Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY
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A Constituent Institution of Manipal University

II SEM M.TECH. (BME) DEGREE MAKE UP EXAMINATIONS, JUNE 2018
SUBJECT: PATTERN RECOGNITION (BME 5237)
(REVISED CREDIT SYSTEM)
Thursday, 21st June 2018: 9 AM to 12 NOON

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

Instructions to Candidates:

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

1. (a) Explain the Design cycle of a Pattern Recognition System with a neat block diagram. **(10)**

(b) Construct a single output perceptron with updated weights for the given inputs $\begin{bmatrix}1 & 2 & 2 & 3\\ 2 & 1 & 3 & 2\end{bmatrix}$ and the desired outputs $[0 \quad 0 \quad 1 \quad 1]$. Use $\eta = 0.2, W(0) = \begin{bmatrix}-1.4\\ 0.1\\ 0.1\end{bmatrix}$. **(10)**

Draw the scatter plot along with the decision surface.

2. (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) Consider the set of feature samples $\begin{bmatrix}1 & 1 & 2 & 3 & 3 & 2 & 5 & 6\\ 6 & 4 & 3 & 4 & 6 & 7 & 4 & 5\end{bmatrix}$. Calculate the optimum direction $\boldsymbol{v}$ that preserves largest variance in the given data using Principle Component Analysis. Illustrate this procedure on a scatter plot. **(10)**

3. (a) Consider the set of feature samples **(10)**

A	B	C	D	E	F	G	H
0	0.5	2	3	4	5	7	9
0	0.5	2	2	3	-1	1	1

Explain the Batchelor and Wilkin's clustering Algorithm. Identify three clusters for given set of feature samples by taking vector A as one of the cluster center.

(b) 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 $C_2 = \begin{bmatrix} 2 & 2 & 3 & 4 & 4 \\ 0 & 1 & 1 & 1 & 2 \end{bmatrix}$. The density function defined on these samples is given by **(10)**

$$p(x|\theta) = \theta x^{(\theta-1)}$$

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

4. (a) Consider two classes with set of feature vectors as: $C_1 = \begin{bmatrix} 1 & 6 & 8 & 11 \\ 8 & 7 & 5 & 4 \end{bmatrix}$ and $C_2 = \begin{bmatrix} 2 & 3 & 6 & 11 \\ 4 & 3 & 2 & 1 \end{bmatrix}$. Design the decision surface using Relaxation criteria, with $\eta = 1.5$, and $W(0) = \begin{bmatrix} -24 \\ 3 \\ 8 \end{bmatrix}$. Draw the scatter plot with decision surface classifying these classes. **(10)**

(b) 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)**

5. (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) Design the decision surface between the three classes ω_1, ω_2 and ω_3 having the corresponding linear discriminant functions as: $g_1(X) = 2x_1 - x_2 + 4$, $g_2(X) = x_1 - x_2 + 4$ and $g_3(X) = x_2 + 2$. Plot and identify the regions pertaining to these classes. Classify the unknown sample $x' = \begin{bmatrix} 5 \\ 4.5 \end{bmatrix}$. **(10)**