INTRODUCTION TO SOFT COMPUTING
(AML3131)

Time Allotted : 2½ hrs **Full Marks : 60**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 4 (four) from Group B to E, taking one from each group.

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

Group – A

1. Answer any twelve: **12 × 1 = 12**

Choose the correct alternative for the following

(i) Let's assume that a fuzzy set A is defined as follows:
A = 0·1/50 + 0·3/60 + 0·5/70 + 0·8/80 + 1/90 + 1/100
What will be the value of | A |?
(a) 1.7 (b) 2.7 (c) 3.7 (d) 4.7

(ii) Consider two fuzzy sets X and Y are defined as follows:
X = {1/ p + 0.3 /q + 0.5/r + 0.2/ s}, Y= {0.5/ p + 0.4/q + 0.1/ r + 1/s}
Then X ∪ Y =
(a) {1/ p + 0.3 /q + 0.5/r + 0.2/ s} (b) {0.5/ p + 0.4/q + 0.1/ r + 1/s}
(c) {1/ p + 0.4/q + 0.5/ r + 1/s} (d) {0.5/ p + 0.2/q + 0.1/ r + 1/s}

(iii) XOR problem can be solved by
(a) single layer perceptron (b) zero layer perceptron
(c) multi-layer peceptron (d) All of the above

(iv) A self-organizing feature map (SOFM) has 10 input units, and 100 output units arranged in a two dimensional grid. How many weights does this network have?
(a) 100 (b) 800 (c) 1000 (d) 1500

(v) The Back Propagation Learning algorithm is used to train
(a) a single layer feed forward neural network only
(b) a multiple layer feed forward neural network only
(c) a recurrent neural network only
(d) any artificial neural network

(vi) Which of the following genetic operators is based on the Darwinian principle of *Survival of the fittest?*
(a) Selection (b) Crossover (c) Mutation (d) Exchange

(vii) If p_c and p_μ be the crossover probability and mutation probability of a GA then which following relations is true?
(a) $p_c < p_\mu$ (b) $p_c > p_\mu$ (c) $p_c = p_\mu$ (d) $p_c = p_\mu^2$

(viii) Roulette wheel selection scheme is preferable when
(a) Fitness values are non-uniformly distributed
(b) Fitness values are uniformly distributed
(c) Needs low selection pressure
(d) Needs high population diversity

(ix) In Neuro-Fuzzy system
(a) Neural network precedes Fuzzy system (b) Fuzzy system precedes Neural network
(c) Both (a) and (b) are true. (d) Both (a) and (b) are false.

(x) Which of the following best describes the role of pheromones in ACO?
(a) Represent the cost or fitness of a solution
(b) Guide the movement of ants towards promising regions of the search space
(c) Determine the velocity of particles in PSO
(d) Define the boundaries of the search space

Fill in the blanks with the correct word

(xi) The degree of membership of an object in a fuzzy lies in the range _____.

(xii) In an artificial neural model, the activation function of the input unit is _____ function.

(xiii) Kohonen's Self-Organizing Map (SOM) employ _____ learning.

(xiv) In order to apply GA, an optimization problem is formulated as _____ problem.

(xv) Defuzzification is done to obtain _____ output.

Group - B

2. (a) Consider $A(x)$ and $B(x)$ are two fuzzy set define below:
$A(x) = \{(x1, 0.3), \{x2, 0.4\}, \{x3, 0.1\}, (x4, 0.5)\}$
$B(x) = \{(x1,0.2) , (x2,0.8) ,(x3,0.7) , (x4,0.3)\}$.
Find out following fuzzy sets. (i) $A(x) \cup B(x)$ (ii) $A(x) \cap B(x)$ (iii) $A(x)$ X$B(x)$
[(AML3131.4)(Apply/IOCQ)]

(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 Q be a relation on D x S.

		D1	D2	D3	D4			S1	S2	S3	S4
	P1	0.0	0.5	0.2	0.8		D1	1.0	0.9	0.3	0.5
	P2	0.3	0.1	0.3	0.2		D2	0.9	0.8	1.0	0.8
R	P3	0.5	0.0	0.4	0.4	**Q**	D3	0.2	0.1	0.5	1.0
	P4	0.8	0.9	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. *[(AML3131.4)(Apply/IOCQ)]*

(2 × 3) + 6 = 12

3. (a) Using appropriate examples, distinguish between fuzzy set and classical set. Discuss the real-life situations where these sets are applicable. *[(AML3131.4)(Understand/LOCQ)]*

(b) The mobile characteristics are defined as speed and cost. The fuzzy set for 'High speed' and 'Costly' are defined as follows:

High Speed= {1/1 + 0.8/2+0.5/3 +0.3/4 + 0.1/5) and
Costly = {0/1+ 0.2/2+ 0.4/3 + 0.7/4 + 0.9/5).
Determine the linguistic variable 'Slightly Costly', 'Very high speed' and 'Not very high speed' and 'Not Costly'. *[(AML3131.4)(Apply/IOCQ)]*

4 + (2 × 4) = 12

Group - C

4. (a) Consider the following 2-dimensional points together with their class labels:

x1	x2	Class
0	0	+1
0	1	+1
1	0	+1
1	1	-1

Find the weight vector after four iterations using single perceptron model. Assume learning rate η = 1, initial weight vector w = [0.5, 0.5]T and bias = 1. *[(AML3131.6)(Apply/IOCQ)]*

(b) "Artificial Neural Network can be used as a classifier" – justify the statement. *[(AML3131.3)(Analyze/IOCQ)]*

6 + 6 = 12

5. (a) The Perceptron may be used to perform numerous logic functions. Demonstrate the implementation of the binary logic function ANDNOT (x1, x2), where x1, x2 ∈ {0, 1} using Perceptron. *[(AML3131.3)(Apply/IOCQ)]*

(b) On what basis is the number of hidden layers and the number of neurons in each hidden layer selected? *[(AML3131.3)(Analyze/IOCQ)]*

(c) 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. *[(AML3131.3)(Analyze/HOCQ)]*

5 + 4 + 3 = 12

Group - D

6. (a) Use genetic algorithm to maximize the function $f(x)=x^3 - 60x^2 +900x + 100$ for $0 \leq x \leq 31$. The initial population contains the five strings as 10011, 00101, 11010, 10101 and 01110.
Fill up the following table where f(x) is the fitness function and P (select) is the probability of selecting each string.

No.	String	x	f(x)	P(select)

[(AML3131.5)(Analyse/IOCQ)]

(b) Assume that single point crossover takes place as given below. Only first offspring after crossover is considered in the next generation. Fill up the table. *[(AML3131.5)(Analyse/IOCQ)]*

Step	Parent 1	Parent 2	Crossover point	Offspring	f(x)
1	1	2	4		
2	5	3	2		
3	5	2	3		
4	4	2	1		
5	2	5	4		

(c) Find out whether overall fitness has improved or not. *[(AML3131.5)(Apply/IOCQ)]*

5 + 4 + 3 = 12

7. (a) Discuss the different types of crossover methods used in genetic algorithm. *[(AML3131.5)(Remember/LOCQ)]*

(b) Consider three strings A1 = 11101111, A2 = 00010100, A3 = 01000011 and three schemata H1 = 1*******, H2 = 0*******, and H3 = ******11. Now, answer the following questions:
(i) Which schemata are matched by which strings?
(ii) What are the order and the defining length of each of the schemata?
(iii) Estimate the probability of survival of each schema under mutation when the probability of a single mutation is $p_m = 0.001$. *[(AML3131.5)(Apply/IOCQ)]*

5 + (2 + 2 + 3) = 12

Group - E

8. (a) Discuss how PSO can be used to cluster data. *[(AML3131.6)(Understand/LOCQ)]*

(b) A particle in a 2-D PSO algorithm has a current position of $x_{current} = (3, 5)$, $x_{pbest} = (2, 8)$ and $x_{gbest} = (4, 6)$. The current velocity of the particle is $v_{current} = (1, -1)$. Using an inertia weight w = 0.5 and c1 = c2 = 2, calculate the new velocity and new position of the particle in two successive iterations. Assume r1 = 0.7 and r2 = 0.3. *[(AML3131.6)(Apply/IOCQ)]*

8 + 4 = 12

9. (a) The inertia weight (w), cognitive parameter (c1), and the social parameter (c2) are crucial to PSO's performance. Explain how adjusting those parameters affect the search behaviour of PSO? *[(AML3131.6)(Analyse/HOCQ)]*

(b) You are using ACO algorithm to solve the Vehicle Routing Problem (VRP). After 10 iterations, you find that all the ants are following the exact same path. Now, answer the following questions:
(i) What is a likely cause of this behaviour?
(ii) What parameters would you like to adjust to encourage more exploration? *[(AML3131.6)(Analyse/IOCQ)]*

(c) In an ACO algorithm for a graph problem, the pheromone trails are updated after each ant has completed its tour. Suppose the path taken by a single ant is a tour of length L. The initial pheromone value on all edges is τ_0. If the pheromone update rule is $\tau_{ij} = \tau_{ij} + Q/L$ and the evaporation rate is $\rho = 0.5$, then what is the new pheromone value on an edge (i, j) that was part of the tour, assuming its value before the update is 10? Assume the value of Q = 50 and L = 25. *[(AML3131.6)(Apply/IOCQ)]*

5 + (2 + 2) + 3 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	17.71	73.96	8.33