

**SOFT COMPUTING
(CSEN 5202)**

Time Allotted : 3 hrs

Full Marks : 70

Figures out of the right margin indicate full marks.

*Candidates are required to answer Group A and
any 5 (five) from Group B to E, taking at least one from each group.*

Candidates are required to give answer in their own words as far as practicable.

**Group - A
(Multiple Choice Type Questions)**

1. Choose the correct alternative for the following: **10 × 1 = 10**
- (i) A fuzzy set whose membership function has at least one element x in the universe whose membership value is unity is called
(a) sub normal fuzzy sets (b) normal fuzzy set
(c) convex fuzzy set (d) concave fuzzy set
- (ii) Consider a fuzzy set old as defined below $old = \{(20,0), (30,0.2), (40,0.4), (50,0.6), (60,0.8), (70,1), (80,1)\}$. Then the alpha-cut for $\alpha = 0.4$ for the set old will be
(a) $\{(40,0.3)\}$ (b) $\{50,60,70,80\}$
(c) $\{(20,0.1),(30,0.2)\}$ (d) $\{(20,0),(30,0),(40,1),(50,1),(60,1),(70,1),(80,1)\}$.
- (iii) The truth values of crisp set theory is _____ and that of fuzzy set is _____
(a) either 0 or 1, between 0 & 1 (b) between 0 & 1, either 0 or 1
(c) between 0 & 1, between 0 & 1 (d) either 0 or 1, either 0 or 1.
- (iv) Learning principle of Kohonen self-organizing network is
(a) supervised (b) unsupervised
(c) reinforcement (d) none of these.
- (v) The most important operation in the convergence of genetic algorithm with elitist model (EGA) is
(a) Selection (b) Crossover (c) Mutation (d) All the above.
- (vi) Which of the following function is differentiable?
(a) Bipolar sigmoid function (b) Unit step function
(c) Threshold function (d) Hard limit function.
- (vii) Perceptron can learn
(a) AND (b) XOR (c) Both (a) and (b) (d) None of these.

- (viii) A 4-input neuron has weights 1, 1, 2 and 2. The transfer function is linear with the constant of proportionality being equal to 1. The inputs are 4, 4, 5 and 5 respectively. The output will be:
 (a) 51 (b) 76 (c) 28 (d) 52.
- (ix) Back propagation is a learning technique that adjusts weights in the neural network by propagating weight changes
 (a) forward from source to sink (b) backward from sink to source
 (c) forward from source to hidden nodes (d) backward from sink to hidden nodes.
- (x) Genetic Algorithm are a part of
 (a) Evolutionary Computing
 (b) inspired by Darwin's theory about evolution - "survival of the fittest"
 (c) are adaptive heuristic search algorithm based on the evolutionary ideas of natural selection and genetics
 (d) All of the above.

Group- B

2. (a) Consider $\tilde{A}(x)$ and $\tilde{B}(x)$ are two fuzzy set define below:

$$\tilde{A}(x) = \{(x_1, 0.3), (x_2, 0.4), (x_3, 0.1), (x_4, 0.5)\}$$

$$\tilde{B}(x) = \{(x_1, 0.2), (x_2, 0.8), (x_3, 0.7), (x_4, 0.3)\}$$

Find out following fuzzy sets.

(i) $\tilde{A}(x) \cup \tilde{B}(x)$ (ii) $\tilde{A}(x) \cap \tilde{B}(x)$

[[CO2](Remember/LOCQ)]

(b) Consider a set P = {P1, P2, P3, P4} of four varieties of paddy plants, set D = {D1, D2, D3, D4} of the various diseases affecting the plants and S = {S1, S2, S3, S4} be the common symptoms of the diseases. Let R be a relation on P x D and S be a relation on D x S.

	D1	D2	D3	D4
P1	0.0	0.5	0.2	0.8
P2	0.3	0.1	0.3	0.2
R P3	0.5	0.0	0.4	0.4
P4	0.8	0.9	0.5	1.0

	S1	S2	S3	S4
D1	1.0	0.9	0.3	0.5
D2	0.9	0.8	1.0	0.8
S D3	0.2	0.1	0.5	1.0
D4	0.8	1.0	0.6	1.0

Obtain the association of the plants with the different symptoms of the diseases using max-min composition. [[CO2](Understand/IOCQ)]

(c) Consider \tilde{A} and \tilde{B} are two fuzzy set defined as follows:

$$\tilde{A} = \{(a, 0), (b, 0.5), (c, 1)\}$$

$$\tilde{B} = \{(1,1), (2, 0.3), (3, 0.8)\}$$

Find out the fuzzy implication $\tilde{A} \rightarrow \tilde{B}$.

[[CO2](Understand/LOCQ)]

4 + 6 + 2 = 12

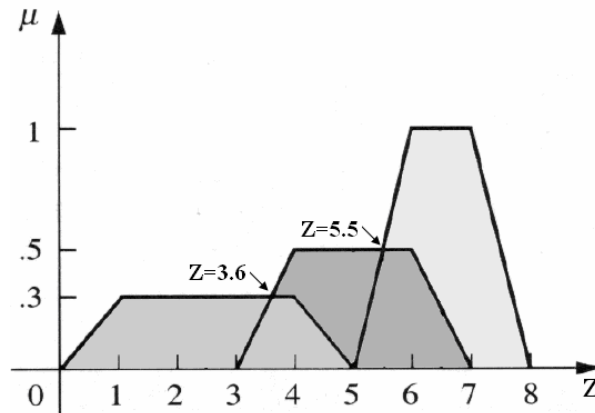
3. (a) Plot the following membership function $\mu_{\tilde{A}}(x)$ for fuzzy set \tilde{A} and find singleton, core, cross-over points and support for the same. Why this fuzzy set \tilde{A} is said to be normal?

$$\mu_{\tilde{A}}(x) = \begin{cases} = 0 & \text{if } x \leq a \\ = (x - a) / (b - a) & \text{if } a \leq x \leq b \\ = (c - x) / (c - b) & \text{if } b \leq x \leq c \\ = 0 & \text{if } c \leq x \end{cases}$$

Where a = 2, b = 4 and c = 6.

[[CO2](Understand/LOCQ)]

(b) The results of three implication processes are shown below:



Find the defuzzified output using the following methods:

- (i) Center of Sum (COS)
- (ii) Center of Gravity (COG).

[[CO1](Apply/IOCQ)]

$$5 + (3 + 4) = 12$$

Group - C

- 4. (a) Briefly explain the convolution, pooling and fully connected layers in a convolutional neural network. [[CO5](Remember/LOCQ)]
- (b) An input of volume $48 \times 48 \times 3$ is fed to a Convolutional Neural Network. What would be the output volume when you apply?
 - (i) Four $5 \times 5 \times 3$ filters with stride 1 without padding.
 - (ii) Three $5 \times 5 \times 3$ filters with stride 2 and a zero (0) padding of size 1.
 What is the difference between Recurrent Neural Network (RNN) and Convolutional Neural Network (CNN)? [[CO5](Analyze/HOCQ)]

$$6 + 6 = 12$$

- 5. (a) Explain training mechanism in a single layered artificial neural network (perceptron) for multi-class data sets using back propagation technique. [[CO6](Understand/LOCQ)]
- (b) Explain the main reasons why a Back-Propagation training algorithm might not find a set of weights which minimizes the training error for a given feed-forward neural network. [[CO5](Analyze/HOCQ)]
- (c) Explain the purpose of the momentum term that is often included in the Back-Propagation learning algorithm. [[CO5](Understand/IOCQ)]

$$6 + 3 + 3 = 12$$

Group - D

- 6. (a) Explain with example the Roulette-wheel selection algorithm. Write the limitations of Roulette-wheel selection algorithm, if any. [[CO3](Design/IOCQ)]

- (b) Suppose you are using Binary Coded Genetic Algorithm (BCGA) to solve
 $Min f(x) = x^2 - 2x + 5 ; -2 \leq x \leq 2.$
- (i) Define an appropriate fitness function in solving the problem.
- (ii) In the process, you got two strings 1000100001 and 0010010010 of length 10 in the population. Find the fitness values of the strings according to the fitness function you defined. [[CO4](Apply/LOCQ)]
6 + (2 + 4) = 12
7. (a) Write the Real Coded Genetic Algorithm (RCGA) and explain, with examples, the genetic operators in RCGA. [[CO3](Understand/LOCQ)]
- (b) Explain briefly the Multi-Objective Optimization Problem (MOOP). Define, with example, non-dominated solutions of a MOOP. [[CO4](Apply/IOCQ)]
6 + 6 = 12

Group - E

8. Briefly discuss any three of the followings: (3 × 4) = 12
- (i) Momentum in Neural Network
- (ii) Hebbian Learning Model
- (iii) Deep Learning Neural Network
- (iv) Competitive Learning Model. [[CO3,CO4,CO5](Remember/LOCQ)]
9. (a) What is ANFIS? What are the two options available for FIS training using ANFIS parameter optimization method? [[CO6](Evaluate/HOCQ)]
- (b) Write Fuzzy C-Means Algorithm and explain it with an application. [[CO2](Understand/LOCQ)]
(4 + 2) + 6 = 12

<i>Cognition Level</i>	<i>LOCQ</i>	<i>IOCQ</i>	<i>HOCQ</i>
<i>Percentage distribution</i>	55	29	16

Course Outcome (CO):

After the completion of the course students will be able to

1. Learn (remember) and understand soft computing techniques and their roles in building intelligent machines.
2. Apply fuzzy logic and reasoning to handle uncertainty and solve various engineering problems.
3. Design (create) methodology to solve optimization problems using genetic algorithms.
4. Analyze and evaluate solutions by various soft computing approaches for a given problem.
5. Understand various models of artificial neural networks and their applications in solving pattern recognition and machine learning problems.
6. Develop intelligent systems leveraging the paradigm of soft computing techniques.

**LOCQ: Lower Order Cognitive Question; IOCQ: Intermediate Order Cognitive Question; HOCQ: Higher Order Cognitive Question.*