Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

A Constituent Institution of Manipal University

II SEM M.TECH. (BME) DEGREE END SEMESTER EXAMINATIONS, APRIL 2018

SUBJECT: PATTERN RECOGNITION (BME 5237)

(REVISED CREDIT SYSTEM)

Wednesday, 25th April 2018, 9 AM-12 NOON

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

Instructions to Candidates:

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

1. (a) Consider two classes C_1 and C_2 with priori probabilities $P(C_1) = P(C_2)$. If class conditional densities are normally distributed with arbitrary but same covariance matrices $\sum_i = \sum, for\ i = 1,2$ then derive the equation of a decision surface for minimum-error-rate classification for these classes. (10)

   (b) Explain a training algorithm to update the weights associated with Multi-Layer Perceptron having one hidden layer, using the back-propagation algorithm. Describe the following stages in detail: feed-forward, error estimation and updating of weights. (10)

2. (a) Consider two classes with the training sample data as: $C_1 = \begin{bmatrix} 1 & 2 & 2 & 3 \\ 1 & 2 & 3 & 1 \end{bmatrix}$ and $C_2 = \begin{bmatrix} 1 & 0 & 0 & -1 \\ 5 & 3 & 4 & 5 \end{bmatrix}$. Calculate the optimum direction $\boldsymbol{v}$ to project classes using Fisher Linear Discriminant Analysis. Illustrate this procedure with the help of a scatter plot. Are these projected classes well separated? Explain. (10)

   (b) Consider two classes with the training sample data as: $C_1 = \begin{bmatrix} 1 & 1 & 2 & 3 & 3 \\ 1 & 3 & 2 & 1 & 3 \end{bmatrix}$ and $C_2 = \begin{bmatrix} 0 & 0 & -1 & 0 & 1 \\ 4 & 6 & 5 & 5 & 5 \end{bmatrix}$. The density function defined on these samples is given by (10)

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

   Estimate the parameter θ associated with each class using the Maximum Likelihood method.

3. (a) Explain the Pattern Recognition System with a block diagram. (10)

   (b) Consider the set of feature samples: $\begin{bmatrix} 1 & 1 & 2 & 3 & 3 & 2 & 5 & 6 \\ 6 & 4 & 3 & 4 & 6 & 7 & 4 & 5 \end{bmatrix}$. Extract three clusters using the k-means clustering algorithm. (10)

4. Consider a two classes $A \& B$, with $P(A) = P(B)$, having three independent binary features $[x_1\ x_2\ \ x_3]^T$. The feature probabilities as $p_1 = p_2 = 0.8,\ p_3 = q_1 = q_2 = q_3 = 0.5$, where $p_i = P[x_i = 1|A]$ and $q_i = P[x_i = 1|B], for\ i = 1,2,3$. (20)

a) Derive the Bayesian decision rule and find the sample data for class A & B.
b) Explain, how each feature contributes towards the right decision.
c) Sketch this procedure graphically.
d) Knowing the sample data for classes A & B, design the decision surface using Perceptron criterion with learning rate $\eta = 0.2$ and initial weight vector as $W(0) = [-3.2\ \ 2.3\ \ 1.9\ \ 0.83]^T$

5. (a) Design the decision-surface for the three classes $\omega_1, \omega_2\ and\ \omega_3$ having the corresponding linear discriminant functions given as: $g_1(X) = -2x_1 - 0.75x_2 + 10.25,\ g_2(X) = 2x_1 - 0.75x_2 + 10.25\ and\ g_3(X) = 0.75x_2 + 2.25$ respectively. Plot and identify the regions pertaining to the classes. Classify an unknown sample $x' = [5\ \ 4.5]^T$. (10)

(b) Construct a single-output perceptron with updated weights for the two dimensional training sample data $[x_1\ x_2]^T$ and the corresponding desired outputs t as shown in Table 1. Use Gradient Decent Procedure with learning rate $\eta = 0.2$ and initial weight vector $W(0) = [1\ \ -0.1\ \ -0.3]^T$ to update weights. Draw the scatter plot along with the decision surface. (10)

Table 1

x_1	1	2	3	4
x_2	1	2	0	1
t	1	0	1	0