

A

221TCS100012501

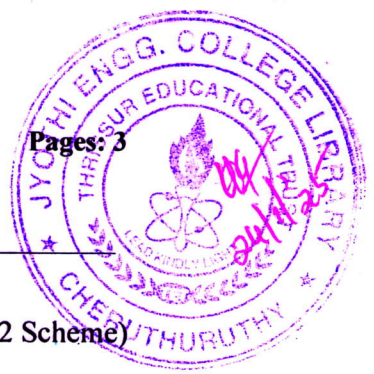
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Reg No.: \_\_\_\_\_

Name: \_\_\_\_\_

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

M.Tech Degree S1 (R,S) / S1 (WP) (R,S) Examination December 2024 (2022 Scheme)



Course Code &amp; Name: 221TCS100 ADVANCED MACHINE LEARNING

Max. Marks: 60

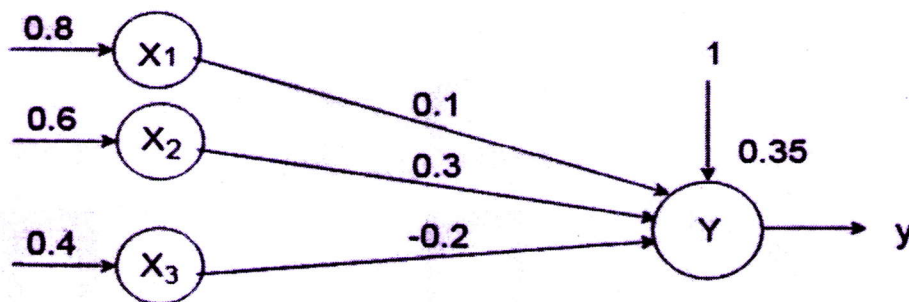
Duration: 2.5 Hours

## PART A

Answer all questions. Each question carries 5 marks

Marks

- 1 Derive the Maximum Likelihood Estimation (MLE) for the mean  $\mu$  and variance  $\sigma^2$  of a normal distribution, given a set of data points  $x_1, x_2, \dots, x_n$ . (5)
- 2 Compute the output  $y$  of a neuron with three inputs and a bias, using the given data in the diagram and the sigmoidal activation function. (5)



- 3 What do you mean by K-means clustering, and what are the detailed steps involved in performing the K-means clustering algorithm to partition a dataset into distinct groups? Illustrate the process with a simple example. (5)
- 4 Explain the significance of Support Vector Machines (SVMs) and show that the kernel  $K(x,y)=(x \cdot y + 1)$  defines a mapping to a 3-dimensional feature space, where  $x$  and  $y$  are 2-D input vectors. (5)
- 5 Given the confusion matrix: (5)

|                 | Predicted Positive | Predicted Negative |
|-----------------|--------------------|--------------------|
| Actual Positive | 80                 | 20                 |
| Actual Negative | 30                 | 70                 |

Calculate the Recall, Specificity, and False Positive Rate (FPR) for the classifier.

## PART B

*Answer any 5 questions. Each question carries 7 marks*

- 6 Compare and contrast supervised learning, unsupervised learning, and reinforcement learning in terms of their applications, and describe the major challenges in reinforcement learning and how they are addressed in real-world scenarios. (7)
- 7 How do LASSO and RIDGE regularization techniques differ in terms of their impact on the model's complexity and generalization? Explain with examples. (7)
- 8 Given the two-dimensional patterns (2, 1), (3, 5), (4, 3), (5, 6), (6, 7), and (7, 8), compute the principal component using the PCA algorithm. (7)
- 9 A city has only three weathers: rainy, sunny, and cloudy. Your friend living in this city has only two moods—happy or sad—based on the weather in his city. You don't know the weather of your friend's city, but you do know his mood. The initial state distribution, transition, and emission probability matrix are

below.

$$\pi = \begin{bmatrix} \text{Rainy} & \text{Cloudy} & \text{Sunny} \\ 0.218 & 0.273 & 0.509 \end{bmatrix}$$

|        | Rainy | Cloudy | Sunny |
|--------|-------|--------|-------|
| Rainy  | 0.5   | 0.3    | 0.2   |
| Cloudy | 0.4   | 0.2    | 0.4   |
| Sunny  | 0     | 0.3    | 0.7   |

|        | Sad | Happy |
|--------|-----|-------|
| Rainy  | 0.9 | 0.1   |
| Cloudy | 0.6 | 0.4   |
| Sunny  | 0.2 | 0.8   |

- a) Draw the HMM. Include the state transition probabilities and emission probabilities for each state.

What is the probability of your friend being happy, happy and sad for three consecutive days given the weather is sunny, cloudy and sunny respectively?

- 10 How does the Random Forest algorithm combine multiple decision trees for classification, and why is it more accurate than a single Decision Tree? Illustrate your explanation with an example. (7)
- 11 Given actual values [12, 15, 18, 22] and predicted values [11, 16, 17, 20], calculate the MAE, RMSE and R-squared. Explain the significance of each metric in evaluating the regression model. (7)

- 12 Given that 165 people were tested, for the presence of influenza with the classifier predicting 'yes' 110 times and 'no' 55 times and in reality, 105 patients have the disease and 60 do not, construct the confusion matrix and calculate the classification performance of the model in terms of accuracy, precision, recall and F1-score. (7)