Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
(A constituent unit of MAHE, Manipal)

V SEMESTER B.TECH(INFORMATION TECHNOLOGY/ COMPUTER AND COMMUNICATION ENGINEERING) END SEMESTER EXAMINATIONS, NOVEMBER 2019

SUBJECT: PROGRAM ELECTIVE I - PATTERN RECOGNITION [ICT 4020]

REVISED CREDIT SYSTEM
(27/11/2019)

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

- Answer **ALL** the questions.
- Missing data if any, may be suitably assumed.

1A. Explain the structure of a general statistical pattern classifier which includes d inputs and c discriminant functions $g_i(x)$. Derive the discriminant function $g_i(x)$ in terms of prior probabilities and likelihood functions for the following case:
i) The multicategory case
ii) The two-category case **5**

1B. Explain the following components of pattern recognition system:
i) Segmentation
ii) Feature extraction
iii) Classification **3**

1C. What are the limitations of chain code? How can it be resolved? **2**

2A. Find the discriminant function for two class category one-dimensional case having $p(x|\omega1) \sim N(0,1)$ and $p(x|\omega2) \sim N(1/2,1/4)$. Assume $P(\omega1) = P(\omega2) = 0.5$. Let the decision rule classifies a sample containing feature vector x according to the following rule:

$$g(x) > 0;\ \omega1$$
$$g(x) \leq 0;\ \omega2$$

What is the class belongingness of a sample having feature value 1? **5**

2B. Express conditional density $p(x|\omega_1)$ in terms of univariate and multivariate density. Using multivariate density, derive discriminant function for the normal density. **3**

2C. Posterior probabilities for two class category problem are $P(\omega_1)=2/3$ and $P(\omega_2)=1/3$ for the class conditional probability densities as shown in Figure Q.2A. The pattern measured to have feature value x=14. What is the probability of error if it is decided in favor of category ω_1? **2**

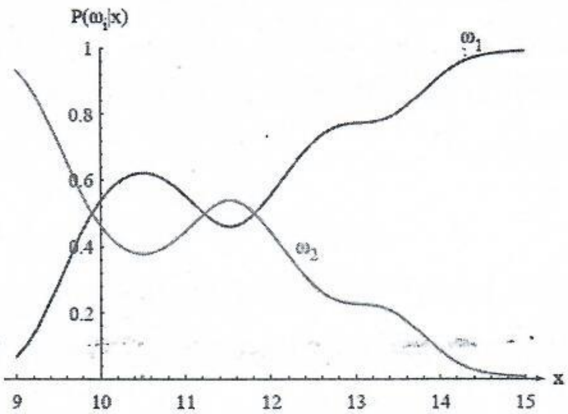
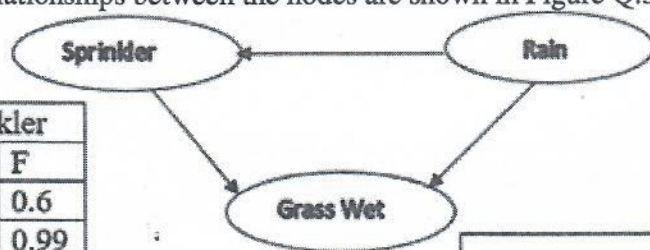


Figure Q.2A

3A. Consider the following Bayesian belief network with 3 nodes standing for grass, sprinkler and rain. The relationships between the nodes are shown in Figure Q.3A.



	Sprinkler	
Rain	T	F
F	0.4	0.6
T	0.01	0.99

Rain	
T	F
0.2	0.8

		Grass wet	
Sprinkler	Rain	T	F
F	F	0.0	1.0
F	T	0.8	0.2
T	F	0.9	0.1
T	T	0.99	0.01

Figure Q. 3A

In this model, grass, sprinkler, and rain are three variables that have two possible values T (for true) and F (for false). Grass is wet because of two reasons: either the sprinkler is on or it's raining, and the use of the sprinkler depends on rain.

i) What is the probability that it is raining in case the grass is wet?

ii) What is the probability that the sprinkler is on, given the grass is not wet? 5

3B. Consider the data collected for finding the interested customers for issuing credit cards. Using K-NN find whether the customer John with age=37, income 50K, number of cards holding=2 will be giving a positive response for getting credit card or not. Assume K=3.

Table Q.3B

Customer Name	Age	Income(K)	No. of cards holding	Response
Aditi	35	35	3	Positive
Mayank	22	50	2	Negative
Nidhi	63	200	1	Negative
Anupam	59	170	1	Negative
Rohit	25	40	4	Positive

3

3C. You are a contestant in the Monty Hall game show. In this game, there are three doors. Behind one door is a brand-new Corvette; there are goats behind the other two doors. Monty Hall asks you to select a door; after you have chosen one, he opens one of the other two doors to reveal a goat behind it. You can now choose to stick with your original choice, or to switch to the remaining door. What should you do? Will it make a difference if you switch? 2

4A. Consider 2D feature vectors $(X_1, X_2)^t$ belonging to class1 and class2. Project the feature vectors into 1D space and find the best projection direction in which the data points could be mapped. **5**

Class1	X_1	2	4	5	6	8
	X_2	3	6	4	7	6
Class2	X_1	7	10	11	13	14
	X_2	3	5	2	4	7

4B. Consider the vector population given by X

$$X = \begin{pmatrix} 1 & 2 & 2 & 3 \\ 2 & 1 & -2 & 1 \end{pmatrix}$$

Use K-L transform to check whether they are correlated or not. **3**

4C. Obtain the criteria function *J(.)* as an explicit function of *w* for fisher discriminant analysis, which best describe the separation between two projected classes. **2**

5A. Consider two states, *Rainy(R)* and *Sunny(S)*. The transition probabilities and emission probabilities for hidden states are given in the Table Q.5A.

Table Q.5A

a_{ij}	R	S
R	0.6	0.4
S	0.2	0.8

b_{jk}	H	G
R	0.4	0.6
S	0.9	0.1

Suppose I can be H*appy(H)* or G*rumpy(G)*. Happiness and grumpiness are caused by the weather.

i) Construct HMM state diagram.
ii) What is the posterior probability for being *Sunny* for day1 if I am happy on day1?
iii) What is the posterior probability for being *Rainy* for day1 if I am grumpy on day1? **5**

5B. Compare and contrast scatter matrix and covariance matrix with the necessary equation. **3**

5C. Derive generalized eigen value problem from Rayleigh quotient. **2**