



AUTUMN END SEMESTER EXAMINATION-2024

5th Semester B.Tech

COMPUTATIONAL INTELLIGENCE

CS30011 / CS 3031

(For 2023 (L.E), 2022 & Previous Admitted Batches)

Time: 2 Hours 30 Minutes

Full Marks: 50

Answer any FIVE questions.

Question paper consists of two SECTIONS i.e. A and B.

Section A is compulsory.

Attempt any Four question from Sections B.

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable and all parts of a question should be answered at one place only.

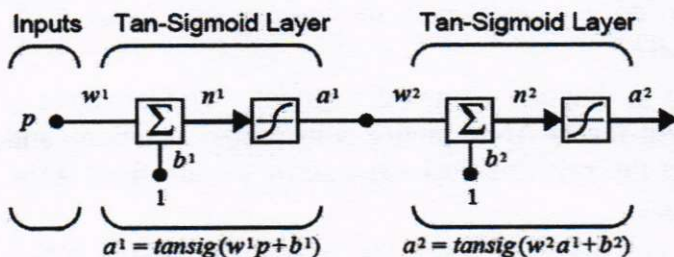
SECTION-A

1. Answer the following questions. [1 × 10]
- (a) Enlist at least 5 characteristics of soft computing.
 - (b) Give a suitable example for each of the universes of discourse in fuzzy set theory.
 - (c) Given fuzzy set $A = 0.1/2 + 0.3/4 + 0.4/5 + 0.6/7 + 0.7/9$ for the universe of discourse $\{1, 2, 3, 4, 5, 6, 7, 8, 9\}$, find the complement of A using Yager's Complement with $w=1$.
 - (d) What do you understand by learning rate in an ANN model?
 - (e) Draw a diagram of a 3-2-1 (Input - Hidden layer - Output layer) ANN model with proper notations and show the mathematical expression for the final ANN output.
 - (f) Given a fuzzy set $A = 0.1/x_1 + 0.3/x_2 + 0.5/x_3 + 0.7/x_4 + 1.0/x_5 + 0.6/x_6 + 0.2/x_7$, find support (A) and core (A). Also find both α -cut (A) and strong α -cut (A) if $\alpha = 0.3$.

- (g) Using the Extension principle, find the image fuzzy set B on domain Y for the fuzzy set A = $0.1/-3 + 0.2/-2 + 0.8/-1 + 1/0 + 0.4/1 + 0.5/2 + 0.1/3$ on domain X, considering the mapping function $y = f(x) = x^2 - 2$.
- (h) What do you understand by local minima and global minima in connection with optimization problem?
- (i) Compare and contrast between PSO and GA.
- (j) Define a linguistic variable as a quintuple with a suitable example.

SECTION-B

2. (a) Find the width of $A_{0.7}$ and bandwidth for the fuzzy set A defined by the membership function: [5]
- 1) *Trapezoid* ($x; 10, 20, 40, 70$).
 - 2) *Gaussian* ($x; 10, 3$)
- (b) For the following two layer network, the initial weights and biases are chosen to be: $w^1(0) = -1$, $b^1(0) = 1$, $w^2(0) = -2$ and $b^2(0) = 1$. An input/ target pair is given to be $\{(p = -1), (t = 1)\}$. Perform one iteration of back propagation with learning rate, $\alpha = 1$. (i.e. obtain new updated values of $w^1(1)$, $b^1(1)$, $w^2(1)$ and $b^2(1)$ where superscript 1 denotes first layer and superscript 2 denotes second layer.) [5]



(Tan-Sigmoid activation function is same as Hyperbolic Tangent Sigmoid or Bipolar Sigmoid activation function.)

3. (a) Apply Genetic Algorithm for the following optimization problem: (Go for at least two generations.) [5]
Maximize $f(x_1, x_2) = 15x_2 + 10x_1^2$, where x_1 and x_2 are integers defined in the range $0 \leq (x_1, x_2) \leq 15$.
- (b) Write down the GMPs for the following fuzzy rule sets and represent them graphically, [5]
- i) single rule with single antecedent
 - ii) Single rule with multiple antecedents
 - iii) Multiple rules with multiple antecedents
4. (a) Realize an XOR function using RBF neural network. [5]
- (b) Explain the following terminologies associated with fuzzy sets with suitable analytical expressions: [5]
- (i) Support (ii) Core (iii) Normality (iv) Convexity (v) Bandwidth
5. (a) Describe any five one-dimensional parameterized membership functions with appropriate diagrams, analytical expressions and examples. [5]
- (b) Assume a membership function for *young* age as *bell* (x ; 20, 2, 0) and for *old* age as *bell* (x ; 30, 3, 100). Find out the fuzzy set representations for the following composite linguistic terms: [5]
- i) Not very young but more or less young
 - ii) Old but not too old
 - iii) Not very young and not very old
6. (a) Implement a two-input OR function using ADALINE. Assume a learning rate, $\alpha = 0.1$, initial weights = [0.2 0.3] and initial bias = 0.1. Go for at least one epoch. [5]

- (b) i) Obtain Sugeno's complement for the following fuzzy set A: [5]

$$A = 0.1/x_1 + 0.3/x_2 + 0.6/x_3 + 0.8/x_4 + 1/x_5 + 0.7/x_6 + 0.4/x_7 + 0.2/x_8$$

(Assume Sugeno parameter, $s = 2$)

- ii) Verify that Yager's complement operator satisfies Involution property.

7. (a) Given $X = \{x_1, x_2\}$ $Y = \{y_1, y_2, y_3\}$ $Z = \{z_1, z_2, z_3\}$ [5]

Let R be the fuzzy relation defined on $X \times Y$ and S be the fuzzy relation defined on $Y \times Z$

$$R = \begin{bmatrix} 0.6 & 0.5 & 0.3 \\ 0.5 & 0.6 & 0.7 \end{bmatrix}$$

$$S = \begin{bmatrix} 0.7 & 0.2 & 0.4 \\ 0.1 & 0.6 & 0.6 \\ 0.4 & 1 & 0.5 \end{bmatrix}$$

Find out the fuzzy relation T defined on $X \times Z$ through max-min composition and max-product composition between R and S.

- (b) What is the purpose of the Particle Swarm Optimization (PSO) algorithm? What are the main equations in the algorithm? Explain the meaning of each variable in the PSO equations. List the steps in PSO. [5]
