B/L/TX

Final Assessment Test – November 2024

VIT
Vellore Institute of Technology

Course: **BCSE401L - Internet of Things**
Class NBR(s): **2074/2076/2078/2080/2083/2084/2086/2087/2088/2089/2092**
Slot: **C2+TC2**
Time: **Three Hours**
Max. Marks: **100**

- **KEEPING MOBILE PHONE/ELECTRONIC DEVICES EVEN IN 'OFF' POSITION IS TREATED AS EXAM MALPRACTICE**
- **DON'T WRITE ANYTHING ON THE QUESTION PAPER**

Answer ALL Questions

(10 X 10 = 100 Marks)

1. List various IoT devices at different levels in OSI layers;

Map the following temperature sensors to the various given applications in the prescribed following format

S.No.	Sensor	Application number
A	Thermocouple	2 5 1
B	Resistance Temperature Detector (RTD)	4 12 8
C	Thermistor	6 9 7
D	Semiconductor Temperature Sensor	3 11 10

Application Number	Application description
1	In Medical devices for thermal therapy devices.
2	In Industrial temperature measurement for Furnaces.
3	In Greenhouses for agriculture to monitor and controlling greenhouse temperatures to optimize plant growth and yield.
4	In Food industry for monitor and control temperatures in food processing and storage.
5	In HVAC systems for temperature control and monitoring.
6	In Data centers to monitor server temperatures and optimize cooling systems for efficient operation.
7	In Medical devices for patient monitoring systems.
8	In Pharmaceutical industry for monitor and control temperatures of pharmaceutical manufacturing processes.
9	In Medical devices for fever thermometers.
10	In Automotive industry for Exhaust gas temperature measurement in vehicles.
11	In Electronics cooling for electronic devices to monitor and control the temperature of integrated circuits to prevent overheating and ensure optimal performance.
12	In Laboratory equipment for Incubators.

2. a. Identify and list them in the prescribed following format appropriate sensors used for four use-cases from the following passage and in the prescribed following format: [4]

S.No	Sensor	Justification
1		
2		
3		
4		

In the bustling city of Bengaluru, technology had advanced to a point where smart homes were the norm. One such home belonged to Dr.Sekhar, a brilliant scientist known for his cutting-edge research in environmental sustainability. Dr.Sekhar's house was a marvel of engineering, equipped with every smart sensor imaginable to ensure both comfort and eco-friendliness. Among these were four crucial sensors, each with its unique role.

i. _____Sensor: This sensor acted as the silent guardian of the house. Positioned at the entrance, it detected movement and automatically unlocked the door when it recognized familiar footsteps. It also activated lights in the pathway, making late-night returns safe and convenient.

ii. _____Sensor: Given Bengaluru' increasing air pollution, this sensor was Dr.Sekhar's vigilant watchman. It continuously monitored the air quality inside the home, detecting harmful gases like carbon monoxide. If the air quality dropped below safe levels, the sensor would trigger an alert and activate the house's air purifiers, ensuring a breathable environment.

iii. _____Sensor: The house's intelligent climate control system relied heavily on this sensor. It constantly measured the humidity levels, adjusting the home's dehumidifiers and humidifiers to maintain optimal comfort. This was particularly important for preserving Dr.Sekhar's extensive collection of rare books, which needed a specific humidity level to prevent damage.

iv. _____Sensor: Dr.Sekhar's home had an advanced water management system that depended on the level sensor. It ensured that the rooftop rainwater harvesting tanks were never overfilled, preventing water wastage. The sensor would prompt the system to redirect excess water to the garden, keeping it lush and green even during dry spells.

As Dr.Sekhar settled in with a cup of tea, he couldn't help but marvel at how these seemingly simple sensors worked in harmony to create a haven of safety, comfort, and sustainability. In that moment, he felt a deep sense of gratitude for the technology that made it all possible. And so, in the heart of Bengaluru, Dr.Sekhar's home stood as a shining example of how sensors and innovation could transform everyday life, one sensor at a time.

b. In IPV4, Identify the classes of the IPs: 110.10.20.30, 150.10.20.30, and 200.10.20.30. Find the network IDs, broadcast IDs, and the number of actual hosts for the given IP addresses and list them in the prescribed table [6]

Details	IP's		
	110.10.20.30	150.10.20.30	200.10.20.30
Class			
Network ID			
Broadcast ID			
Number of Actual Hosts			

3. Compare IEEE 802.11 and IEEE 802.15.4 across the features of Purpose, Frequency Bands, Range, and Data Rate;

Calculate the throughput for Pure ALOHA and Slotted ALOHA given the following parameters: a 10-byte frame (Frame Size), a shared channel bandwidth of 160 kbps (Channel Speed), and end nodes transmitting at a rate of 500 frames per second (fps).

4. Write a brief note on Duty Cycle, Dwell and Hop Time, and Robustness in the context of the LoRaWAN Protocol.

Analyze the following scenarios and identify the Application layer protocol most likely used in each case. Provide a brief justification for your choice based on the characteristics of the application protocol and its suitability for the given scenario. Provide your answer using the following table –

Scenario	Application protocol	Justification
Scenario – 1		
Scenario – 2		
Scenario – 3		

Scenario 1: In a smart agriculture system, sensors across expansive farmlands collect real-time data on soil moisture and environmental conditions. The system relies on a lightweight and efficient Application layer protocol for seamless communication between the sensors and the central monitoring server.

Scenario 2: In a smart city's traffic management system, various sensors and traffic lights communicate real-time data to optimize traffic flow. The system relies on a lightweight and efficient protocol for scalable and reliable communication, ensuring timely updates and coordination.

Scenario 3: An online shopping platform implements a protocol for secure and encrypted communication between users and the server, ensuring the confidentiality and integrity of sensitive user data during online transactions.

5. What are the common evaluation metrics used to assess the performance and effectiveness of machine learning models? Provide a brief note on each metric with an appropriate formula;

Consider the given raw dataset as shown in table. Perform Naive Bayes classification algorithm and determine the posterior probability if the weather is windy.

Weather	No	Yes
Sunny	1	2
Rainy	0	4
Windy	2	3

6. In data privacy Anonymization, list the drawbacks of k-Anonymity. What are methods that use to address some of the drawbacks of k-anonymization? Write about them briefly; [4]

K-anonymity describes that for each person within the data, their information cannot be distinguished from at least k -1 other individuals whose information also appears in the data. Note that "distinguishing" is defined over quasi-identifiers. Assume that for this exercise, the attributes age and gender are the quasi identifiers.

ID	Age	Gender	Fav. Show
1	12-15	female	Friends!
2	19-25	male	Friends!
3	19-25	male	Friends!
4	12-15	female	Friends!
5	19-25	male	G.o.T.
6	19-25	male	G.o.T.
7	19-25	male	G.o.T.

$Dataset_1$

ID	Age	Gender	Fav. Show
1	19-25	female	Grey's A.
2	19-25	female	Simpsons
3	19-25	female	Futurama
4	19-25	female	Friends!
5	19-25	male	G.o.T.
6	19-25	male	C.Minds
7	19-25	male	Br.Ba.

$Dataset_2$

ID	Age	Gender	Fav. Show
1	19	male	Friends!
2	19	male	Friends!
3	19	male	Friends!
4	19	female	Friends!
5	20	male	G.o.T.
6	20	male	G.o.T.
7	20	male	G.o.T.

$Dataset_3$

a) Does Dataset1 satisfy k-anonymity? If so: what is the maximal k for which it satisfies k-anonymity? Explain your answer by giving the anonymity sets consisting of the equivalent identities! [2]

b) Does Dataset2 satisfy k-anonymity? If so: what is the maximal k for which it satisfies k-anonymity? Explain your answer by giving the anonymity sets consisting of the equivalent identities! [2]

c) Does Dataset3 satisfy k-anonymity? If so: what is the maximal k for which it satisfies k-anonymity? Explain your answer by giving the anonymity sets consisting of the equivalent identities! [2]

7. Describe sensor data fusion and write brief note on three types of fusion architectures used in sensor data fusion systems;

A sensor network consists of four anchor nodes positioned at known locations, and an unknown node whose location needs to be estimated using Angle-of-Arrival (AoA) measurements. The actual location of the unknown node is $[x\ y]^T = [0.5\ 0.5]^T$

The coordinates of the four anchor nodes are:

$$[x_1\ y_1]^T = [0\ 0]^T, [x_2\ y_2]^T = [0\ 1]^T, [x_3\ y_3]^T = [1\ 0]^T, [x_4\ y_4]^T = [1\ 1]^T$$

The angles of arrival (AoA) at each anchor node are:

$$\varphi_1 = 180^o + 45^o, \varphi_2 = 180^o - 45^o, \varphi_3 = 360^o - 45^o, \varphi_4 = 45^o$$

a. Construct matrices A and B based on the angle and anchor information. The system of equations for localization is represented as:

$$\mathrm{A} = \begin{bmatrix} 1 & -tan\varphi_1 \\ 1 & -tan\varphi_2 \\ . & . \\ 1 & -tan\varphi_N \end{bmatrix} \mathrm{B} = \begin{bmatrix} x_1 - y_1 tan\varphi_1 \\ x_2 - y_2 tan\varphi_2 \\ . \\ x_N - y_N tan\varphi_N \end{bmatrix}$$

b. Using the least-squares method $\bar{X} = (A^T A)^{-1} A^T B$, calculate the estimated location $\bar{X}$ of the unknown node.

8. A Virtual Machine (VM) in a data center is relocated to a new server, requiring its traffic to be routed through a different router. Explain how the Locator/Identifier Separation Protocol (LISP) manages this change, focusing on the roles of Endpoint Identifiers (EIDs), Routing Locators (RLOCs), and the steps involved in updating the routing. Draw and label the architecture of LISP to illustrate the flow of traffic between Ingress Tunnel Routers (ITRs) and Egress Tunnel Routers (ETRs).

9.a) What are various supervised learning algorithms to predict outcomes and recognize patterns in machine learning and write about any one of them in-detail?

In the process of reduction of dimension using Principal Component Analysis (PCA), compute eigenvalues, λ_e from covariance matrix and data of table

X= Moisture	2	1	0	-1
Y= Leaf Wetness	4	3	1	0.5

Covariance matrix(S)=$\begin{vmatrix} 1.67 & 2.08 \\ 2.08 & 2.73 \end{vmatrix}$

OR

9.b) State any four compelling reasons, Why Elliptic Curve Cryptosystem (ECC) is a popular choice for securing IoT applications?

Consider the elliptic curve $y^2 = (x^3 + ax + b) \, mod \, p_r$ for a=1, b=0, and $p_r = 7$ with generator point g $\equiv (x_g, y_g) = (3, 3)$ and encoded message on the curve, message $\equiv (x_M, y_M) = (3, 4)$. Assume the private key for sender and receiver are respectively 3 and 2.

Value of 3λ mod 7							
λ	1	2	3	4	5	6	7
3λ	3	6	9	12	15	18	21
3λ mod 7	3	6	2	5	1	4	0

Compute public key of receiver (r_{pub})

10.a) On the vibrant campus of VIT, nestled in the bustling SJT area, a parking problem emerged. Students and staff often found themselves circling the parking lot, wasting precious time and fuel in search of an available spot. One afternoon, an innovative engineering student from B.Tech., CSE, observed the parking chaos from the lab window and decided it was time to take action. It's time to test their skills and design a Smart Parking System for the SJT car park. Considering the layout, where each parking space measures 8 sq.ft. in width and 12 sq.ft. in length, develop a design with necessary components such as sensors and application protocols, and provide justification for your choices.

OR

10.b) In the bustling cities of India, air pollution has emerged as a major concern, impacting health and quality of life. To combat this, a group of innovative B.Tech CSE students decided to harness the power of technology. They envisioned an IoT application named "AiryyMeter" that leverages cloud data on local emission sources and administrative measures to manage air pollution. This application would use user location data (via GPS) to provide real-time air quality information from the cloud. For users traveling to a destination, AiryyMeter would predict pollution levels along the entire route, issuing warnings if levels are too high, thus enabling users to re-route their journeys. This system would function similarly to the Google Traffic and Navigation application on Google Maps.

Based on this context, Design an embedded application called 'AiryyMeter' to monitor and predict air quality along travel routes using user location data (via GPS) and cloud-based air quality information. Include the types of sensors, actuators, communication modules, and application protocols you would use. Justify your recommendations by highlighting the features and benefits of your design.

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