FACULTY OF ENGINEERING & TECHNOLOGY

Effective from Academic Batch: 2022-23

Programme: **Bachelor of Technology (Artificial Intelligence (AI) and Data Science)**

Semester: **VII**

Course Code: **202046720**

Course Title: **Fuzzy Systems and Computational Intelligence**

Course Group: **Professional Elective Course - III**

Course Objectives: The main objective of the course is to learn concepts and working of various soft computing techniques such as genetic algorithms, fuzzy logic and apply them for various real-time engineering problems such as optimizations and controls.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Internal		External		Total
Lecture	Tutorial	Practical		Theory	J/V/P*	Theory	J/V/P*	
3	0	2	4	50 / 18	50 / 17	25 / 09	25 / 09	150 / 53

* **J**: Jury; **V**: Viva; **P**: Practical

Detailed Syllabus:

Sr.	Contents	Hours
1	**Fuzzy Sets and Relations:** Classical sets: Operations and properties of classical sets, Mapping of classical sets to the functions. Fuzzy sets: Membership functions, Fuzzy set operations, Properties of fuzzy sets. Classical and Fuzzy relations: Cartesian product, crisp relations-cardinality, operations and properties of crisp relations. Fuzzy relations-cardinality, operations, properties of fuzzy relations, fuzzy Cartesian product and composition, Fuzzy tolerance and equivalence relations, value assignments and other format of the composition operation.	06
2	**Fuzzification and Defuzzification:** Features of the membership functions, various forms, fuzzification, defuzzification to crisp sets, - cuts for fuzzy relations, defuzzification to scalars. Fuzzy logic and approximate reasoning, Other forms of the implication operation. **Fuzzy Reasoning and Clustering** Introduction, Fuzzy logic Controller, Fuzzy Clustering	07

3	**Fuzzy Systems:** Natural language, Linguistic hedges, Fuzzy (Rule based) System, Aggregation of fuzzy rules, Graphical techniques of inference, Membership value assignments: Intuition, Inference, rank ordering, Fuzzy Associative memories.	**06**
4	**Evolutionary Computation and Genetic Algorithm (GA):** Introduction to Evolutionary Computation Paradigms; Fundamentals of GA; Genotype representation; Population; Fitness function; Genetic operators – Selection, Crossover, Mutation; Termination condition; Models of lifetime adaptation; effective implementation Binary-coded GA; GA parameter setting; Constraint handling in GA; Real-coded GA	**09**
5	**Swarm Intelligence based Algorithms:** Introduction to swarm intelligence **Particle Swarm Optimization (PSO):** Principles of Bird Flocking and Fish Schooling, Evolution of PSO, Operating Principles – position and velocity updates, PSO Algorithm, Neighborhood Topologies, Convergence Criteria, Variants of PSO, Applications of PSO. **Ant Colony Optimization (ACO):** Ant Foraging Behavior, Theoretical Considerations, Convergence Proofs, ACO Algorithm, ACO and Model Based Search, Variations Of ACO: Elitist Ant System (EAS), Minmax Ant System (MMAS), and Rank Based Ant Colony System (RANKAS).	**12**
	Total	**40**

List of Practicals:

1	Study of Membership functions using MATLAB.
2	Design of Fuzzy control systems.
3	Application development using Fuzzy control systems
4	Implementation of fuzzy C-means clustering
5	Using GA for various optimization problems
6	Apply GA for Constrained optimization problems
7	Apply ACO for a given optimization problem.
8	Apply PSO for a given optimization problem.
9	Study of Multi objective optimization.
10	Project/ Case Study/Research Paper

Reference Books:

1	Timothy J. Ross - Fuzzy logic with engineering applications, 3rd edition, Wiley.
2	S. Rajasekaran, G. A. Vijayalakshmi - Neural Networks and Fuzzy logic and Genetic Algorithms, Synthesis and Applications, PHI.
3	George J. KlirBo Yuan - Fuzzy sets and Fuzzy logic theory and Applications, PHI.
4	Ant Colony Optimization - Techniques and Applications by Helio J.C. Barbosa, Intech.
5	Swarm Intelligence and Bio-Inspired Computing by Yang , Cui, XIao, Gandomi, Karamanoglu First Edition, Elsevier

6	Genetic Algorithms in Search, Optimization and Machine Learning by David E. Goldberg, ddison-Wesley
7	Evolutionary Computation A Unified Approach by Kenneth A DeJong, PHI.

Supplementary learning Material:	
1	Lecture Note
2	NPTEL - Swayam Course: Intelligent Systems and Control- http://nptel.ac.in/courses/108104049/16
3	Coursera

Pedagogy:

- Direct classroom teaching
- Audio Visual presentations/demonstrations
- Assignments/Quiz
- Continuous assessment
- Interactive methods
- Seminar/Poster Presentation
- Industrial/ Field visits
- Course Projects

Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks						**R**: Remembering; **U**: Understanding; **A**: Application, **N**: Analyze; **E**: Evaluate; **C**: Create
R	**U**	**A**	**N**	**E**	**C**	
15%	40%	30%	10%	5%	--	

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcomes (CO):

Sr.	Course Outcome Statements	% weightage
CO-1	Understanding of different soft computing techniques like Genetic Algorithms, Fuzzy Logic and their hybridizations.	**30**
CO-2	Ability to identify, analyze and apply suitable soft computing techniques to solve engineering or real life problems.	**20**
CO-3	Apply genetic algorithms for real-time search, optimization, and design problems	**30**
CO-4	Apply fuzzy reasoning for real-time control systems	**20**

Curriculum Revision:	
Version:	2.0
Drafted on (Month-Year):	June -2022
Last Reviewed on (Month-Year):	-
Next Review on (Month-Year):	June-2026