DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING

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CSXX1923: ***Soft Computing*** **L-T-P-Cr: 3-0-0-3**

Pre-requisites: Fundamental knowledge of algorithms and linear algebra

Objectives/Overview:

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

Course Outcomes:

At the end of the course, a student should:

Outcome	**Mapping to POs**
CO1: Explain the fundamental principles of soft computing and its differentiation from traditional hard computing approaches	PO1, PO5
CO2: Describe the core components and functionalities of neural networks, including single-layer and multi-layer architectures.	PO1, PO5
CO3: Distinguish between crisp and fuzzy sets, analyze their characteristics, and identify the features of membership functions in fuzzy logic systems.	PO1
CO4: Apply fuzzy reasoning principles to construct fuzzy rule-based systems, encompassing rule formation, aggregation, and inference mechanisms.	PO1, PO3
CO5: Utilize basic genetic algorithm (GA) concepts like fitness function, selection, crossover, mutation, and inheritance operators to solve single-objective optimization problems.	PO1, PO3, PO5
CO6: Demonstrate an understanding of particle swarm optimization (PSO) by explaining its model, updating equations, and different variations.	PO1, PO2, PO3,
CO7: Compare and contrast different bio-inspired optimization techniques like differential evolution (DE) and ant colony optimization (ACO), outlining their basic concepts and applications.	PO1, PO5

UNIT I **Lectures: 14**

A) **Introduction**: Introduction of Soft Computing, Soft Computing vs. Hard Computing, Various Types of Soft Computing Techniques, Applications of Soft Computing.

B) **Neural Networks**: Introduction to neural networks, single layer and multi-layer network.

C) **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.

UNIT II **Lectures: 14**

A) **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.

B) **Genetic Algorithm**: Basic Concepts, Fitness Function, Genetic Modelling: Inheritance Operator, Cross Over, Selection, Mutation Operator.

C) **Application:** Solving Single-Objective Optimization Problems using GAs.

UNIT III **Lectures: 14**

A) **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.

B) **Differential Evolution:** DE as modified GA, generation of population, operators and their implementation.

C) **Ant Colony Optimization:** Basic Concepts, Ant System, Application.

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

Reference Book:

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