

Section A: [40 Marks]

This section contains **THREE** questions; Answer any **TWO** questions from this section.

Question 1: [20 Marks]

You are part of a Team that design an Artificial Intelligence system for Autonomous Vehicle (AV) to operate in a highly dynamic environment. You are assigned the following tasks.

Task1 - The vehicle needs to predict and respond to potential hazards, such as other vehicles performing unexpected manoeuvres or pedestrians crossing the street unpredictably, requiring real-time decision-making to avoid collisions.

Task 2 - The vehicle must plan its route dynamically, considering not only its current position but also factors like traffic congestion, road closures, and weather conditions that can affect its journey. The vehicle must optimize its route for efficiency while adhering to traffic laws.

- 1.1** Identify and explain the key function/s (perception, prediction, planning and control) of an AV that responsible for Task1 and Task 2. **[4]**
- 1.2** Explain why the selected function/s is the most suitable for these tasks and how it contributes to the AVs overall performance in the given task. **[4]**
- 1.3** Explain how the function/s selected for Task1 interacts with the function/s selected for Task 2. **[4]**
- 1.4** Explain how Weak AI can be utilized to enable an AV to handle challenging environmental factors such as poor road infrastructure, and sudden obstacles. **[4]**
- 1.5** How do Weak AI and Strong AI differ in handling challenges like potholes, traffic signs, or bad weather in autonomous vehicles? How would Strong AI help the vehicle adapt to these unpredictable road conditions? **[4]**

Question 2: [20 marks]

XYZ Company is in the process of developing autonomous systems based on reinforcement learning for autonomous vehicles that navigate urban streets and warehouse robots for automated pick-and-deliver tasks.

2.1 Compare and contrast the roles of agent, environment, reward and strategy in the context of AV navigating city traffics and warehouse robot performing pick and deliver tasks. **[8]**

2.2 Discuss the concepts of exploration and exploitation in reinforcement learning. How does the warehouse robot balance the trade-off between exploration and exploitation. **[4]**

2.3 Define the components of the PEAS (Performance Measure, Environment, Actuators, Sensors) framework and identify two key examples for each component in the context of an Autonomous Vehicle (AV) to perform its functions. **[8]**

Question 3: [20 Marks]

ABC-Tech company is developing a Natural Language Based chatbot to automate customer service for an online retail platform. The chatbot is designed to handle a wide range of customer queries, from order status inquiries to product information and return policies.

3.1 Analyse the following conversation and identify the intent, entities and dialogue management strategies used by the chatbot. Explain how these elements contribute to the overall effectiveness of the chatbot. **[6]**

Customer : "I want to check the order status of my recent order."

Chatbot : "Hello, I can help you with that, please provide the order number. "

Customer : "The order number for the bag is #345543. "

Chatbot : "Thank you. One moment please... Your order is currently out for delivery and should be in two days. "

Customer: "Thank you for the update. "

Chatbot: "Is there anything else I can assist with ? "

Customer: "No, that's all. "

Chatbot: "You are welcome. "

3.2 Explain text preprocessing, feature extraction, and modelling in Natural Language Processing (NLP) and provide the significance of these key stages. **[9]**

3.3 Explain how the Term Frequency-Inverse Document Frequency (TF-IDF) method helps in identifying important words in a document. Consider the following dialogue to calculate the Term frequency (TF) of the term, *order*. **[5]**

"I want to check the order status of my recent order"

Section B [35 Marks]

Question 4: [35 Marks]

A team of students is tasked with developing a predictive model for a financial institution. The goal is to predict customer churn based on various features such as transaction history, customer demographics, account activity, and customer service interactions. The dataset includes numerical, categorical, and time-series data. Importantly, the dataset contains labels indicating whether each customer has churned or not.

4.1 In the context of predicting customer churn for a financial institution, determine whether this task is a supervised or unsupervised learning problem. Justify your answer based on the nature of the data provided. **[3]**

4.2 Describe the key steps involved in building an Artificial Neural Network (ANN) for predicting customer churn. **[10]**

4.3 Explain why an Artificial Neural Network (ANN) is a suitable choice for the customer churn prediction task. How does the nature of the data and the problem influence this decision compared to using a Convolutional Neural Network (CNN)? **[3]**

4.4 Discuss how a confusion matrix can be used to evaluate the performance of the ANN model in predicting customer churn. What insights can be derived from the confusion matrix? **[4]**

4.5 The proposed model was trained with a dataset containing 20000 customer records. 500 were correctly classified as churned; 3000 were incorrectly classified as non-churned but actually churned; 1500 were incorrectly classified as churned but actually non-churned; 15000 customers were correctly classified as non-churned.

(i). Complete the following confusion matrix by identifying the values of True Positive (TP), False Positive (FP), False Negative (FN) and True Negative (TN). **[4]**

Actual	Predicted		
		Churned	Not-churned
	Churned	?	?
	Not-churned	?	?

(ii). Based on the confusion matrix in question 4.5 (i) , calculate the accuracy, precision, recall and F1-score (with a Beta value of 2) of the proposed ANN model and interpret the results. Use the attached Formula sheet (appendix A) for selecting the correct equation. **[8]**

(iii). Discuss the potential business implications of the model's performance, particularly focusing on the impact of false positives and false negatives. **[3]**

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Appendix A: Formula Sheet

$Accuracy = \frac{TP + TN}{TP + TN + FP + FN}$	$Sensitivity = \frac{TP}{TP + FN}$
$Specificity = \frac{TN}{TN + FP}$	$Precision = \frac{TP}{TP + FP}$
$F1\ score = \frac{2 * Precision * Recall}{Precision + Recall}$	$Error\ Rate = \frac{FP + FN}{TP + TN + FP + FN}$
$False\ Positive\ Rate = \frac{FP}{TN + FP}$	$True\ Positive\ Rate = \frac{TP}{FN + TP}$