M.E. ELECTRONICS AND TELE-COMMMUNICATION ENGINEERING
FIRST YEAR SECOND SEMESTER-2017

PATTERN RECOGNITION **Time: 3 hours** **Full Marks: 100**

Answer **any five** questions

1. (a) Discuss the different stages of a pattern recognition system. 5
   (b) If $p(x) = 2x/9$ for $0<x< 3$ and $p(x) =0$ otherwise, what is the probability that $0<x<1$? 5
   (c) Define mean (μ_X) and variance (σ_X^2) of a random variable X. 4
   (d) Prove that $\sigma_X^2 = E(X^2) - (\mu_X)^2$, where, $E(.)$ is the expectation operator. 6

2. (a) Why parameter estimation can be important for a pattern recognition problem? 2
   (b) Discuss any two strategies for parameter estimation. 8
   (c) Suppose three samples x = 13, 20, 27 are drawn from a uniformly distributed population with unknown range. Estimate the range using i) maximum likelihood approach and ii) the method of moments. 10

3. (a) What is meant by parametric decision making? 2
   (b) Explain how Bayes Theorem can be used for parametric decision making. 5
   (c) For class A, feature x is normally distributed with μ =1 and σ = 2. For class B, x is uniformly distributed in the range [2, 4]. The prior probabilities are $P(A)$ = 1/3 and $P(B)$ = 2/3. What is the probability that a sample with x =3 belongs to class A? 8
   (d) Obtain the decision boundary of a 2-class classification problem with known prior probabilities and class conditional densities. 5

4. (a) Explain the histogram based strategy of non-parametric density estimation. 4
   (b) Mention some disadvantages of the technique in (a). 2
   (c) Discuss Parzen window based approach of non-parametric density estimation and analyze whether this method can get rid of the disadvantages in (b). 6
   (d) Given a dataset X = {4,5,5,6,12,14,15,15,16,17}, Estimate the density of $p(x)$ at i) y = 3 and ii) y = 7 with a window of size 4. 8

5. (a) What are support vectors? How can they help in classification of patterns? 5
   (b) Mathematically argue that the optimum hyperplane classifier of a SVM is unique. 6
   (c) What do you mean by non-linearly separable class of patterns? Give an example. 3
   (d) Explain the importance of hidden layers in neural networks for the classification of non-linear patterns. 6

6. (a) State the importance of dimensionality reduction for a pattern recognition problem. 2
(b) Define Fisher's Discriminant Ratio. How it is important for pattern recognition? 4
(c) Obtain the generalized Rayleigh quotient in LDA. 7
(d) Show how the Karhunen-Loeve Transform of an input vector can be obtained from its autocorrelation matrix. 7

7. (a) Distinguish between classification and clustering. 2
(b) Discuss how k-means algorithm can be used for pattern clustering. 5
(c) Cluster {(1,1), (2,1), (4,3), (5,4)} into 2 clusters using the k-means algorithm with Euclidean distance as the distance function. Take first two samples as the initial cluster centroids. Show your steps. 8
(d) Compare and contrast k-means algorithm and Forgy's method. 5

8. (a) A sample from class A is located at $(x,y,z) = (1,2,3)$, a sample from class B is located at (7,4,5) and a sample from class C is located at (6,2,1). How would a sample (3,4,5) be classified using i) 1NN and city block distance and ii) i) 1NN and Euclidean distance? 6
(b) Perform a hierarchical clustering of the following data using the average linkage algorithm and city block distance. Show the distance matrices and the dendogram. 8

Sample	x	y
1	0.0	0.0
2	0.5	0.0
3	0.0	2.0
4	2.0	2.0
5	2.5	8.0
6	6.0	3.0
7	7.0	3.0

(c) Explain the advantages of graph based clustering. 2
(d) Discuss how minimum spanning tree can be used in a graph based approach for clustering of data. 4