a central control and monitoring system
3rd stage—application layer	Responsive measures can be taken based on the data gathered • Alerting authorities if water level is high • Dimming of streetlights if surrounding level is high Monitoring traffic based on air pollution levels Monitor air levels for any toxic gas present and will alert authorities if present

Weather Monitoring System:

• The system proposed is an advanced solution for monitoring the weather conditions at a particular place and make the information visible anywhere in the world.

• The technology behind this is Internet of Things (IoT), which is an advanced and efficient solution for connecting the things to the internet and to connect the entire world of things in a network.

• The system deals with monitoring and controlling the environmental conditions like temperature, relative humidity, light intensity and CO level with sensors and sends the information to the web page and then plot the sensor data as graphical statistics.

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The data updated from the implemented system can be accessible in the internet from anywhere in the world.