7. (a) Demonstrate the architecture of a Radial Basis Function Network (RBFN).

(b) Explain the RBFN process for the given output equation

$$y(X)=\sum_{i=1}^{M} w_i \left(\frac{\left(\|X-c_i\|\right)^2}{2\sigma^2} \right)$$

Where the input is x, and the corresponding output is y(x). c and σ represent the mean value and base-width respectively.

(c) Analyze the importance of learning rate in back propagation neural network.

3 + 6 + 3 = 12

Group – E

8. (a) Suppose a genetic algorithm uses chromosomes of the form *x* = *abcdefgh* with a fixed length of eight genes. Each gene can be any digit between 0 and 9. Let the fitness of individual *x* be calculated as: f(*x*) = (a + b) − (c + d) + (e + f) − (g + h) ,and let the initial population consist of four individuals with the following chromosomes:

*x*1 = 6 5 4 1 3 5 3 2
*x*2 = 8 7 1 2 6 6 0 1
*x*3 = 2 3 9 2 1 2 8 5
*x*4 = 4 1 8 5 2 0 9 4

Evaluate the fitness of each individual, showing all your workings, and arrange them in order with the fittest first and the least fit last.

(b) Apply the following crossover operations:

i) Cross the fittest two individuals using one–point crossover at the middle point.
ii) Cross the second and third fittest individuals using a two–point crossover (points b and f).
iii) Cross the first and third fittest individuals (ranked 1st and 3rd) using a uniform crossover.

(c) Suppose the new population consists of the six offspring individuals received by the crossover operations in the above question. Evaluate the fitness of the new population, showing all your workings. Has the overall fitness improved?

(d) By looking at the fitness function and considering that genes can only be digits between 0 and 9 find the chromosome representing the optimal solution (i.e. with the maximum fitness). Find the value of the maximum fitness.

(e) By looking at the initial population of the algorithm can you say whether it will be able to reach the optimal solution without the mutation operator?

2 +3 + 3 + 3 +1=12

9. (a) What two requirements should a problem satisfy in order to be suitable for solving it by a GA?

(b) Explain genotype representation with example.

(c) Explain the influence of genetic algorithm in fuzzy-genetic hybrid system with proper block diagram and work flow.

3 + 3 +6= 12

SOFT COMPUTING

(AEIE 4142)

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) Consider a fuzzy set A defined on the interval X = [0, 10] of integers by the membership function $\mu A(x) = x / (x+2)$
Then the α cut corresponding to α = 0.5 will be
(a) {0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10}
(b) {1, 2, 3, 4, 5, 6, 7, 8, 9, 10}
(c) {2, 3, 4, 5, 6, 7, 8, 9, 10}
(d) None of the above.

(ii) $\mu_{A\cap B}(x,y); x\in A, y\in B$ in fuzzy set is represented by
(a) complement operator (b) minimum operator
(c) maximum operator (d) disjunctive sum operator.

(iii) If A and B are two fuzzy sets with membership functions
μA(x) = {(0.6,x1),(0.5,x2), (0.1,x3), (0.7,x4), (0.8,x5)}
μB(x) = {(0.9,x1), (0.2,x2), (0.6,x3), (0.8,x4), (0.5,x5)}
Then the value of μ(A∪B)c(x) will be
(a) {(0.9,x1), (0.5,x2), (0.6,x3), (0.8,x4), (0.8,x5)}
(b) {(0.6,x1), (0.2,x2), (0.1,x3), (0.7,x4), (0.5,x5)}
(c) {(0.1,x1), (0.5,x2), (0.4,x3), (0.2,x4), (0.2,x5)}
(d) {(0.1,x1), (0.5,x2), (0.4,x3), (0.2,x4), (0.3,x5)}.

(iv) If $\tilde{A}=\{(x_1,0.2),(x_2,0.3),(x_3,0.5)\}; \mu_{A^3}(x_1)$ equals to
(a) 0.0025 (b) 0.009 (c) 0.008 (d) 0.0008.

(v) In a single perceptron, the updation rule of weight vector is given by
(a) w(n + 1)=w(n)+η[d(n)-y(n)]
(b) w(n + 1)=w(n)–η[d(n)-y(n)]
(c) w(n + 1)=w(n)+η[d(n)-y(n)]* x (n)
(d) w(n + 1)=w(n)–η[d(n)-y(n)]* x (n).

(vi) The number of hidden layers can be present in BPNN is_____
(a) 2 (b) any numbers (c) 3 (d) 1.

(vii) In Delta Rule for error minimization
(a) weights are adjusted w.r.to change in the output
(b) weights are adjusted w.r.to difference between desired output and actual output
(c) weights are adjusted w.r.to difference between input and output
(d) none of the above.

(viii) SOM is a _____ network.
(a) unsupervised (b) reinforce (c) supervised (d) mapping.

(ix) Which of the following(s) is/are found in Genetic Algorithms?
(i) crossover (ii) selection (iii) reproduction (iv) mutation
(a) i & ii only (b) i, ii & iii only
(c) ii, iii & iv only (d) all of the above.

(x) The truth values of fuzzy set is
(a) both 0 and 1 (b) between 0 and 1
(c) between -1 and 1 (d) either 0 or 1

Group – B

2 . (a) Explain the possibility theorem to understand the concept of multivalued logic and distinguish it from probability theorem.

(b) Build the membership function for children having age group of 5 to 12 years. Consider average life span of the human beings is 100 years.

(c) A fuzzy set B is given as $\left[(x_1,0.7),(x_2,0.5),(x_3,0.3)\right]$.Evaluate the power set $\mu_{B^3}(x)$. Also determine the values of $\mu_{B^2}(x_2)$ and $\mu_{B^4}(x_3)$.

(4 + 3 + (3+1+1)) = 12

3. (a) Develop triangular type membership function with appropriate diagram and present the mathematical formulation.

(b) The discretized membership functions of set A and B are represented by :

$$\mu_A(x)=\left\{\frac{0.2}{1}+\frac{0.4}{2}+\frac{0.8}{3}+\frac{0.9}{4}+\frac{1}{5}\right\}$$

$$\mu_B(x)=\left\{\frac{0.9}{1}+\frac{0.6}{2}+\frac{0.5}{3}+\frac{0.4}{4}+\frac{0.1}{5}\right\}$$

Where, x = {1,2,3,4 and 5}.

Determine the union, intersection, difference and disjunctive sum of the given two fuzzy sets.

(4 + (1+1+3+3))= 12

Group – C

4. (a) Using Zadeh implication, build the relation matrix for the given fuzzy sets A and B:

$$A=\left\{\frac{0.2}{x_1}+\frac{0.5}{x_2}+\frac{0.9}{x_3}\right\}$$

$$B=\left\{\frac{0.1}{y_1}+\frac{0.3}{y_2}+\frac{0.7}{y_3}+\frac{0.8}{y_4}\right\}$$

(b) Predict fuzzy set B using composition operator from the supplied data. Fuzzy set 'A' is defined by

$$A=\left\{\frac{0.3}{x_1}+\frac{0.8}{x_2}+\frac{0.1}{x_3}\right\}$$

and the corresponding relation matrix 'R' is represented by

R =

	Y_1	Y_2	Y_3	Y_4
X_1	0.8	1	0.1	0.7
X_2	0	0.8	0	0
X_3	0.9	1	0.7	0.8

where μ_R is defined as $\mu_R : \tilde{A}\times\tilde{B}\in\left[0,1\right]$.

6 + 6 = 12

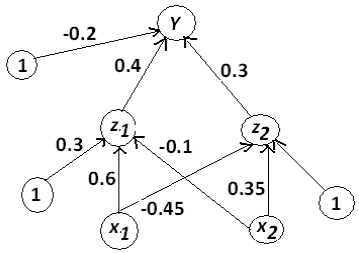
5. Develop a fuzzy PD controller through the following steps:

(i) Evaluate two inputs: error and change of error from a temperature process.
(ii) Apply normalization.
(iii) Design a fuzzification module for two input system.
(iv) Develop a rule matrix for the 2nd order underdamped temperature system.
(v) Choose any suitable defuzzification method.
(vi) Apply denormalization to get the final controller output.

2 +1 + 3 +3 + 2 +1 = 12

Group – D

6. (a) Apply McCulloch –Pitts neuron model to realize NAND function.



(b) For the back propagation network shown, create the new weights with the input pattern (1, 0) and target output is 1. Use learning rate parameter α=0.3 and binary sigmoid function.

2 + 10 = 12