Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY
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II SEM M.TECH. (BME) DEGREE END SEMESTER EXAMINATIONS, APRIL/MAY 2017
SUBJECT: PATTERN RECOGNITION (BME 5237)
(REVISED CREDIT SYSTEM)
Thursday, 20th April 2017, 9 AM-12 NOON

TIME: 3 HOURS **MAX. MARKS: 100**

Instructions to Candidates:

1. **Answer ALL questions.**
2. **Draw labeled diagram wherever necessary**

Q1. (a) Consider a two class problem having three independent binary features with known feature probabilities: $p_1 = p_2 = p_3 = 0.8,\ q_1 = q_2 = q_3 = 0.5$. Find the Bayesian decision rule and find the classes if $P(C_1) = P(C_2)$. Justify this decision (explain how each feature contributes towards right decision). Provide a graphical representation of these classes along with the decision surface. 10

(b) Knowing the classes from question 1(a), design the decision surface using Perceptron criteria, with $\eta = 0.2$, and $W(0) = \begin{bmatrix} -4 \\ 1.5 \\ 1.5 \\ 1.5 \end{bmatrix}$. Draw the scatter plot with decision surface classifying these classes. 10

Q2. (a) Consider the set of feature vectors for two classes $C_1 = \begin{bmatrix} 1 & 1 & 2 & 1 & 3 \\ 0 & 1 & 2 & 2 & 2 \end{bmatrix}$ and $C_2 = \begin{bmatrix} 2 & 2 & 3 & 4 & 4 \\ 0 & 1 & 1 & 1 & 2 \end{bmatrix}$. Calculate the optimum direction $\boldsymbol{v}$ to project classes using Fisher Linear Discriminant Analysis. Illustrate this procedure on a scatter plot. Are these projected classes well separated? Explain. 10

(b) Consider the projected classes from question 2(a). The density function defined on these samples is given by 05

$$p(x|\theta) = e^{-(x-\theta)^2}$$

Estimate the parameter θ associated with each class using the Maximum Likelihood method. Plot the posterior densities pertaining to C_1 and C_2, and the decision surface when $P(C_1) = P(C_2) = 0.5$. List the number of misclassification.

(c) Consider the projected classes from 2(a) and the density function defined on these samples from 2(b) with the estimated parameter θ for two classes. If a loss incurred for misclassifying a sample that is truly from class C_1 is 100, and that is truly from class C_2 is 50, and $P(C_1) = 0.01P(C_2)$, find the optimal decision region. 05

Q3. (a) With a neat diagram, explain a training algorithm to update the weights for a Multi-Layer Perceptron having one hidden layer, using the back-propagation algorithm. Describe the following major stages in detail: feed-forward, error estimation and updating of weights. 10

(b) Construct a single output perceptron with updated weights for the given inputs $[x_1\ x_2]$ and the desired outputs y as shown in the Table 1. Use $\eta = 0.2$, $W(0) = \begin{bmatrix} -1.4 \\ 0.1 \\ 0.1 \end{bmatrix}$. Draw the scatter plot along with the decision surface. 10

Table 1

x_1	x_2	y
1	2	0
2	1	0
2	3	1
3	2	1

Q4. (a) Consider three classes $C_1, C_2\ and\ \ C_3$, with $P(C_1) = 2P(C_2) = 3P(C_3)$. Assume the features to be statically independent, and normally distributed as $C_1 \sim N\left(\begin{bmatrix} 1 \\ 1 \end{bmatrix}, \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}\right)$, $C_1 \sim N\left(\begin{bmatrix} 4 \\ 2 \end{bmatrix}, \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}\right)$ and $C_1 \sim N\left(\begin{bmatrix} 3 \\ 6 \end{bmatrix}, \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}\right)$. Design the discriminant function for each class. 10

(b) Design the decision surface between the classes using the discriminant functions from question 4(a). Plot and identify the regions pertaining to these classes. 10

Q5. (a) Consider the set of feature samples $\begin{bmatrix} 0 & 2 & 0.5 & 5 & 4 & 9 & 3 & 7 \\ 0 & 2 & 0.5 & -1 & 3 & 1 & 2 & 1 \end{bmatrix}$. Explain the complete Hierarchical clustering using the Complete Linkage Algorithm. Identify three clusters for given set of feature samples. 10

(b) Explain iterative clustering using the k-means algorithm for the feature samples from question 5(a) and extract three clusters. 10