



INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal - 500 043, Hyderabad, Telangana

COURSE CONTENT

FUZZY LOGIC SYSTEMS								
VII Semester: CSE(DS)								
Course Code	Category	Hours / Week			Credits	Maximum Marks		
ACDD22	Elective	L	T	P	C	CIA	SEE	Total
		3	0	0	3	40	60	100
Contact Classes: 48	Tutorial Classes: Nil	Practical Classes: Nil			Total Classes: 48			
Prerequisites: Basic knowledge of discrete mathematics, set theory, logic, and programming fundamentals.								

I. COURSE OVERVIEW:

This course provides an introduction to fuzzy set theory and its applications in intelligent systems and decision-making. It covers the differences between classical (crisp) logic and fuzzy logic, explores fuzzy set operations, fuzzy inference systems, membership functions, fuzzification and defuzzification methods. The course also introduces fuzzy control systems and demonstrates how fuzzy logic can be applied in areas such as artificial intelligence, robotics, control engineering, and data-driven decision systems.

II. COURSE OBJECTIVES:

The students will try to learn:

- I. The basic concepts of fuzzy set theory and its distinction from classical set theory.
- II. The mathematical operations on fuzzy sets and fuzzy relations.
- III. The principles and components of fuzzy inference systems, including rule bases and decision-making logic.
- IV. The practical applications of fuzzy logic in control systems, classification, and intelligent decision-making.

III. COURSE OUTCOMES:

- CO1 Explain the concepts of fuzzy sets, membership functions, and linguistic variables in comparison to classical set theory.
- CO2 Perform operations on fuzzy sets including union, intersection, complement, and fuzzy relations.
- CO3 Analyze membership function types and fuzzification/defuzzification techniques used in fuzzy inference systems.
- CO4 Design rule-based fuzzy logic systems for control and decision-making applications.
- CO5 Implement fuzzy inference systems using Mamdani and Sugeno models.
- CO6 Evaluate the effectiveness of fuzzy logic approaches in real-world systems like robotics, consumer electronics, and medical diagnostics.

IV. COURSE CONTENT:

MODULE I: INTRODUCTION TO FUZZY SET THEORY (9)

Classical Sets vs Fuzzy Sets, Fuzzy Set Notation, Membership Functions and Grades, Properties of Fuzzy Sets, α -Cuts, Representations of Fuzzy Sets, Applications of Fuzzy Logic in Real Life

MODULE II: FUZZY SET OPERATIONS AND RELATIONS (10)

Operations on Fuzzy Sets: Union, Intersection, Complement, T-Norm and T-Conorm, Fuzzy Relations: Composition, Projection, Cylindrical Extension, Properties of Fuzzy Relations, Fuzzy Equivalence and Compatibility Relations

MODULE III: MEMBERSHIP FUNCTIONS AND FUZZIFICATION (10)

Membership Function Types: Triangular, Trapezoidal, Gaussian, Bell-Shaped, Fuzzification Methods.

Linguistic Variables and Hedges, Similarity Measures and Distance Metrics.

MODULE IV: FUZZY INFERENCE SYSTEMS (9)

Fuzzy Rule-Based Systems, Mamdani vs Sugeno Models, Rule Base Design, Inference Mechanisms, Aggregation of Rules, Fuzzy Implication, Case Studies in Fuzzy Inference

MODULE V: DEFUZZIFICATION AND APPLICATIONS (10)

Defuzzification Techniques: Centroid, Bisector, Mean of Maximum, Weighted Average, Fuzzy Control Systems, Fuzzy Decision-Making, Applications in Smart Systems, Robotics, Consumer Products, Medical Diagnosis

V. TEXTBOOKS:

1. **Timothy J. Ross**, Fuzzy Logic with Engineering Applications, 4th Edition, Wiley, 2020.
2. **George J. Klir and Bo Yuan**, Fuzzy Sets and Fuzzy Logic: Theory and Applications, Prentice Hall, 1995.
3. **H.-J. Zimmermann**, Fuzzy Set Theory—and Its Applications, 4th Edition, Springer, 2001.

VI. REFERENCE BOOKS:

1. **S. N. Sivanandam and S. N. Deepa**, *Principles of Soft Computing*, 2nd Edition, Wiley India, **2008**.
2. **Bart Kosko**, *Neural Networks and Fuzzy Systems: A Dynamical Systems Approach to Machine Intelligence*, Prentice Hall, **1992**.

VII. WEB REFERENCES

1. NPTEL - Soft Computing by IIT Kharagpur
2. NPTEL - Fuzzy Systems
3. GeeksforGeeks – Introduction to Fuzzy Logic
4. MathWorks – Fuzzy Logic Toolbox Documentation

VIII. MATERIALS ONLINE

1. Course template
2. Tutorial question bank
3. Tech talk topics
4. Open-ended experiments
5. Definitions and terminology
6. Assignments
7. Model question paper – I
8. Model question paper – II

9. Lecture notes
10. PowerPoint presentation
11. E-Learning Readiness Videos (ELRV)