MMTE-007

ASSIGNMENT BOOKLET

(Valid from 1st January, 2023 to 31st December, 2023)

M.Sc. (Mathematics with Applications in Computer Science)

SOFT COMPUTING AND ITS APPLICATIONS (MMTE-007)

School of Sciences
Indira Gandhi National Open University
Maidan Garhi, New Delhi-110068

2023

Dear Student,

Please read the section on assignments and evaluation in the Programme Guide for Elective courses that we sent you after your enrolment. A weightage of 20 per cent, as you are aware, has been assigned for continuous evaluation of this course, **which would consist of one tutor-marked assignment**. The assignment is in this booklet.

Instructions for Formatting Your Assignments

Before attempting the assignment please read the following instructions carefully.

1) On top of the first page of your answer sheet, please write the details exactly in the following format:

ROLL NO :……

NAME :……

ADDRESS :……

……

……

COURSE CODE: …….

COURSE TITLE : …….

ASSIGNMENT NO. ……..…

STUDY CENTRE: ……..….. DATE:

…….……...

PLEASE FOLLOW THE ABOVE FORMAT STRICTLY TO FACILITATE EVALUATION AND TO AVOID DELAY.

2) Use only foolscap size writing paper (but not of very thin variety) for writing your answers.

3) Leave 4 cm margin on the left, top and bottom of your answer sheet.

4) Your answers should be precise.

5) While solving problems, clearly indicate which part of which question is being solved.

6) This assignment is to be submitted to the Programme Centre as per the schedule made by the programme centre. Answer sheets received after the due date shall not be accepted.
We strongly suggest that you retain a copy of your answer sheets.

7) This assignment is valid only upto December, 2023. For submission schedule please read the section on assignments in the programme guide. If you have failed in this assignment or fail to submit it by December, 2023, then you need to get the assignment for the session 2024 and submit it as per the instructions given in the programme guide.

We wish you good luck.

Assignment (MMTE-007)

Course Code: MMTE-007
Assignment Code: MMTE-007/TMA/2023
Maximum Marks: 100

1. State whether the following statements are True or False. Give short proof or a counter example in support of your answer. (10)

   a) The length of chromosomes to determine the maximum value of the set:

   $S = \{X \mid 0 \le x \le 4096\}$ is 12.

   b) In the Hopfield network, the neurons belonging to the same layer receive input from the neurons of the previous layer and send their value only to the neurons of the next layer.

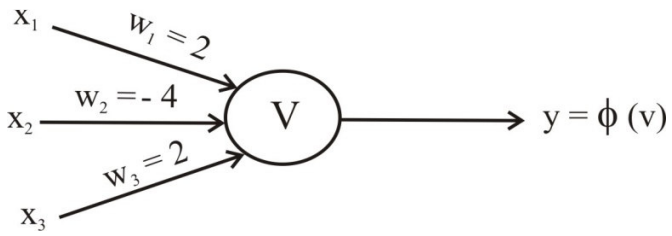
   c) In a single layer neural network, if $\sum_{i=1}^{n} x_i \omega_i > 0$, then the output is -1.

   d) The fuzzy relation (R) given below, is an equivalence relation.

$$R = \begin{bmatrix} 1 & 0.6 & 0 & 0.2 \\ 0.6 & 1 & 0.4 & 0 \\ 0 & 0.4 & 1 & 0 \\ 0.2 & 0 & 0 & 1 \end{bmatrix}$$

   e) The Self Organizing Map (SOM) is a supervised learning technique.

2. a) Consider the single layer perception given below: (6)



The activation function is:

$$\phi(v) = \begin{cases} 1; & v \ge 0 \\ 0; & v < 0 \end{cases}$$

Obtain the output for each of the following input pattern:

Patterns	p_1	p_2	p_3	p_4
x_1	1	0	1	1
x_2	0	1	0	1
x_3	0	1	1	1

b) Consider the ADALINE filter with three neurons in the input layer having weights $3,1$ and -2 and the input sequence $.....,0,0,0,-4,5,0,0,0,.....\}$. Find the filter output. (4)

3. a) Determine the fuzzy relation T as a composition between the fuzzy relations R and S given below by using max-min and max-product: (4)

$$R = \begin{array}{c} \\ x_1 \\ x_2 \end{array} \begin{array}{c} \begin{array}{cc} y_1 & y_2 \end{array} \\ \begin{bmatrix} 0.6 & 0.3 \\ 0.2 & 0.9 \end{bmatrix} \end{array}$$

and $$S = \begin{array}{c} \\ y_1 \\ y_2 \end{array} \begin{array}{c} \begin{array}{ccc} z_1 & z_2 & z_3 \end{array} \\ \begin{bmatrix} 1 & 0.5 & 0.3 \\ 0.8 & 0.4 & 0.7 \end{bmatrix} \end{array}$$

b) Solve the network to approximate the function:

$$g(x) = 1 + \sin\left(\frac{\pi x}{2}\right)$$

for $-1 \le x \le 1$, choosing the initial weights and bias as the random numbers.

4. a) Find the length and order of the following schema: (4)

i) $S_1 = 1{**}\,0\,0{*}1{**}$

ii) $S_2 = {*}0\,0\,{*}\,1\,{**}$

iii) $S_3 = {***}\,0\,{****}$

iv) $S_4 = {*}\,1\,{*}\,0\,1\,{*}$

b) Consider the fuzzy sets A and B defined on the interval [0, 5]. Their membership functions are: (6)

$$\mu_A(x) = \frac{x}{x+1}$$

and $\mu_B(x) = 2^{-x}$

Determine the membership function and graph them for each of the following:

i) A^C, B^C

ii) $A \cup B$

iii) $A \cap B$

iv) $(A \cup B)^C$

v) $(A \cap B)^C$

5. a) Verify whether the Genetic Algorithm (GA) improves the solution from one generation to the next generation, for the function given below: (6)

Maximize:

$$f(x) = \sqrt{x}$$

Subject to:

$$1 \leq x \leq 16$$

Assume that chromosomes of length 6 are created at random and modified by Roulette-Wheel selection.

b) A single layer neural network is to have six inputs and three outputs. The outputs are continuous over the range 0 to 1. Now answer the following: (4)

i) How many neurons are required?

ii) What are the dimensions of the weight matrix?

iii) What kind of transfer function could be used?

iv) Is a bias required? Give reasons.

6. a) Computer the output for the neurons in the kohonen networks, the related data is given below: (6)

i) Input to Kohnen neural network:

Input Neuron-1 $(I_1) = 0.5$
Input Neuron-2 $(I_2) = 0.75$

ii) Connected weights between the neurons are as given below:

$I_1 \rightarrow O_1 : 0.1$

$I_2 \rightarrow O_2 : 0.2$

$I_1 \rightarrow O_2 : 0.3$

$I_2 \rightarrow O_2 : 0.4$

b) Consider the two parents which are participating in partially mapped cross over as shown below: (4)

Parent 1: C D | E A B I | H G F

Parent 2: A B | C D E F | G H I

Using partially mapped crossover assuming 2nd and 6th as the cross over sites, find the children solution.

7. a) Determine the $\alpha-$cut of the fuzzy set (A) are given below, at 0.7 and 0.2. (3)

$$A=\left\{\frac{0}{10},\frac{0}{20},\frac{0.2}{30},\frac{0.8}{40},\frac{1.0}{50},\frac{1.0}{60},\frac{0.6}{70},\frac{0.2}{80},\frac{0}{.90},\frac{0}{100}\right\}$$

Also, compare the $\alpha-$cut of the two outcomes, and give comments for status of $\alpha-$value variation.

b) Consider the following table for the connections between input neurons and the hidden layer neurons: (5)

Input Neurons	Hidden Layer Neurons	Connection Weight
1	1	-1
1	2	- 0.1
1	3	1
2	1	-1
2	2	1
2	3	1
3	1	-0.2
3	2	-0.3
3	3	-0.6

The connection weights from the hidden layer neurons to the output neurons are $-0.6,-0.3$ and -0.6, for the first, second and third neurons, respectively.
Corresponding threshold value for the output layer is 0.5 and for the hidden layer is 1.8, 0.005 and 0.2 for the first, second and third neurons, respectively.

i) Draw the diagram of the network.
ii) Write the output at each node.

c) Using diagram, show the difference between feed-forward neural network and recurrent neural network. (2)

8. a) Let A and B be two Fuzzy sets as given below: (4)

$$A=\left\{\frac{0.5}{\text{Mohan}},\frac{0.9}{\text{Sohan}},\frac{0.7}{\text{John}},\frac{0}{\text{Abdul}},\frac{0.2}{\text{Abraham}}\right\}$$

$$B = \left\{ \frac{0.75}{\text{Mohan}}, \frac{0.4}{\text{Sohan}}, \frac{0}{\text{John}}, \frac{0.8}{\text{Abdul}}, \frac{0}{\text{Abraham}} \right\}$$

Determine the following:

i) Universe of discourse for Set A and Set B.
ii) Complements of Set A and Set B
iii) $A \cap B$
iv) $A \cup B$

b) Implement AND function using McCulloch-Pitts neuron. (3)

c) Out of three genetic operators viz. selection, cross-over and mutation, list and justify which operator or combination there of will be required for the following: (3)

i) To fill the population with copies of the best individual from the population.

ii) For the convergence of an algorithm to good but sub-optimal solution.

9. Approximate the function $f(x) = 1 + \cos \pi x$ for $-1 \le x \le 1$, by solving $1-2-1$ network, using Back propagation algorithm. The weighted structure and initial input are as follows: (10)

Weighted structures are:

$$[W]^o = \begin{bmatrix} -0.25 \\ -0.40 \end{bmatrix} \text{ and bias } \phi_{(0)}^{(1)} = \begin{bmatrix} -0.50 \\ -0.1 \end{bmatrix}$$

$$[V]^o = \begin{bmatrix} 0.1 & -0.2 \end{bmatrix} \text{and bias } \phi_{(0)}^{(2)} = [0.5]$$

The initial input is 1.

Draw the architecture of the model. Perform one iteration.

10. a) Consider a dataset of five observations given in the following table, each of which has two features f_1 and f_2 : (6)

	x_1	x_2	x_3	x_4	x_5
f_1	2	3	4	3	5
f_2	6	7	5	4	6

Assume the number of cluster $c = 3$ and the real number $m = 2$. Also, assume the initial cluster centers as $V_1 = (1,1)$ and $V_2 = (2,2)$. Apply fuzzy c-mean algorithm to find the modified cluster center after one iteration.

b) Generate the population in the next iteration by using Roulette-Wheel criterion: (4)

k	F_k
1	3.5
2	4.6
3	5
4	2.8
5	1.8