INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal - 500 043, Hyderabad, Telangana

COURSE CONTENT

FUZZY LOGIC AND INFERENCE SYSTEMS								
VI Semester: CSE (AI&ML)								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
ACAD12	Core	**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: Python Programming / Applied Artificial Intelligence								

I. COURSE OVERVIEW:

This course a fuzzy logic and inference systems course covers fundamental concepts like fuzzy sets, membership functions, and fuzzy logic principles, followed by advanced topics such as fuzzy relations, inference systems (e.g., Mamdani and Takagi-Sugeno), fuzzification/defuzzification, and applications like control systems (e.g., washing machine controllers) and ANFIS (adaptive neuro-fuzzy inference system). The syllabus often includes practical implementation and problem-solving, sometimes using tools like the MATLAB Fuzzy Logic Toolbox.

II. COURSE OBJECTIVES:

The students will try to learn:

I. The fundamental concepts such as fuzzy sets, operations and fuzzy relations.
II. The fuzzification of scalar variables and the defuzzification of membership functions.
III. The three different inference methods to design fuzzy rule-based systems.

III. COURSE OUTCOMES:

CO1 Understand the basic ideas of fuzzy sets, operations and properties of fuzzy sets and about fuzzy relations.
CO2 Understand the basic features of membership functions, fuzzification process and defuzzification process.
CO3 Design fuzzy rule-based system for application to handle real-time problems .
CO4 Understand about combining fuzzy set theory with probability to handle random and non-random uncertainty, and the decision-making process.
CO5 Apply fuzzy systems to develop decision-making systems.
CO6 Apply the knowledge of fuzzy C-Means clustering to handle classification tasks.

IV. COURSE CONTENT:

MODULE – I: FUZZY SET THEORY (10)
Overview of uncertainty, imprecision, and vagueness; classical logic versus fuzzy logic, Membership functions, operations on fuzzy sets (union, intersection, complement), and properties of fuzzy sets, Fuzzy Cartesian product, fuzzy relations, and composition of fuzzy relations, Fuzzy numbers, fuzzy arithmetic, and inference in fuzzy logic.

MODULE – II: FUZZY INFERENCE SYSTEMS (10)
Basic principles of fuzzy inference, fuzzy if-then rules, and approximate reasoning, Modeling with fuzzy inference systems, including the Mamdani, Takagi-Sugeno (TSK), and Wang-Mendel models.

MODULE – III: FUZZIFICATION AND DEFUZZYFICATION (10)
Techniques for converting continuous inputs to fuzzy sets (fuzzification) and converting fuzzy outputs back to crisp values (defuzzification), Architecture and application of ANFIS, which combines neural networks and fuzzy logic.

Fuzzy system components, rule base construction, design options for fuzzy systems, fuzzy system optimization and tuning, adaptive fuzzy systems, real-time applications in control systems, computer vision, decision support.

MODULE – IV: FUZZY DECISION MAKING (09)
Fuzzy synthetic evaluation, Fuzzy ordering, Preference and consensus, Multi objective decision making, Fuzzy Bayesian, Decision method, Decision making under Fuzzy states and fuzzy actions.

MODULE – V: FUZZY CLASSIFICATION (09)
Classification by equivalence relations-crisp relations, Fuzzy relations, Cluster analysis, Cluster validity, C-Means clustering, Hard C-Means clustering, Fuzzy C-Means algorithm, Classification metric, Hardening the Fuzzy C-Partition.

V. TEXTBOOKS:

1. Timothy J.Ross - Fuzzy logic with engineering applications, 3rd edition, Wiley,2010.
2. George J.KlirBo Yuan - Fuzzy sets and Fuzzy logic theory and Applications, PHI, New Delhi,1995.

VI. REFERENCE BOOKS:

1. S.Rajasekaran, G.A.Vijayalakshmi - Neural Networks and Fuzzy logic and Genetic Algorithms, Synthesis and Applications, PHI, New Delhi,2003.

VII. WEB REFERENCES

1. http://www.nptel.ac.in/syllabus/syllabus.php?subjectId=111106048

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)