School of Computer Science and Engineering

Fall Semester 2024-25

SLOT: C1+TC1

Programme Name & Branch: B.Tech CSE (Specialization in Data Science)

Course Name & Code: BCSE310L – IoT Architectures and Protocols

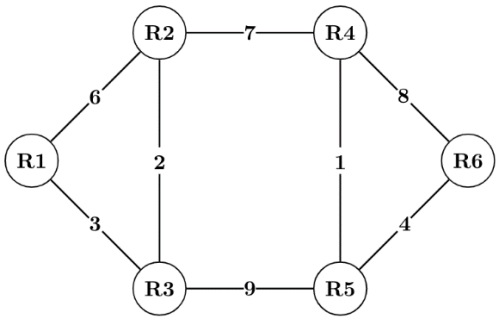
Class Number (s):

Faculty Name (s):

Exam Duration: 90 Min. **Maximum Marks: 50**

Answer ALL the questions

Q. No.	Question	Max Marks	CO	BL
1.	IoT based agriculture system uses sensors to monitor and manage crop health in real-time. The system continuously monitors soil moisture, temperature, humidity, and nutrient levels via sensors placed in the field. Data is transmitted to the cloud and analyzed to optimize irrigation and fertilization schedules. The system also includes an alert mechanism that notifies the farmer's mobile app when any parameter falls outside the optimal range. Design the IoT protocol stack and the protocols used in each layer with proper justification. Solution (2+2+2+3+1 (listing the protocols) Physical layer – IEEE 802.14.5 There is a need to build a sensor networks in large agricultural fields. So more number of devices are required. Network Layer – 6lowpan IPv6 provides a vast address space, which is necessary for the large number of devices in IoT networks. 6LoWPAN allows IPv6 packets to be sent over low-power wireless networks Transport Layer – UDP Speed is more required than reliability. Application layer CoAP protocol soil moisture, temperature, humidity -> data is transmitted ot cloud using the coap	10	CO1	BL3

	CoAP can send real-time alerts to the farmer's mobile app when any parameter falls outside the optimal range (remote control) MQTT can also be used			
2.	a. Describe the process of fragmentation and reassembly in 6LoWPAN when the packet size exceeds the maximum transmission unit of the IEEE 802.15.4 standard. (4 Marks) Solution 2 marks – header field, 2 marks – process When a packet exceeds the MTU of 127 bytes defined by IEEE 802.15.4, it needs to be fragmented. Fragmentation header has these field - **Datagram Size (t**otal size of the original packet), **Datagram Tag (u**nique identifier for the packet to ensure fragments are correctly reassembled), **Datagram Offset (p**osition of the fragment within the original packet) Process - the original packet is divided into smaller fragments, each fitting within the MTU limit, including the fragmentation header. The receiving node collects fragments based on the datagram tag. Using offset they are reassembled. b. Determine the optimal path from the sensor nodes to the border router (R1) using RPL, where each node has a rank based on its distance from the border router. (6 Marks)  Solution Nodes periodically exchange DIO messages to update their rank and optimize the path. Give the steps R2 → R1 with a rank of 6 R3 → R1 with a rank of 3 R2 → R3 → R1 with a rank of 5 R4 → R2 → R1 with a rank of 13 R5 → R3 → R1 with a rank of 12 R4 → R2 → R3 → R1 with a rank of 12 R6 → R5 → R3 → R1 with a rank of 16	10	CO2	BL2

3.	Illustrate and explain in detail how data are collected, analysed and monitored in an industrial IoT using SCADA. Solution Identify all parts (2 marks) each component description (2 marks) Data collection is through sensors. RTUs - collect data from sensors and transmit it to the SCADA system. PLC – covert analog to digital and controls the machinery Data transmission – data from sensor is transmitted to other devices using communication protocols (any communication modules can be written) Data analysis – is done using the SCADA programming (process) to identify trends and anomalies Data monitoring - HMI and supervisory system displays real-time data and analytics results. All components RTU, HMI, PLC, SCADA Programming, supervisory systems, communication interface need to be explained.	10	CO2	BL2
4.	Compare request-response model with the push-pull communication model with examples and discuss which logical design model is preferred when network bandwidth is limited and justify your choice. Solution Comparison (5 points with e.g) – 6 marks Justification – 4 marks the client sends a request to the server, and the server processes the request and sends back a response. This is a synchronous communication model. The client waits for the server to respond before proceeding. Each request is independent, and the server does not retain any information about previous requests. E,g web browser requests a webpage from a web server. The server processes the request and sends the webpage back to the browser. Push pull In this model, data producers (publishers) push data into a queue, and data consumers (subscribers) pull data from the queue. This is an asynchronous communication model. Producers and consumers operate independently. Producers and consumers do not need to know about each other. Efficient bandwidth Data is only transmitted when necessary. Producers push data into the queue, and consumers pull data as needed. (push pull is preferred)	10	CO1	BL2

	The client continuously sends requests, which can lead to higher bandwidth usage,			
5.	A smart city employs a wireless sensor network to monitor various environmental parameters such as air quality, temperature, humidity, and noise levels. The system also detects unusual events like fires or gas leaks and reports them to the emergency services. How can MQTT be utilized to manage and monitor the city's environmental conditions continuously? Provide a scenario and describe the frame format, topics and QoS levels used for effective communication in this context. Solution Scenario – (3 marks) Sensors measure environmental parameters and detect unusual events. Publisher (air quality sensor) using the topic city/environment/air_quality with QoS 1. Fire detection sensor publishes alerts to city/alerts/fire with QoS 2. Publishers (sensors) send data to the MQTT broker, the broker routes the messages to the appropriate subscribers. monitoring systems subscribe to topics like city/environment/# to receive all environmental data. emergency services subscribe to city/alerts/# to receive critical alerts. Upon receiving a fire alert, the emergency service system triggers an immediate response. 2marks MQTT broker – central hub, MQTT client (publisher and subscriber) MQTT messages consist of a fixed header (message type, flags, remaining length), variable header (QoS levels), and payload (actual data transmitted – sensor readings) – define all these Topics (2 marks) city/environment/air_quality city/environment/temperature city/environment/humidity city/environment/noise alerts city/alerts/fire city/alerts/gas_leak (3 marks) QoS 0 - The message is delivered at most once, with no acknowledgment. Suitable for non-critical data like periodic temperature updates	10	CO2	BL3

	QoS 1 - the message is delivered at least once, with acknowledgment required. Suitable for important data like air quality readings. QoS 2 - The message is delivered exactly once, with a four-step handshake process. Suitable for critical alerts like fire or gas leak notifications.			