K. J. Somaiya Institute of Technology, Sion, Mumbai-22
(Autonomous College Affiliated to University of Mumbai)

May – June 2025

PhD Program: Academic Year 2024-25

Course Work Examination

Course Code: **PhD102** and Course Name: **Introduction to Machine Learning**

Date: 21-05-2025 Duration: 2.00 PM to 4.30 PM Max. Marks: 70

Instructions:
(1) All questions are compulsory.
(2) Draw neat diagrams wherever applicable.
(3) Assume suitable data, if necessary.

QN	Question	Max. Marks	CO	BT Level
Qu-1	Solve any **Six** questions out of **Eight.**	**30**		
i)	Consider the following dataset. X1 | X2 | y 1.0 | 0.0 | 2.65 -1.0 | 0.5 | -2.05 2.0 | 1.0 | 1.95 -2,0 | -1.5 | 0.90 1.0 | 1.0 | 0.60 -1.0 | -1.0 | 1.45 Using the k-nearest neighbour (k-NN) regression model with k=3, predict the value of y at (x1, x2) = (1.0, 0.5). use the Euclidean distance to find the nearest neighbours.	5	CO3	3
ii)	List activation functions used in neural networks. How do they impact network performance?	5	CO3	2
iii)	Differentiate Bias and Variance in Machine Learning	5	CO6	4
iv)	Consider the following dataset. X1 | X2 | y 1.0 | 0.0 | 2.65 -1.0 | 0.5 | -2.05 2.0 | 1.0 | 1.95 -2,0 | -1.5 | 0.90 1.0 | 1.0 | 0.60 -1.0 | -1.0 | 1.45 Fit a linear regression model of the $y = \beta_0 + \beta_1 x_1 + \beta_2 x_2$ using the mean-squared error loss. Using this model predict the value of y at the point (x1, x2) = (0.5, -1.0).	5	CO1	3
v)	Define the curse of dimensionality and compare feature selection with feature extraction.	5	CO2	4

vi)	Explain Boosting and Bagging Ensemble techniques.	5	CO5	2
vii)	What are the distinguishing characteristics between reinforcement learning and supervised learning methodologies?	5	CO4	4
viii)	For a dataset with n points in d dimensions, what is the maximum number of support vectors possible in a hard-margin SVM? Explain	5	CO2	2
Qu-2	Solve any **TWO** questions out of **THREE.**	**20**		
i)	a) Explain in details expectation maximization algorithm. b) Illustrate characteristics of Decision tree with example.	10	CO6 CO4	2
ii)	How can we determine the optimal number of clusters (K) for the k-means algorithm? Additionally, perform k-means clustering on: {2, 3, 4, 10, 11, 12, 20, 25, 30}, for K=2.	10	CO5	3
iii)	Explain the architecture of a perceptron and working process with its types.	10	CO2	3
Qu-3	Solve any **TWO** questions out of **THREE.**	**20**		
i)	Describe linear regression in machine learning, including its various types and the evaluation metrics commonly used for assessing performance.	10	CO1	2
ii)	Why dimensionality reduction is an important issue. Describe dimension reduction techniques in ML.	10	CO3	2
iii)	Apply Agglomerative clustering algorithm on given data (table-1) and draw dendrogram. Show three clusters with its allocated point. Use the Single link method.	10	CO4	3

Table-1: Dataset for Agglomerative Algorithm.

Sample No	X	Y
S1	4	3
S2	1	4
S3	2	1
S4	3	8
S5	6	9
S6	5	1

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