

FACULTY OF ENGINEERING & TECHNOLOGY

Effective from Academic Batch: 2021-22

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

Semester: VII

Course Code: 102046720

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)				
Lecture	Tutorial	Practical		Internal		External		Total
				Theory	J/V/P*	Theory	J/V/P*	
3	0	2	4	40 / 16	20 / 10	60 / 24	30 / 15	150 / 75

* 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, Xlao, Gandomi, Karamanoglu First Edition, Elsevier

6	Genetic Algorithms in Search, Optimization and Machine Learning by David E. Goldberg, Addison-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:	1.0
Drafted on (Month-Year):	June -2021
Last Reviewed on (Month-Year):	-
Next Review on (Month-Year):	June-2025