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**Gandhi Institute of Engineering and Technology University, Odisha, Gunupur
(GIET University)**

M. Tech. (Third Semester - Regular) Examinations, December – 2025

24MECPE2001- Pattern Recognition and Machine Learning



Time: 2 hrs

Maximum: 60 Marks

Answer ALL questions

(The figures in the right hand margin indicate marks)

PART – A

(2 x 5 = 10 Marks)

Q.1. Answer **ALL** questions

	CO #	Blooms Level
a. Define pattern recognition and give one real-world application.	CO1	K1
b. Write the general form of a linear regression model.	CO2	K1
c. Define a linear discriminant function.	CO3	K1
d. What is meant by bias in a learning algorithm?	CO4	K1
e. What is unsupervised learning? Give one example.	CO5	K1

PART – B

(10 x 5 = 50 Marks)

Answer **ALL** the questions

	Marks	CO #	Blooms Level
2. a. Explain the general pattern recognition system design cycle with a neat block diagram and suitable examples at each stage.	5	CO1	K2
b. Derive the Bayes decision rule for minimum error rate classification in the two-class case and explain the resulting discriminant function.	5	CO1	K3
(OR)			
c. Discuss parametric learning and explain how maximum likelihood estimation is used to estimate Gaussian parameters in pattern recognition problems.	5	CO1	K3
d. Explain Bayesian error analysis and the concept of Bayes optimal classifier with an illustrative diagram.	5	CO1	K3
3.a. Derive the normal equations for linear regression using the least squares criterion. Explain how the model parameters are obtained.	5	CO2	K2
b. Explain logistic regression for binary classification. Derive the decision rule and discuss how parameters are estimated using maximum likelihood.	5	CO2	K3
(OR)			
c. With a neat diagram, explain the architecture of a multi-layer perceptron (MLP) and describe the working of the backpropagation algorithm.	5	CO2	K3
d. Discuss the characteristics of error surfaces in neural network training and explain two practical techniques to improve backpropagation convergence.	5	CO2	K3
4.a. Explain linear discriminant functions for two-category classification and show how the decision surface is obtained.	5	CO3	K2
b. Describe the minimum-squared error procedure for designing linear discriminant functions and derive the corresponding weight update using least squares.	5	CO3	K3

(OR)

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| c. | Explain the Ho–Kashyap procedure for designing linear classifiers and outline the main algorithmic steps. | 5 | CO3 | K3 |
| d. | Discuss how linear programming techniques can be used for designing linear classifiers. Present the optimization formulation and constraints. | 5 | CO3 | K3 |
| 5.a. | Explain the concept of algorithm-independent machine learning and relate it to the idea that no single classifier is best for all problems. | 5 | CO4 | K2 |
| b. | Describe the bias–variance trade-off with suitable diagrams and explain how model complexity influences bias and variance. | 5 | CO4 | K3 |
| (OR) | | | | |
| c. | Explain resampling methods such as k-fold cross-validation and bootstrap and discuss their role in classifier design and model selection. | 5 | CO4 | K3 |
| d. | Discuss the principles of bagging and boosting as classifier combination techniques and highlight their similarities and differences. | 5 | CO4 | K3 |
| 6.a. | Explain the k-means clustering algorithm. Describe its steps in detail and discuss its advantages and limitations. | 5 | CO5 | K2 |
| b. | Describe the fuzzy k-means (fuzzy c-means) clustering algorithm and explain how membership values and cluster centers are updated. | 5 | CO5 | K3 |
| (OR) | | | | |
| c. | Compare k-means and fuzzy k-means clustering with respect to objective function, membership assignment and applications. | 5 | CO5 | K3 |
| d. | Explain agglomerative hierarchical clustering and describe single-linkage, complete-linkage and average-linkage methods. | 5 | CO5 | K3 |

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