

NIRMA UNIVERSITY

Institute:	Institute of Technology
Name of Programme:	BTech Electronics and Instrumentation Engineering
Semester:	V
Course Code:	
Course Title:	Fuzzy Systems and Applications
Course Type:	Department Elective-I
Year of Introduction:	2025-26

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Course Learning Outcomes (CLOs):

At the end of the course, the students will be able to –

1. Interpret basics of fuzzy set theory (BL3)
2. Analyze fuzzy inference system (BL4)
3. Execute fuzzy based control system (BL5)
4. Design fuzzy logic controller for various applications. (BL6)

Unit	Contents	Teaching Hours (Total 45)
Unit - I	Introduction and Fuzzy Sets Theory: Background of Fuzzy Logic, Boolean (Binary) vs Fuzzy Logic, why should we use fuzzy logic/system, when should we not use fuzzy logic, Real time applications of Fuzzy Systems.	05
Unit - II	Theory of Fuzzy logic: Fuzzy sets and Fuzzy Logic, Membership Functions, nomenclatures used in Fuzzy set Theory, Set theoretic operations on fuzzy sets, Properties of Fuzzy Sets, Distance Between Fuzzy Sets, Arithmetic Operations on Fuzzy Numbers, Complement of Fuzzy Sets, T-norm Operators, S-norm Operators, Parameterized T-norm, Parameterized S-norm, Fuzzy Relation, Projection of Fuzzy Relation, Cylindrical Extension of Fuzzy, Properties of Fuzzy Relation, Extension Principle, Composition of Fuzzy Relations, Properties of Composition of Fuzzy Relations, Fuzzy Tolerance and Equivalence Relations, Linguistic Hedges, Linguistic Hedges and Negation/Complement and Connectives, Concentration, Dilation, Composite Linguistic, Contrast Intensification of Fuzzy Sets, Orthogonality of Fuzzy Sets, Fuzzy Rules and Fuzzy Reasoning.	15
Unit-III	Fuzzy System Design: Fuzzy Inference System, Mamdani Fuzzy Model, Larsen Fuzzy Model, Tsukamoto Fuzzy Model, Wang and Mendel Model, TSK Fuzzy Model, Fuzzifiers and Defuzzifiers, ANFIS Architecture.	12

Unit - IV Fuzzy Logic Control (FLC) Systems Applications:

Introduction: A closed-loop control system, control system design problem, examples of fuzzy control system design: aircraft landing control problem, Liquid-Level Control Problem, Multi-input, Multi-output (MIMO) Control Systems: The Three-tank MIMO Problem, Inverted pendulum and robots.

13

Self-Study:

The self-study contents will be declared at the commencement of semester. Around 10% of the questions will be asked from self-study contents.

Suggested Readings/References:

1. Ross, T. J. (2005), "Fuzzy logic with engineering applications," John Wiley & Sons.
2. Jang, T. Sun and E. Mizutani, Neuro-Fuzzy and Soft computing, A computational Approach to learning and machine intelligence, Prentice Hall Publication.
3. Fuzzy Set Theory, H.J. Zimmermann
4. Introduction to Fuzzy Logic and Fuzzy Sets, J.J. Buckley and E. Eslami
5. Kevin Passino, Fuzzy control, Addison Wesley Publication.
6. D.Driankov, H. Hellendoorn and M. Reinfrank, An Introduction to Fuzzy Control, Springer Publication.

Suggested List of experiments:

Laboratory work will be based on the above syllabus with a minimum 09 experiments/exercises to be incorporated. The students in a suitable group size will design and perform one experiment as a part of laboratory work.

(Only for Information)

Sr No.	Name of Experiments/Exercises	Hours
1.	Familiarization with fuzzy logic toolbox	(02Hrs)
2.	Verification of crisp set properties using fuzzy sets	(02Hrs)
3.	Verification of membership function related operation	(02Hrs)
4.	Verification of various fuzzy complement operations	(02Hrs)
5.	Verification of T-norm and S-norm operations using fuzzy membership functions	(02 Hrs)
6.	Design of FAMM [Fuzzy Associative Memory Map] to develop fuzzy rules	(02 Hrs)
7.	Tuning of fuzzy rules	(02 Hrs)
8.	Analyze various defuzzification methods	(02 Hrs)
9.	Design of fuzzy logic system	(02 Hrs)
10.	Design of fuzzy logic-based control system with fuzzy logic toolbox	(02 Hrs)
11.	Case study 1: Fuzzy controller design	(02 Hrs)
12.	Case study 2: Fuzzy controller design	(02 Hrs)