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***CSX432 Computational Intelligence***

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

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

**Objectives/Overview:**

* 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.
* To introduce multi-objective optimization problem and evolutionary algorithms for them.

**Course Outcomes:**

At the end of the course, a student should:

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| **Sl. No.** | **Outcome** | **Mapping to POs** |
|  | Understand Fuzzy set theory. | PO1 |
|  | Be able to describe fuzzy rule based systems and apply them for decision making. | PO1, PO2 |
|  | Be able to describe the framework of Genetic Algorithms. | PO1 |
|  | Be apply to apply Genetic Algorithms for solving real world problems.  | PO1, PO2 |
|  | Be able to describe evolutionary optimization techniques (PSO, DE, Ant Colony optimization)  | PO1, PO12 |
|  | Be able to apply evolutionary optimization techniques for solving real world problems.  | PO1, PO2, PO12 |
|  | Be able to describe basic concepts of multi-objective optimization problem and evolutionary algorithms to solve them.  | PO1, PO2, PO12 |

**UNIT I: Lectures: 08**

1. **Introduction**: Introduction of Soft Computing, Soft Computing vs. Hard Computing, Various Types of Soft Computing Techniques, Applications of Soft Computing.
2. **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**

1. **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.
2. **Genetic Algorithm**: Basic Concepts, Fitness Function, Genetic Modelling: Inheritance Operator, Cross Over, Selection, Mutation Operator.
3. **Application:** Solving Single-Objective Optimization Problems using GAs.

**UNIT III: Lectures: 14**

1. **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.
2. **Differential Evolution:** DE as modified GA, generation of population, operators and their implementation.
3. **Ant Colony Optimization:** Basic Concepts, Ant System, Application.
4. **Artificial Bee Colony:** Historical Development, Types of Bees and Their Role in the Optimization Process.

**UNIT IV: Lectures: 12**

1. **Multi-Objective Optimization Problem**: Concept of Multi-Objective Optimization Problems (MOOPs). Linear and Nonlinear Multi-Objective Problems, Convex and Non – Convex Problems, Dominance – Concepts and Properties, Pareto – Optimality,
2. **Multi-Objective Evolutionary Algorithm (MOEA):** Non-Pareto approaches, Pareto-based approaches.

**Text/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.

1. K.H.Lee. *First Course on Fuzzy Theory and Applications*, Springer-Verlag.
2. J. Yen and R. Langari. *Fuzzy Logic, Intelligence, Control and Information*, Pearson Education.
3. Evolutionary Algorithm for Solving Multi-objective, Optimization Problems (2nd Edition),
4. Collelo, Lament, Veldhnizer ( Springer).