

## राष्ट्रीय प्रौद्योगिकी संस्थान पटना / NATIONAL INSTITUE OF TECHNOLOGY PATNA

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| No:- | Date: |
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CSX4219: Soft Computing

L-T-P-Cr:3-0-0-3

Pre-requisites: Fundamental knowledge of linear algebra, and algorithms

## **Objectives/Overview:**

- To understand working of Neural Networks and their application for solving real world problems.
- To understand working of Fuzzy systems and their application for solving real world problems.
- To understand working of genetic algorithms and their application for solving real world problems.
- To learn evolutionary optimization techniques such as Particle Swarm Optimization, ant colony optimization and Differential Evolution.

Course Outcome: Upon successful completion of this course, students should be able to:

| Sl.<br>No. | Course Outcome (CO)  | Program Outcome<br>(PO) |
|------------|--|-------------------------|
| 1          | Explain the fundamental concepts of artificial neural networks, including neuron structure, activation functions, network architectures (single layer, multilayer, recurrent), and learning algorithms (gradient descent). | PO1                     |
| 2          | Design and implement basic neural networks for tasks like pattern recognition or function approximation using auto-associative and hetero-associative memory models.   | PO1, PO2, PO3           |
| 3          | Apply fuzzy logic principles, including fuzzy sets, membership functions, fuzzy rules, and fuzzy reasoning, to solve problems involving uncertainty or vagueness.  | PO1, PO2, PO3           |
| 4          | Design and implement fuzzy logic systems for decision making processes, utilizing techniques like rule base formation, aggregation, and defuzzification.   | PO1, PO2, PO3           |
| 5          | Explain the core concepts of genetic algorithms (GAs) such as selection, crossover, mutation, and inheritance operators, and apply them to solve single-objective optimization problems.                                   | PO1, PO2, PO3           |
| 6          | Compare and contrast different optimization algorithms like Differential Evolution (DE) with GAs, understanding their strengths and applications.  | PO1, PO2                |
| 7          | Explore additional swarm intelligence optimization techniques like Particle Swarm Optimization (PSO) and Ant Colony Optimization (ACO), understanding their basic principles and potential applications.                   | PO1, PO2                |

UNIT I: Lectures: 12

Neural Networks(Introduction & Architecture): Artificial Neuron and its model, activation functions,

Neural network architecture: single layer and multilayer feed forward networks, recurrent networks. Gradient descent and convergence, Auto-associative and hetro-associative memory. Applications of neural networks.

UNIT II: Lectures: 12

Fuzzy Logic: Introduction to Set Theory, Fuzzy Set versus Crisp Set, Crisp Relation & Fuzzy Relations. Fuzzy systems: Crisp Logic, Fuzzy Logic- Introduction & Features of Membership Functions.

Fuzzy Rule Base System: Fuzzy Propositions, Formation, Decomposition & Aggregation of Fuzzy Rules, Fuzzy Reasoning, Fuzzy Inference Systems, Fuzzy Decision-Making & Applications of Fuzzy Logic. Defuzzification.

UNIT II: Lectures: 12

Genetic Algorithm: Basic concepts, working principle, procedures of GA, flow chart of GA, Genetic representations, (encoding) Initialization and selection, Fitness Function, Genetic Modelling: Inheritance Operator, Cross Over, Selection, Mutation Operator. Application: Solving Single-Objective Optimization Problems using GAs. Differential Evolution: DE as modified GA, generation of population, operators and their implementation.

UNIT III: Lectures: 12

Particle Swarm Optimization: PSO Model, Global Best, Local Best, Velocity Update Equations, Position Update Equations, Velocity Clamping, Inertia Weight, Constriction Coefficients, Synchronous and Asynchronous Updates, Binary PSO. Ant Colony Optimization: Basic Concepts, Ant System, Application.

Artificial Bee Colony: Historical Development, Types of Bees and Their Role in the Optimization Process.

## **Text/Reference Books**

- 1) Soft Computing, Sivanandan and Deepa, Wiley
- 2) Neural Networks Fuzzy Logic, and Genetic Algorithms. S. Rajasekaran and G.A. Vijaylakshmi Pai. Prentice Hall of India.
- 3) First Course on Fuzzy Theory and Applications. K.H.Lee, Springer-Verlag.
- 4) Fuzzy Logic, Intelligence, Control and Information. Pearson Education. J. Yen and R. Langari
- 5) Evolutionary Algorithm for Solving Multi-objective, Optimization Problems (2nd Edition), Collelo, Lament, Veldhnizer (Springer).