Time: 2½ Hours **Total Marks: 75**

N. B.: (1) **All** questions are **compulsory**.
(2) Make **suitable assumptions** wherever necessary and **state the assumptions** made.
(3) Answers to the **same question** must be **written together**.
(4) Numbers to the **right** indicate **marks**.
(5) Draw **neat labeled diagrams** wherever **necessary**.
(6) Use of **Non-programmable** calculators is **allowed**.

1.	**Attempt *any three* of the following:**	**15**
a.	What is Machine Learning? Describe its key applications across various domains.	
b.	Discuss the major challenges faced in Machine Learning.	
c.	Illustrate the general architecture of a Machine Learning system with a detailed explanation.	
d.	Differentiate between Supervised and Unsupervised Learning with suitable examples.	
e.	Provide an overview of Reinforcement Learning and its key concepts.	
f.	Describe effective techniques to manage and prevent overfitting in Machine Learning models.	
2.	**Attempt *any three* of the following:**	**15**
a.	Define binary and multi-class classification with relevant examples.	
b.	Explain the working principles of the K-Nearest Neighbors (KNN) algorithm.	
c.	Describe different distance metrics used in KNN. How does the choice of distance metric affect the model's performance?	
d.	Describe the fundamental terminologies associated with Decision Trees.	
e.	Outline the different techniques used for multi-class classification.	
f.	Demonstrate the process of splitting a Decision Tree using the ID3 algorithm.	
3.	**Attempt *any three* of the following:**	**15**
a.	Describe the various types of kernels used in Support Vector Machines (SVM).	
b.	Explain the following SVM concepts: i. Hard margins ii. Soft margins iii. Support vectors	
c.	Illustrate the working of Bayes' Theorem with an example.	
d.	Discuss the advantages and limitations of Bayesian Learning.	
e.	Explain the Linear Regression algorithm with its working principles.	
f.	Define the concept of Regularization and elaborate on its different types	

4. **Attempt *any three* of the following:**

a Explain the concept of Confusion Matrix and accuracy of classifier. Why accuracy alone may not always be a reliable performance metric? 15

b Describe the ROC (Receiver Operating Characteristic) curve and AUC (Area Under the Curve).

c How is Cross-Validation applied in Machine Learning models? Explain with examples.

d Define the concept of Clustering and explain at least three real-world applications of Clustering.

e Discuss the types of Hierarchical Clustering methods in detail.

f Explain the various linkage methods used in Hierarchical Clustering.

5. **Attempt *any three* of the following:**

a. What is K-Means Clustering? Explain its working with an example. 15

b. Write a detailed note on Dimensionality Reduction techniques.

c. Explain the term Principal Component Analysis (PCA). How does it help in reducing dimensionality?

d. Provide a brief overview of Market Basket Analysis and its significance.

e. Explain the main steps involved in Apriori Algorithm with a suitable example.

f. Discuss the strengths and weaknesses of K-Means Clustering. In which situations is it most effective?