No. of Printed Pages : 8 **MMTE–007**

M. SC. (MATHEMATICS WITH APPLICATIONS IN COMPUTER SCIENCE) [M. SC. (MACS)]

Term-End Examination

December, 2025

MMTE-007 : SOFT COMPUTING AND ITS APPLICATIONS

Time : 2 Hours *Maximum Marks : 50*

Weightage : 50%

Note : *(i) Question No.* ***7*** *is compulsory.*

(ii) Attempt any ***four*** *questions from question nos.* ***1*** *to* ***6****.*

(iii) Use of non-programmable and non-scientific calculator is allowed.

(iv) Symbols have their usual meanings.

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1. (a) Compute $A \cup B$, $A \cap B$, $A \cap \overline{B}$ and $A \cap \overline{A}$ for the fuzzy sets A and B given below : 4

$$A = \left\{ \frac{1}{1.0}, \frac{0.75}{1.5}, \frac{0.3}{2.0}, \frac{0.15}{2.5}, \frac{0}{3.0} \right\}$$

and $$B = \left\{ \frac{1}{1.0}, \frac{0.6}{1.5}, \frac{0.2}{2.0}, \frac{0.1}{2.5}, \frac{0}{3.0} \right\}$$

(b) Write the schema for the gene sequence {0111000} and {1110011}. Also, find the length and order of the schema. 3

(c) Verify that a multilayer network with linear transfer function is equivalent to a single layer linear network. 3

2. (a) Determine the weight matrix for a Hopfield network with standard binary pattern (S), given below : 5

S = [111; 101; 100]

(b) Solve the following network with three layers 1-2-1 and weighted structure as :

$$[W]^{\circ} = \begin{bmatrix} -0.25 \\ -0.40 \end{bmatrix}, \quad \phi^{(1)}(0) = \begin{bmatrix} -0.50 \\ -\ 0.1 \end{bmatrix}$$

and $[V]^{\circ} = \begin{bmatrix} 0.1, & -0.2 \end{bmatrix}$, $\phi^{(2)}(0) = [0.5]$

to approximate the function :

$$f(x) = 1 + \sin \frac{\pi x}{2}, \quad \text{for } -1 \le x \le 1$$

using back propagation algorithm. 5

3. (a) Describe Multiplayer Perceptron (MLP) model. Compare MLP with sigma-P_i network. Also, give the limitations of sigma-P_i network. 6

(b) Use genetic algorithm to maximize $f(x) = \sqrt{x}$, subject to $1 \le x \le 15$ by considering the string as 4. Show only *one* iteration. 4

4. (a) Implement AND function using McCulloch-Pitt's neuron for the binary data given below : 6

Input	
x_1	x_2
0	0
0	1
1	0
1	1

(b) Given the input vector (I), initial weight matrix for hidden nodes (W_H) and initial weight matrix for output nodes (W_O) of a 3-layer perception : 4

$$I = \begin{bmatrix} 4 & 5 & 1 \end{bmatrix}; \; W_H = \begin{bmatrix} 3 & 2 & 1 \\ 2 & 3 & 3 \\ 1 & 4 & 2 \end{bmatrix}; \; W_O = \begin{bmatrix} 0 \\ 2 \\ 3 \end{bmatrix}$$

Determine the output using hard limiting function as activation function.

(**Note :** 3-layer perceptron has 3 input, 3 hidden and 1 output unit).

5. (a) Write Fuzzy C-Mean (FCM) algorithm. Apply FCM algorithm to the following dataset, comprising of 5 points for features f_1 and f_2 : 6

	f_1	f_2
x_1	7	12
x_2	12	3
x_3	13	8
x_4	4	4
x_5	5	5

and find the new cluster centre after one iteration. Given the initial cluster centres as $V_1 = (4, 5)$ and $V_2 = (11, 10)$ assume the constants C = M = 2.

(b) Consider the following TSP involving 9 cities : 4

Parent-1	Parent-2
F	C
I	B
G	G
E	I
D	H
C	F
A	D
H	E
B	A

Determine the children solution using :

(i) Order crossover #1, assuming 4th and 7th sites as the crossover sites.

(ii) Order crossover #2, assuming 3rd, 5th and 7th as the key positions.

6. Write short notes on the following : $4 \times 2\frac{1}{2} = 10$

(a) Knowledge based pattern recognition

(b) Perceptron learning rule

(c) Kohonen network structure

(d) Schema theorem

7. State whether the following statements are True *or* False. Give reasons for your answers : 10

(a) Only linearly separable data can be classified by multilayer perceptron.

(b) Self-organizing map is a special class of Artificial Neural Network based on competitive learning.

(c) Laws of excluded middle are not valid for fuzzy sets.

(d) Radial Basis Function (RBF) is a function whose response function has a constant distance from a central point.

(e) The order of schema **10** is 6.

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