Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

(A constituent unit of MAHE, Manipal 576104)

II SEMESTER M.Tech.(BME) DEGREE END SEM EXAMINATIONS APR/MAY 2019
SUBJECT: PATTERN RECOGNITION (BME 5237)
Elective II
(REVISED CREDIT SYSTEM)
Saturday, 2nd MAY 2019: 9 am to 12 noon

TIME: 3 HOURS **MAX. MARKS: 50**

Instructions to Candidates:

1. **Answer all the questions.**
2. **Draw labeled diagrams wherever necessary.**

1. (a) 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 [05]

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

Estimate the parameter $\boldsymbol{\theta}$ associated with each class using the Maximum Likelihood method.

(b) Consider two classes with set of feature vectors as: $C_1 = \begin{bmatrix} -1 & -1 & 0 & 0 \\ -2 & 0 & -1 & 1 \end{bmatrix}$ and $C_2 = \begin{bmatrix} 1 & 2 & 3 & 3 \\ 2 & 0 & 1 & -1 \end{bmatrix}$. Design the decision surface using Perceptron criteria, with $\eta = 0.8$, and $W(0) = \begin{bmatrix} 1.4 \\ -0.6 \\ -1.4 \end{bmatrix}$. Draw the scatter plot with decision surface classifying these classes. [05]

2. Consider two classes C_1 *and* C_2 with priori probabilities $P(C_1)$ *and* $P(C_2)$ respectively. If class conditional densities are normally distributed with the covariance matrices $\sum_i = \boldsymbol{\sigma^2 I}$, $for\ i = 1,2$ then for minimum-error-rate classification for these classes.

a) Determine the discriminating function $g_i(\boldsymbol{x})$ for each class. [03]
b) Design the decision surface. [04]
c) Analyze the decision surface. [03]

3. (a) Develop a training algorithm to update the weights associated with Multi-Layer Perceptron having one hidden layer. Discuss the following stages in detail: feed-forward, error estimation, sensitivity at output and hidden layer, and change in weights to update the new weights. [05]

(b) Consider two classes with the training sample data as: $C_1 = \begin{bmatrix} 0 & -1 & 0 & 1 \\ 2 & 0 & -2 & 0 \end{bmatrix}$ and $C_2 = \begin{bmatrix} 1 & 2 & 2 & 3 \\ 2 & 1 & 3 & 2 \end{bmatrix}$. Determine the optimum direction to project classes that can be discriminated. Illustrate this procedure with the help of a scatter plot. [05]

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 $p_1 = p_2 = p_3 = 0.8,\ q_1 = q_2 = q_3 = 0.2$, where $p_i = P[x_i = 1|A]$ and $q_i = P[x_i = 1|B],\ for\ i = 1,2,3$. Then

a) Determine the Bayesian decision rule and find the sample data for class A & B. [05]
b) Explain, how each feature contributes towards the right decision. [03]
c) Sketch this procedure graphically. [02]

5. (a) Consider the set of feature samples [05]

A	B	C	D	E	F	G	H
2	-1	2	-4	-4	0	-1	-3
0	-2	2	-2	-4	-1	0	-3

Explain Graph based clustering using the Minimal Spanning Tree algorithm. Determine three clusters for given set of feature samples.

(b) Design the decision-surface for the three classes $\omega_1, \omega_2\ and\ \omega_3$ having the corresponding linear discriminant functions given as: [05]
$g_1(X) = -2x_1 - 0.75x_2 + 10.25$,
$g_2(X) = 2x_1 - 0.75x_2 + 10.25$ and
$g_3(X) = 0.75x_2 + 2.25$ respectively. Determine and plot the regions pertaining to the classes. Classify an unknown sample $x' = [5\ \ 4.5]^T$.