

B.Tech-3rd(ETC)
Optimization and Soft Computing

Full Marks : 50

Time : $2\frac{1}{2}$ hours

Answer all questions

The figures in the right-hand margin indicate marks

Symbols carry usual meaning

1. Answer *all* questions : 2×5
- (a) What is the Pareto optimal front in multi-objective optimization, and how does it help in identifying the best trade-offs between conflicting objectives ?
- (b) Distinguish between fuzzy sets and crisp sets in terms of their key characteristics related to membership and application.

(Turn Over)

- (c) What is supervised learning, and how does it differ from unsupervised learning?
- (d) What is the primary function of the selection operator in genetic algorithms, and how does it influence the convergence of the optimal solution?
- (e) Identify two points that differentiate the search mechanisms employed by Particle Swarm Optimization and Ant Colony Optimization.
2. Describe the difference between the triangular and trapezoidal membership functions, providing their respective mathematical expressions and graphs. 8

Or

Consider the following two fuzzy sets A and B defined over a universe of discourse

[0,3] of real numbers with their membership functions

$$\mu_A(x) = \frac{x+3}{x+7} \text{ and } \mu_B(x) = 2^{-x}.$$

Prove the De Morgan's law. 8

3. Enlist all defuzzification methods. Describe in detail about Maxima methods with suitable graphical interpretation. 8

Or

Explain the inferring procedures in fuzzy logic system with suitable examples. 8

4. (a) Illustrate the concepts of linearly separable and non-linearly separable tasks, and explain how neural networks are used to solve these tasks. 4
- (b) Explain the concept of Hebbian learning and its significance in the context of neural networks. 4

*Or**Or*

(a) Describe the steps involved in training a single-layer feedforward neural network. 4

(b) Explain the formulation of cost function in steepest descent algorithm and recursive update of neural weights with minimization of error. 4

5. (a) Explain the selection process in Genetic Algorithms and its importance in generating the next population. How does fitness evaluation guide the creation of a population closer to the global optimum solution? 4

(b) Explain the mutation operator in binary-coded Genetic Algorithms, and describe how mutation probability is used to determine if a bit will be mutated. 4

Describe at least four different crossover schemes used in Genetic Algorithms and explain how they differ from each other. 8

6. Explain the concept of Swarm Intelligence Algorithms, highlighting their inspiration from natural systems. Compare and contrast Particle Swarm Optimization (PSO) and Ant Colony Optimization (ACO) techniques, discussing their : 8

(a) Mathematical formulations

(b) Algorithmic steps

(c) Parameter settings (e.g., particle velocity, pheromone trails)

(d) Convergence properties

Or

Discuss the fundamental principles and operational framework of Ant Colony Optimization (ACO) algorithm, including :

- Pheromone trails and their updates
- Stochastic transition rules
- Exploration-exploitation trade-off

Use suitable diagrams and examples to illustrate how ACO adapts to solve complex optimization problems.

8