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)   Fuzzy logic is usually represented as _____
            (a) If-Then-Else rules   (b) For-End rules
            (c) Both (a) and (b)   (d) If-Then rules.

    (ii)   If fuzzy set A defined by $\mu_{A(x)} = \{(0.1, x_1), (0.0, x_2), (0.9, x_3), (0.3, x_4)\}$; then its
            complement would be
            (a) $\{(1.1, x_1), (1.0, x_2), (1.9, x_3), (1.3, x_4)\}$
            (b) $\{(0.9, x_1), (1.0, x_2), (0.1, x_3), (0.7, x_4)\}$
            (c) $\{(0.01, x_1), (0.0, x_2), (0.81, x_3), (0.09, x_4)\}$
            (d) $\{(0.9, x_1), (1.0, x_2), (0.01, x_3), (0.7, x_4)\}$.

    (iii)   If $X = \{(x_1, 0.1), (x_2, 0.3), (x_3, 0.02)\}$; $\mu_{X^2}(x_3)$ equals to
            (a) 0.04   (b) 0.000008   (c) 0.0004   (d) 0.004.

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

    (v)   The temperature of Kashmir is very cold at winter. The word "Very Cold"
            (linguistic variable) can be represented by _____
            (a) Fuzzy Set   (b) Crisp Set
            (c) Fuzzy & Crisp Set   (d) Unable to represent by any set.

    (vi)   In a single perceptron, the updation rule of weight vector is given by
            (a) $w(n + 1) = w(n) + \eta[d(n) - y(n)]$
            (b) $w(n + 1) = w(n) - \eta[d(n) - y(n)]$
            (c) $w(n + 1) = w(n) + \eta[d(n) - y(n)] * x(n)$
            (d) $w(n + 1) = w(n) - \eta[d(n) - y(n)] * x(n)$

(vii)   An artificial neuron network receives n inputs $\{x_1, x_2, \cdots, x_n\}$ having weights $\{\omega_1, \omega_2, \cdots, \omega_n\}$. The weighted sum _____ is computed to be passed on to an activation function Φ to release the output.
(a) $\sum \omega_i$ (b) $\sum x_i$ (c) $\sum \omega_i + x_i$ (d) $\sum \omega_i * x_i$

(viii) Supervised learning is the
(a) weight adjustment based on deviation of desired output from actual output
(b) weight adjustment based on desired output
(c) weight adjustment based on actual output only
(d) none of the mentioned.

(ix)   Fuzzy-Genetic Hybrid system is a
(a) Fuzzy logic in parallel with the Genetic algorithm
(b) Fuzzy logic controlled Genetic algorithm
(c) Genetic algorithm controlled Fuzzy logic
(d) None of the above.

(x)   Write the result after performing crossover between the 3rd and 4th digit of the strings of integers: 1324421 and 2751421.
(a) 1321421 and 2754421   (b) 1324421 and 2751421
(c) 1351421 and 2724421   (d) 1325141 and 2754421.

Group – B

2. (a)   Derive the followings from the given fuzzy sets A, B, C and D:
(i) $\mu_{C \cup B}(x)$ and $\mu_{A \cap C}(x)$ (ii) $\mu_{0.3*D^c}(x)$
(iii) $\mu_{A^2}(x_5)$, $\mu_{C^3}(x_3)$ (iv) $\mu_{D-B}(x)$
(v) $\mu_{B \oplus C}(x)$
A=$\{(x_1, 0.5), (x_2, 0.8), (x_3, 0.6), (x_4, 0.3)\}$;
B=$\{(x_1, 1.0), (x_2, 0.8), (x_3, 0.0), (x_4, 0.1)\}$;
C=$\{(x_1, 0.3), (x_2, 0.4), (x_3, 0.0), (x_4, 0.8)\}$;
D=$\{(x_1, 0.3), (x_2, 0.7), (x_3, 0.3), (x_4, 0.8)\}$;

(1 + 1) + 2 + (1 + 1) + 3 + 3 = 12

3. (a)   The elements of a set are, $A = \{3,4,5,6,7,8,9\}$, find closeness membership function of 5, *i.e.,* $\mu_{close}(5)$ with proper logic.

    (b)   Graphically represent the following membership functions and derive mathematical relations from them:
(i)   the notion of being baby; $\mu_{age}(baby)$
(ii) the notion of feeling comfortable temperature; $\mu_{comfort}(T)$
(iii) the notion of steady state in a process $\mu_{ss}(process\_variable)$.

3 + (3 + 3 + 3) = 12

Group – C

4. (a)   Two sets $U = \{1,2,3\}$ and $V = \{1,2,3\}$ are given. Find the remoteness MF relation matrix $\mu_R(x, y)$ among the elements of the sets.

(b) Predict fuzzy set B (defined in y) using composition operator from the above remoteness rule matrix and fuzzy set A (defined in x), as given by.

$$A = \left\{ \frac{0.2}{x_1} + \frac{0.6}{x_2} + \frac{0.1}{x_3} \right\}$$

(c) Apply Mamdani relation to determine $\mu_{R_C}(x, y)$ from the given two fuzzy sets:

$$A = \left\{ \frac{0.5}{x_1} + \frac{0.9}{x_2} + \frac{0.1}{x_3} \right\} \text{ and } B = \left\{ \frac{0.7}{y_1} + \frac{0.3}{y_2} + \frac{0.5}{y_3} \right\}$$

4 + 5 + 3 = 12

5. (a) Write the importance of scaling factor in fuzzy controller design.

(b) Derive a 5×5 rule matrix for two input variables (e and Δe) defined on the span of $[-1, +1]$. Take the linguistic terms as $\{NB, NS, Z, PS, PB\}$.

(c) In fuzzy controller design after fuzzification following values are obtained for error (e) and change of error (Δe).

$$for\ (e) = 0.7 \Rightarrow \begin{cases} \mu_{PB}(e) = 0.3 \\ \mu_{PS}(e) = 0.6 \end{cases}; for\ (\Delta e) = -0.9 \Rightarrow \begin{cases} \mu_{NB}(\Delta e) = 0.8 \\ \mu_{NS}(\Delta e) = 0.2 \end{cases};$$

Answer the followings from the above statement:
(i) How many fuzzy if-then rules can be generated?
(ii) Write the if-then rules.
(iii) Apply Mamdani implication to find the numerical values from the rules.

2 + 3 + (1 + 4 + 2) = 12

Group – D

6. (a) What is reinforce learning? Give one example.

(b) (i) What is MLP?
(ii) How it is different from single layer neural network?
(iii) How long a network should be trained?
(iv) How many hidden layers are necessary to approximate a continuous function?

(c) Determine the output Z of the network for sigmoidal activation function with steepness factor of 0.5.
Inputs: $x_0 = 1$, $x_1 = 0.5$ and $x_2 = 0.2$;
Weights: $w_0 = 0.1$, $w_1 = 0.02$ and $w_2 = 0.05$;
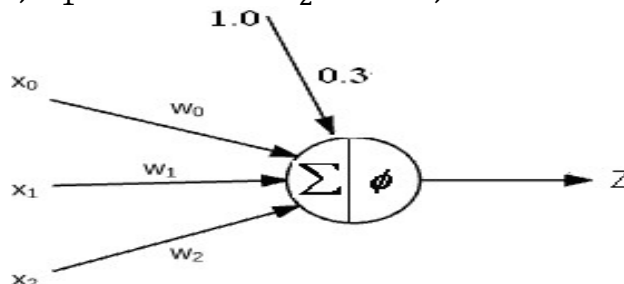
2 + (1.5 × 4) + 4 = 12

7. (a) Realize NAND and OR logic using McCulloch Pitts model

(b) Identify differences between BPNN and RBFN by drawing their architecture

(c) Demonstrate the steps of back propagation neural network (BPNN) to notice the weight change in the network in presence of error.

(2 + 2) + 4 + (2 + 2) = 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) Explain the difference between a genotypic representation and a phenotypic representation. Give an example of each.

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

(3 + 3) + 6 = 12

Department & Section	Submission link:
AEIE	https://classroom.google.com/c/MTQxODcxMzcxNzgx/a/MjcxMTIzNjAzODk3/details