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
<u>any 5 (five)</u> from Group B to E, taking <u>at least one</u> 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) The fuzzy PI controller output *u(k)* equals to
(a) $\Delta u - u(k-1)$ (b) Δu
(c) $\Delta u + u(k+1)$ (d) $\Delta u + u(k-1)$

(ii) Choose the correct sequences in designing a fuzzy controller
(a) fuzzification ->rule determination->defuzzification
(b) rule determination->fuzzification->defuzzification
(c) fuzzy Sets->defuzzification->Rule determination
(d) defuzzification->rule determination->fuzzification.

(iii) The statement $\{x|x \in M : or : x \in N\}$ is equivalent to

(a) $M \subset N$ (b) $M \cup N$
(c) $M \cap N$ (d) $M \not\subset N$.

(iv) Fuzzy logic controller is suitable for
(a) ill-defined process   (b) complex process
(c) nonlinear process   (d) all or any of the processes.

(v) In the power set $\tilde{A} = \{(x_1, 0.2),(x_2, 0.3),(x_3, 0.05)\}; \mu_{A^2}(x_3)$ equals to

(a) 0.0005   (b) 0.0025   (c) 0.05   (d) 0.005.

(vi) In a fuzzy controller, if error is positive and change of error is negative, the control output should be
(a) positive   (b) negative
(c) zero   (d) it can be any value.

(vii) In an air-conditioner design by fuzzy logic, comfort membership function is represented by
(a) triangular MF   (b) increasing MF
(c) decreasing MF   (d) pie MF.

(viii) The network that involves backward links from output to the input and hidden layers is called as _____.
(a) self organizing maps   (b) pPerceptrons
(c) recurrent neural network   (d) multi layered perceptron.

(ix) Room temperature is cold. The cold membership function can be represented by
(a) Π MF   (b) Γ MF   (c) *L* MF   (d) Λ MF.

(x) A = {1,5,6,0}; B = {1,6,7,8,9}; Then $A \cup B =$
(a) {1,6}   (b) {0,1,5,6,7,8,9}
(c) {5,6}   (d) {1,5,6,7,8,9}.

Group – B

2. (a) Write the main goals of soft-computing.

(b) Distinguish probability and possibility theorem with reference to the statement – "Aniket can eat 10 eggs".

(c) A number set is defined by N ∈ [10, 20,30,40,50,60,70,80,90,100].
(i) Using your knowledge derive the closeness membership functions of the set elements with respect to the number "50'.
(ii) Also draw membership function plots of the set N in terms of smallest and largest numbers.

            2 + 4 + (3 + 3) = 12

3. (a) "Ronaldo is able to score 6 goals in a match" Justify the statement with reference to possibility and probability theorem.

(b) Assign different membership functions to design a room air-conditioner, considering the temperature range of 0 to 50 deg C.

(c) Compute the disjunctive sum for the given fuzzy sets X and Y:
$X = \{(x_1, 0.5),(x_2, 0.1),(x_3, 0.8),(x_4, 0.3)\}$
$Y = \{(x_1, 0.3),(x_2, 0.9),(x_3, 0.5),(x_4, 0.2)\}$

            4 + 4 + 4 = 12

Group – C

4. (i) Write the difference between Zadeh and Mamdani implication.

   (ii) From the given fuzzy sets M and N, derive two dimensional relation matrixes using Mamdani as well as Zadeh implications.

   $$M = \left\{ \frac{0.2}{x_1} + \frac{0.5}{x_2} + \frac{0.8}{x_3} + \frac{0.4}{x_4} \right\}$$

   $$N = \left\{ \frac{0.1}{y_1} + \frac{0.3}{y_2} + \frac{0.7}{y_3} \right\}$$

   (iii) Take projection on the above Zadeh relation matrix along both X and Y axis and construct the fuzzy sets from the projected values.

   (2 + 6 + 4) = 12

5. (a) Establish the relation between controller output (u) and the input variables error (e) and change of error (Δe) in a typical second order under damped system response.

   (b) Show the different steps to develop a fuzzy PD controller with suitable block diagram. Point out the modification needed in the above fuzzy PD controller to design a fuzzy PI controller.

   4 + (6 + 2) = 12

Group – D

6. (a) Generate the output of logic NAND function by McCulloch-Pitts neuron model.

   (b) What is MLP? Explain with diagram.

   (c) A single layer neural network with 3 inputs and 1 output with a bias is shown in fig. below. Determine the output (Z) from the network if the activation functions are:
   (i) binary sigmoidal and (ii) bipolar sigmoidal.
   The inputs values (x_0, x_1, x_2) are 0.8, 0.6 and 0.4 respectively and their corresponding synaptic weights (w_0, w_1, w_2) are 0.1, 0.3 and -0.2.
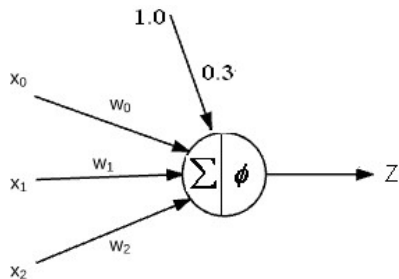
   4 + 3 + 5 = 12

7. (a) Draw the architecture and list the stages involved in training of back propagation neural network (BPNN).

   (b) Discuss the importance of hidden layer in BPNN.

   (c) What is supervised learning and how is it different from unsupervised learning?

   (2 + 6) + 2 + 2 = 12

Group – E

8. (a) With a net flowchart, explain the operation of a simple genetic algorithm.

   (b) Mention two advantages and limitations of genetic algorithm.

   8 + 4 = 12

9. (a) Explain a genetic fuzzy rule based system with proper block diagram and discuss its importance in tuning and parameter optimization.

   (b) State the limitations of neural networks and fuzzy systems when operated individually.

   8 + 4 = 12