PATTERN RECOGNITION
(INFO 4243)

Time Allotted : 2½ hrs **Full Marks : 60**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 4 (four) from Group B to E, taking one from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A

1. Answer any twelve: **12 × 1 = 12**

Choose the correct alternative for the following

(i) Fisher's linear discriminant analysis is used in _____.
(a) unsupervised classification (b) supervised classification
(c) reinforcement classification (d) competitive classification

(ii) In pattern recognition, what are metric spaces used for?
(a) To measure the accuracy of classification algorithms (b) To define distances between data points
(c) To determine decision boundaries (d) To represent high-dimensional data

(iii) Which of the following is limitation of Gaussian Mixture Models (GMM)?
(a) Flexible Cluster Shapes (b) Soft Assignment
(c) Handles Overlapping Data (d) Computational Complexity

(iv) What is the fundamental principle behind Bayesian algorithms?
(a) Minimizing error (b) Maximizing accuracy
(c) Incorporating prior knowledge (d) Optimizing computational complexity

(v) What is the objective of perceptron learning?
(a) Class identification (b) Weight adjustment
(c) Weight adjustment along with classification (d) None of the above

(vi) Which of the following could be possible stopping criteria in K-means clustering?
(a) Convergence. (No further change in centroids). (b) Maximum number of iterations.
(c) Both (a) and (b) (d) None of these

(vii) Which of the following can act as the best possible termination condition in fuzzy c-Means clustering algorithm?
(a) For a fixed number of iterations
(b) Until the cluster centroids do not change
(c) Centroids of each cluster changes alternatively between successive iterations
(d) Variance of each cluster changes frequently between successive iterations.

(viii) Principal component analysis is one important application in_____.
(a) data dimension reduction (b) data encryption
(c) noise filtering (d) data communication

(ix) Which of the following option is true about k-NN algorithm?
(a) It can be used for classification (b) It can be used for regression
(c) It can be used in both classification and regression (d) None of these.

(x) Which of the following is NOT a commonly used class separability measure in feature selection?
(a) Between-class variance (b) Signal-to-noise ratio
(c) Entropy (d) Euclidean distance.

Fill in the blanks with the correct word

(xi) _____ probability distribution is often used for modeling continuous variables in Bayesian algorithms.

(xii) Gradient descent algorithm is generally used _____.

(xiii) _____ principle is used to avoid overfitting in decision trees.

(xiv) A high between-class variance means that the classes are well _____ from each other.

(xv) Decision tree uses the _____ learning approach.

Group - B

2. (a) Describe the basic steps involved in the design of a pattern recognition system. *[(CO1)(Remember/LOCQ)]*

(b) What are the differences between metric and non-metric measures? Give one example of a measure which qualifies as a metric. Give one example of a measure which qualifies as a non-metric. *[(CO3)(Remember/LOCQ)]*

3 + (3 + 3 + 3) = 12

3. (a) Why naïve Bayesian classification is called naïve? Briefly outline the major ideas of naïve Bayesian classification. *[(CO3)(Remember/LOCQ)]*

(b) Use Naïve Bayes' classifier to predict whether a baloon defined by the tuple (Colour = Purple, Size = Small, Act = Dip and Age = Child) is inflated or not. The training data is as follows:

Table – I

Sl No	Color	Size	Act	Age	Inflated
1	Yellow	Small	Stretch	Child	T
2	Yellow	Small	Stretch	Child	T
3	Yellow	Small	Stretch	Child	T
4	Yellow	Small	Stretch	Child	T
5	Yellow	Small	Stretch	Adult	T
6	Yellow	Small	Stretch	Child	F
7	Purple	Large	Dip	Adult	F
8	Purple	Large	Dip	Child	F
9	Purple	Small	Stretch	Adult	T
10	Purple	Small	Stretch	Child	F
11	Purple	Small	Dip	Adult	T
12	Purple	Small	Dip	Child	T
13	Purple	Large	Stretch	Adult	F
14	Purple	Large	Stretch	Child	F
15	Purple	Large	Dip	Adult	F
16	Purple	Large	Dip	Child	T

[(CO3)(Apply/IOCQ)]

(2 + 2) + 8 = 12

Group - C

4. (a) Write the steps of k-NN in the context of nonparametric techniques. *[(CO4)(Understand/LOCQ)]*

(b) Let the patterns (0, 3), (0, 2), (0, 1), (0, 0), (– 1, 0), (– 2, 0) belong to C1 and (1, 3), (1, 1), (1, 0), (0, – 1) belong to C2. Classify the pattern (1, 4) using k–NN algorithm where value of k is 1 and 3. *[(CO4)(Apply/IOCQ)]*

(c) Write the decoding algorithm of Hidden Markov Model. *[(CO2)(Understand/LOCQ)]*

4 + 4 + 4 = 12

5. (a) Discuss in detail the steps of creating the **root node** of a decision tree using the following credit card fraudulence data, where information about fraud and honest class of credit card users are provided:

User #	Country	Avg. delay of bill payment	User class
U1	Pakistan	>12 months	Fraud
U2	India	<6 months	Honest
U3	Bhutan	Between 6 to 12 months	Honest
U4	USA	>12 months	Fraud
U5	USA	Between 6 to 12 months	Honest
U6	USA	>12 months	Fraud
U7	Pakistan	>12 months	Fraud
U8	Pakistan	>12 months	Fraud
U9	Pakistan	Between 6 to 12 months	Honest
U10	Bhutan	<6 months	Honest
U11	Bhutan	<6 months	Honest
U12	Bhutan	<6 months	Honest
U13	India	>12 months	Fraud
U14	India	Between 6 to 12 months	Honest
U15	India	<6 months	Honest
U16	USA	>12 months	Fraud
U17	USA	<6 months	Honest
U18	India	>12 months	Fraud

[(CO3)(Analyse/HOCQ)]

(b) Briefly explain the Bayesian estimation technique. *[(CO4)(Remember/LOCQ)]*

(c) Discuss about decision boundaries in context of classification? *[(CO3)(Remember/LOCQ)]*

6 + 3 + 3 = 12

Group - D

6. (a) What are the different stages in the design of a classification system? Explain with a diagram. *[(CO1)(Remember/LOCQ)]*

(b) What is supervised pattern recognition? What is a training set? How is a-priori information used? *[(CO3)(Remember/LOCQ)]*

(c) What is the function of a threshold element, and an activation element in a Perceptron model? *[(CO5)(Remember/LOCQ)]*

(d) Describe the Fuzzy C-means algorithm in the context of clustering. *[(CO6)(Remember/LOCQ)]*

3 + (1 + 1 + 1) + 3 + 3 = 12

7. (a) Based on the samples of data in table 1, design a decision tree and classify the new pattern Weather = Sunny, Humidity = Normal, Windy = True.

Table 1

Weather	Humidity	Windy	Play Golf
Rainy	High	False	No
Rainy	High	True	No
Overcast	High	False	Yes
Sunny	High	False	Yes
Sunny	Normal	False	Yes
Overcast	Normal	True	Yes
Rainy	Normal	False	Yes
Overcast	High	True	Yes
Rainy	Normal	True	Yes
Sunny	High	True	No

[(CO5)(Apply/IOCQ)]

(b) Describe a "Perceptron" model for two training class. *[(CO5)(Remember/LOCQ)]*

8 + 4 = 12

Group - E

8. (a) From the given square matrix,

$$\begin{matrix} 504 & 360 & 180 \\ 360 & 360 & 0 \\ 180 & 0 & 720 \end{matrix}$$

Compute its Eigen Value and Eigen Vector. *[(CO1)(Apply/IOCQ)]*

(b) Discuss the difference between Principal Component Analysis and Independent Component Analysis in the context of Feature/ Dimension Reduction. *[(CO1)(Remember/LOCQ)]*

(c) Explain how PCA maximizes variance in the data in a new dimension space. *[(CO1)(Remember/LOCQ)]*

(2 + 2) + 4 + 4 = 12

9. (a) Describe the class separability measures in the context of Feature selection. *[(CO1)(Remember/LOCQ)]*

(b) Explain the Chernoff Bound in the context of feature selection. *[(CO1)(Remember/LOCQ)]*

6 + 6 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	68.75	25	6.25