राष्ट्रीय प्रौद्योगिकी संस्थान पटना / NATIONAL INSTITUE OF TECHNOLOGY PATNA
संगणक विज्ञान एंव अभियांत्रिकी विभाग / DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING
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No:- **Date:**

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. No.	Course Outcome (CO)	Program Outcome (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).