

SOFT COMPUTING
(AEIE 4132)

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) Oldness MF is defined by μ_{old} as:
 $\mu_{old} = \{(20, 0.1), (30, 0.2), (40, 0.4), (50, 0.6), (60, 0.8), (70, 1), (80, 1)\}$
Then the α -cut for $\alpha = 0.4$ for the set old will be
(a) $\{(40, 0.4)\}$
(b) $\{50, 60, 70, 80\}$
(c) $\{(20, 0.1), (30, 0.2)\}$
(d) $\{(40, 0.4), (50, 0.6), (60, 0.8), (70, 1), (80, 1)\}$
- (ii) Core of soft computing are combination of
(a) Fuzzy Computing, Neural Computing, Genetic Algorithms
(b) Fuzzy Networks and Artificial Intelligence
(c) Artificial Intelligence and Neural Science
(d) Neural Science and Genetic Science
- (iii) Fuzzy Computing
(a) mimics human behavior
(b) doesn't deal with two valued logic
(c) deals with information which is vague, imprecise, uncertain, ambiguous, inexact, or possibilistic
(d) all of the above
- (iv) The temperature of Shimla 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
- (v) ANN receives n ($i=1$ to n) inputs $\{x_1, x_2, \dots, x_n\}$ having weights $\{w_1, w_2, \dots, w_n\}$. The weighted sum computed is _____.
(a) $\sum w_i$ (b) $\sum x_i$
(c) $\sum w_i + \sum x_i$ (d) $\sum w_i * x_i$

- (vi) The number of hidden layers can be present in between input and output layer in BPNN is _____
 (a) 2 (b) any numbers (c) 5 (d) 1
- (vii) 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 $\mu_{A^c}(x)$ would be
 (a) $\{(0.9, x_1), (1.0, x_2), (0.1, x_3), (0.7, x_4)\}$ (b) $\{(1.1, x_1), (1.0, x_2), (1.9, x_3), (1.3, x_4)\}$
 (c) $\{(0.01, x_1), (0.0, x_2), (0.9, x_3), (0.8, x_4)\}$ (d) $\{(0.9, x_1), (1.0, x_2), (0.01, x_3), (0.7, x_4)\}$
- (viii) 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
- (ix) 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
- (x) In a single perceptron neural network model, 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) $w(n+1) = w(n) - \eta[d(n) - y(n)] * x(n)$

Group- B

2. (a) Explain the possibility theorem to understand the concept of multi-valued logic and distinguish it from probability theorem. [(CO1) (Understand/LOCQ)]
 (b) Estimate the membership function for children having age group of 5 to 12 years. Consider average life span of the human beings is 100 years.
 [(CO1) (Evaluate/HOCQ)]
 (c) A fuzzy set $\mu_B(x)$ given as $[(x_1, 0.3), (x_2, 0.6), (x_3, 0.2)]$. Compute the power set $\mu_{B^3}(x)$. Also determine the values of $\mu_{B^2}(x_2)$ and $\mu_{B^4}(x_3)$. [(CO2)(Apply/IOCQ)]

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

3. (a) Distinguish between classical set and fuzzy set using mathematical expression.
 [(CO1) (Analyze/IOCQ)]

- (b) The discretized membership functions of fuzzy 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, $x = \{1, 2, 3, 4 \text{ and } 5\}$.

Determine the union, intersection, difference and disjunctive sum of the given two fuzzy sets. [(CO2) (Evaluate/HOCQ)]

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

Group - C

4. (a) Given two fuzzy sets U and V with same elements [1,2,3,4]. Formulate a closeness relation matrix $\mu_R(u,v)$ among the elements of the sets.

[[CO2] (Create/HOCQ)]

- (b) Determine $\mu_{R_C}(x,y)$ from the given two fuzzy sets A and B using Zadeh

$$\text{implication } \mu_A(x) = \left\{ \frac{0.5}{x_1} + \frac{0.9}{x_2} + \frac{0.1}{x_3} \right\} \text{ and } \mu_B(y) = \left\{ \frac{0.7}{y_1} + \frac{0.3}{y_2} + \frac{0.5}{y_3} \right\}$$

[[CO2] (Apply/IOCQ)]

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

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

Determine the followings from the above statement:

- (i) How many fuzzy if-then rules can be generated?
 (ii) Apply Mamdani implication to find the numerical values from the rules.

[[CO3] (Apply/IOCQ)]

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

5. (a) Two sets X and Y are given, where $x \in X$ and $y \in Y$.

Lets $X = \{-2, -1, 0, 1, 2\}$ and $Y = \{0, 1, 2, 3, 4\}$.

Determine the relation matrix using the relation (mapping): $y = /4x/ + 2$.

[[CO2] (Analyze/IOCQ)]

- (b) Explain the importance of scaling factor in fuzzy controller design.

(CO3) (Understand/LOCQ)]

- (c) Develop a 5x5 rule matrix for two input variables error and change of error (e and Δe) defined on the span of [-1, +1]. Take the linguistic terms as {NB, NS, Z, PS, PB}. [[CO3] (Create/HOCQ)]

$$6 + 2 + 4 = 12$$

Group - D

6. (a) Define unsupervised learning. Name one example of it.

[[CO4] (Remember/LOCQ)]

- (b) Tell the answer of the following questions:

(i) What is MLP?

(ii) How it is different from single layer neural network?

(iii) How long should a network be trained?

(iv) How many hidden layers are necessary to approximate a continuous function? [[CO4] (Remember/LOCQ)]

- (c) Justify OR and NAND logic using McCulloch Pitts model.

[[CO5](Evaluate/HOCQ)]

$$2 + (1.5 \times 4) + (2 + 2) = 12$$

7. (a) Demonstrate the architecture of a Radial Basis Function Network (RBFN). [(CO5) (Understand/LOCQ)]
- (b) Analyze the RBFN process for the given output equation [(CO5) (Analyze/IOCQ)]

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

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

- (c) Detect the value of the output Z of the network (Fig.1) for the given data:
 Inputs: $x_0=1$, $x_1=0.5$ and $x_2=0.2$;
 Weights: $w_0=0.1$, $w_1=0.02$, $w_2=0.05$;
 Activation function ϕ , is a bipolar sigmoidal type

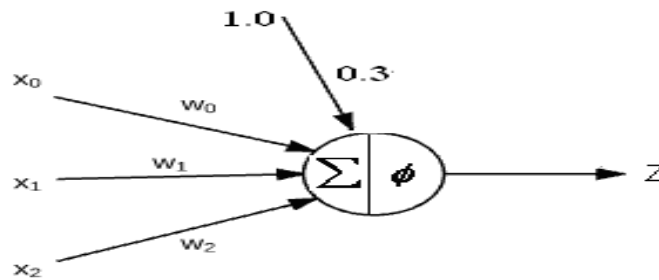


Fig.1

[(CO4) (Evaluate/HOCQ)]
3 + 6 + 3 = 12

Group - E

8. (a) Using an example, explain the importance of mutation operator in genetic algorithm. [(CO6) (Analyse/IOCQ)]
- (b) A person is going to spend a month in the wilderness. Only thing he is carrying is the backpack which can hold a maximum weight of **30 kg**. Now there are different survival items, each having its own "Survival Points" as shown in the table1 below. The objective of the problem is to maximize the survival points. Solve this problem using Genetic algorithm.

Item	Weight	Survival Points
Sleeping Bag	15	15
Rope	3	7
Pocket Knife	2	10
Torch	5	5
Bottle	9	8
Glucose	20	17

Table1

[(CO6) (Evaluate/HOCQ)]
3 + 9 = 12

9. (a) Explain the difference between a genotypic representation and a phenotypic representation. Explain with example. [(CO6) (Understand/LOCQ)]

- (b) Illustrate the different steps to design a neuro-genetic hybrid system with diagram. [(CO6) (Analyze/IOCQ)]

(3 + 3) + 6 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	23.96%	39.58%	36.46%

Course Outcome (CO):

After the completion of the course students will be able to

1. Classify the soft-computing into the different computing methods based on their application, knowledge-base, mode of operation, construction, etc.
2. Explain the functions and properties of different fuzzy sets and compare with crisp set, explain different fuzzy relations and implications.
3. Design and analyze the different components of fuzzy controller appropriately to develop the best possible fuzzy controller that can be applied to any process control systems.
4. Identify different component of biological and artificial neural network, and acquire knowledge of different ANN terminologies to apply in solving control problems.
5. Analyze and design algorithms for different supervised and unsupervised learning networks.
6. Illustrate the biological background and give idea about the basics of genetic algorithm and its application in optimizing system parameters.

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

Department & Section	Submission Link
AEIE	https://classroom.google.com/c/NDA1MjE4NTQ0MzUx/a/NDYzODQ1MDc2Mzg1/details