



**M.E/M.TECH DEGREE EXAMINATIONS: NOV/DEC 2023**

(Regulation 2018)

Third Semester

**COMMUNICATION SYSTEMS**

P18AET2001: Machine Learning

**COURSE OUTCOMES**

- CO1:** Discuss the various learning methods.
- CO2:** Apply appropriate linear model for a given application.
- CO3:** Solve a given problem using probabilistic model.
- CO4:** Use appropriate graphical models for specific application.
- CO5:** Review and Employ the neural network-based learning algorithm.

**Time: Three Hours**

**Maximum Marks: 100**

**Answer all the Questions:-**

**PART A (10 x 1 = 10 Marks)**

1. Assertion (A): Machine learning is inspired by the way the human brain and neurons work. CO1 [K<sub>4</sub>]  
Reason (R): The concept of artificial neural networks is based on the functioning of biological neurons in the human brain.
  - a) The assertion is not correct but the reasoning is the correct explanation for the assertion.
  - b) Both the assertion and reasoning are not correct.
  - c) The assertion is correct but the reasoning is not the correct explanation for the assertion.
  - d) Both the assertion and reasoning are correct, and the reasoning is the correct explanation for the assertion.
2. In reinforcement learning, predict which one is responsible to make decisions for optimizing their long-term reward. CO1 [K<sub>3</sub>]
  - a) Intermediate layers
  - b) agents
  - c) Output layers
  - d) Intermediate neurons
3. In linear regression, interpret the goal of the bias-variance decomposition. CO2 [K<sub>2</sub>]
  - a) To increase the complexity of the model
  - b) To minimize the training error

- c) To understand the trade-off between model bias and variance      d) To reduce bias in the model

4. Match the following linear models to their applications:

CO2 [K4]

List I	List II
A. Bayesian linear regression	i. Predicting stock prices with uncertainty estimates.
B. Linear discriminant analysis	ii. Dimensionality reduction
C. Maximum margin classifier	iii. Classifying emails as spam or not spam with a large margin between classes.
D. Support Vector Machine	iv. Image classification

- |    | A     | B     | C     | D     |
|----|-------|-------|-------|-------|
| a) | (i)   | (ii)  | (iii) | (iv)  |
| b) | (ii)  | (iii) | (i)   | (iv)  |
| c) | (iii) | (ii)  | (i)   | (iv)  |
| d) | (iv)  | (i)   | (ii)  | (iii) |

5. Assertion (A): Principal Component Analysis (PCA) finds a linear transformation of data that maximizes the variance. CO3 [K4]

Reason (R): Principal Component Analysis (PCA) aims to preserve the least important features of the data.

- a) Both the assertion and reasoning are correct, and the reasoning is the correct explanation for the assertion.      b) Both the assertion and reasoning are correct, but the reasoning is not the correct explanation for the assertion.
- c) The assertion is true but the reason is not the correct explanation.      d) The assertion is false, and the reason is not the correct explanation.

6. Identify the probabilistic model that is often used for modeling data with multiple underlying clusters of data points. CO3 [K2]

- a) K-means clustering      b) Factor analysis
- c) Principal Component Analysis      d) Gaussian mixture model

7. Select the types of graphical models that are typically used for structured prediction tasks: (More than one option may be correct. ) CO4 [K1]

- a) Decision trees      b) Ensemble learning
- c) Bayesian networks      d) Markov Random Fields

8. Assertion (A): Bayesian networks are used to model causal relationships among variables. CO4 [K<sub>3</sub>]  
Reason (R): In Bayesian networks, directed edges between nodes represent the direction of causality.
- a) The assertion is not correct but the reasoning is the correct explanation for the assertion.      b) Both the assertion and reasoning are not correct.
- c) The assertion is correct but the reasoning is not the correct explanation for the assertion.      d) Both the assertion and reasoning are correct, and the reasoning is the correct explanation for the assertion.
9. Identify the primary function of a neuron in a neural network. CO5 [K<sub>2</sub>]
- a) Data transformation      b) Data storage  
c) Data encryption      d) Data transmission
10. Arrange the following neural network models in sequential order based on their historical development, from the earliest to the most recent. CO5 [K<sub>2</sub>]
- (i) Feed-forward neural networks      (ii) Multi-layer perceptron  
(iii) Convolutional neural network      (iv) Auto encoder networks
- a) (i), (ii), (iv), (iii)      b) (ii), (i), (iv), (iii)  
c) (ii), (i), (iii), (iv)      d) (i), (ii), (iii), (iv)

**PART B (10 x 2 = 20 Marks)**

11. What is the version space, and how is it maintained during concept learning? CO1 [K<sub>1</sub>]
12. Infer the primary objective of the concept learning task in machine learning. How does a maximally specific hypothesis relate to this task? CO1 [K<sub>2</sub>]
13. Identify the role of the support vector machine (SVM) in linear classification, and outline how does it differ from other classifiers. CO2 [K<sub>3</sub>]
14. Infer the concept of a linear basis function model in the context of linear regression. CO2 [K<sub>2</sub>]
15. Compare the K-means clustering and the k-nearest neighbor (KNN) method in terms of their objectives. CO3 [K<sub>3</sub>]
16. In the context of dimensionality reduction, what does Principal Component Analysis (PCA) seek to achieve? CO3 [K<sub>1</sub>]
17. Compare Classification and Regression Trees (CART) and Decision Trees in machine learning. CO4 [K<sub>2</sub>]
18. Identify the key characteristic that defines Hidden Markov Models (HMMs), and what CO4 [K<sub>3</sub>]

kinds of applications are HMMs well-suited for?

19. What distinguishes a feed-forward neural network from other neural network architectures? CO5 [K<sub>1</sub>]
20. Interpret the concept of generalized radial-basis function networks. How do they differ from feed-forward networks, and what are their typical applications? CO5 [K<sub>2</sub>]

**PART C (10 x 5 = 50 Marks)**

21. List an example of a real-world application for three different types of machine learning, and explain how they differ in terms of learning paradigms and use cases. CO1 [K<sub>2</sub>]
22. Outline the steps of candidate elimination algorithm in the context of concept learning. Provide an example to illustrate how it helps in hypothesis refinement. CO1 [K<sub>2</sub>]
23. Explain Fisher's linear discriminant in the context of linear classification. How does it work for two-class and multiple-class classification problems? CO2 [K<sub>5</sub>]
24. Interpret the concept of probabilistic generative models for classification. How do these models differ from discriminative models, and what are their applications? CO2 [K<sub>2</sub>]
25. Examine the concept of the "curse of dimensionality". Discuss the challenges and implications of this phenomenon for machine learning and data analysis. CO3 [K<sub>4</sub>]
26. Identify the primary objective and applications of Independent Component Analysis (ICA) in dimensionality reduction. How does ICA extract statistically independent components, and what are its potential use cases? CO3 [K<sub>3</sub>]
27. Outline the principles of Bayesian networks and Markov Random Fields (MRFs) as directed and undirected graphical models, respectively. Describe their applications and scenarios in which one might be preferred over the other. CO4 [K<sub>2</sub>]
28. Examine the process of inference in graphical models, focusing on the types of queries that inference algorithms can address and their significance in machine learning and data analysis. CO4 [K<sub>4</sub>]
29. Draw the architecture of a multi-layer perceptron (MLP) neural network. How does it handle complex functions and non-linear relationships in data? CO5 [K<sub>2</sub>]
30. Outline the concept of backpropagation algorithm in neural networks. Discuss how it computes gradients and how these gradients are used to update model parameters. CO5 [K<sub>2</sub>]

**Answer any TWO Questions**

**PART D (2 x 10 = 20 Marks)**

31. Consider that you are given a dataset of 6 data points in a 2D space and are asked to perform K-means clustering with  $K = 2$ . The data points are as follows: CO3 [K<sub>5</sub>]

Data Points:

Point A(2, 3)

Point B(3, 3)

Point C(3, 4)

Point D(5, 6)

Point E(6, 7)

Point F(7, 8)

For the above data, perform one iteration of the K-means algorithm, calculate the new cluster centroids, and assign the data points to the nearest clusters.

32. Consider that you are working for a financial institution, and you are tasked with developing a credit scoring model to evaluate loan applicants. The goal is to minimize the risk of default while maximizing the number of approved loans. You decide to explore the application of ensemble learning techniques to improve the accuracy of credit scoring. CO4 [K<sub>5</sub>]

Problem Statement:

Your dataset consists of historical information about loan applicants, including features such as income, credit score, employment status, and loan amount. You want to build an ensemble model to predict whether an applicant is likely to default on a loan or not. Based on this, answer the following questions.

- i) Describe the dataset preprocessing steps you would undertake to prepare the data for ensemble learning. What measures would you take to handle missing data and categorical features?
  - ii) Propose an ensemble model for credit scoring. Choose two or more ensemble techniques and explain why you selected them. Discuss the trade-offs between bias and variance in ensemble models.
  - iii) How would you evaluate the performance of your ensemble credit scoring model? Provide examples of evaluation metrics suitable for this classification task.
33. Consider that you are working on a Convolutional Neural Network (CNN) for image classification problem. The input images have dimensions of 64x64 pixels, CO5 [K<sub>5</sub>]

and it is required to use a 3x3 filter with a stride of 1 for the convolutional layer. The convolutional layer is followed by a max-pooling layer with a 2x2 pooling size and a stride of 2. For this task, calculate the dimensions of the feature map after the convolutional layer and after the max-pooling layer.

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