CVM UNIVERSITY
Aegis: Charutar Vidya Mandal (Estd.1945)

# FACULTY OF ENGINEERING & TECHNOLOGY

## Effective from Academic Batch: 2020-21

**Programme:** **Bachelor of Engineering (Information Technology)**

**Semester:** **V**

**Course Code:** **102005601**

**Course Title:** **Fuzzy Logic with Engineering Applications**

**Course Group:** **Open Elective - I**

**Course Objectives:** The main objective of this course is to make the students aware about the fundamentals of Fuzzy Sets and Fuzzy Logic and to give them a brief insight into the applications of this knowledge to solve numerous engineering problems.

**Teaching & Examination Scheme:**

| Contact hours per week | | | Course Credits | Examination Marks (Maximum / Passing) | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | Theory | | J/V/P* | | Total |
| Lecture | Tutorial | Practical | | Internal | External | Internal | External | |
| 2 | 0 | 2 | 3 | 40 / 14 | 60 / 21 | 20 / 7 | 30 / 10 | 150 / 52 |

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

**Detailed Syllabus:**

| Sr. | Contents | Hours |
|---|---|---|
| 1 | **Classical Sets and Fuzzy Sets:**<br>Classical Sets, Operations on Classical Sets, Properties of Classical (Crisp) Sets, Mapping of Classical Sets to Functions, Fuzzy Sets, Operations on Fuzzy Sets, Properties of Fuzzy Sets, Alternative Fuzzy Set Operations | 03 |
| 2 | **Membership Functions, Fuzzification and Defuzzification::**<br>Features of the Membership Function, Various Forms of Membership Functions, Membership Value Assignments, Assignment by Intuition, Inference and Rank Ordering Methods, Fuzzyfication, Defuzzification to Crisp Sets, Defuzzification to Scalars | 05 |
| 3 | **Classical Relations and Fuzzy Relations:**<br>Cartesian Product, Crisp Relations, Cardinality of Crisp Relations, Operations on Crisp Relations, Properties of Crisp Relations, Composition of Crisp Relations, Crisp Equivalence Relations<br>Fuzzy Relations, Cardinality of Fuzzy Relations, Operations on Fuzzy Relations, Properties of Fuzzy Relations, Fuzzy Cartesian Product and Composition of Fuzzy Relations, Fuzzy Equivalence Relations | 04 |

| | | |
|---|---|---|
| **4** | **Logic and Fuzzy Systems:** Classical Logic, Tautotlogies, Contradictions, Equivalence, Exclusive Or and Exclusive Nor, Logical Proofs, Deductive Inferences, Fuzzy Logic, Approximate Reasoning, Fuzzy Systems, Natural Language, Linguistic Hedges, Fuzzy Rule-Based Systems | **06** |
| **5** | **Fuzzy Classification:** Classification, Classification by Crisp and Fuzzy Equivalence Relations, Cluster Analysis, Cluster Validity, $c$ −Means Clustering, Hard $c$ −Means (HCM), Fuzzy $c$ −Means (FCM), Classification Metric, Hardening the Fuzzy $c$ −Partition | **05** |
| **6** | **Fuzzy Control Systems:** Control System Design Problem, Control (Decision) Surface, Assumptions in a Fuzzy Control System Design, Simple Fuzzy Logic Controllers, Examples of Fuzzy Control System Design, Aircraft Landing Control Problem | **05** |
| | **Total** | **28** |

**List of Practicals / Tutorials:**

| | |
|---|---|
| **1** | Introduction to various Membership functions and their plots |
| **2** | Implement Union, Intersection, Complement and Difference operations on fuzzy sets. |
| **3** | Create fuzzy relation by Cartesian product of any two fuzzy sets and perform different compositions on any two fuzzy relations. |
| **4** | Implement fuzzification and defuzzification of a fuzzy set. |
| **5** | Study of ANFIS Architecture |
| **6** | Implementation of different functions related to Fuzzy Inference System |
| **7** | Implementation of Fuzzy c-Means Clustering. |
| **8** | Implement svm classification by fuzzy concepts. |
| **9** | Write a program to implement a Fuzzy Controller (Washing Machine) |
| **10** | Using Fuzzy toolbox to model tips value |

**Reference Books:**



| | |
|---|---|
| **1** | Fuzzy Logic with Engineering Applications by Timothy J. Ross, Second Edition, Wiley India |
| **2** | Fuzzy Sets, Uncertainty and Information by G. Klir, PHI Publication |
| **3** | Fuzzy Set Theory and Its Applications by H. Zimmermann, Fourth Edition, Springer Publication |
| **4** | Neural Networks, Fuzzy Logic and Genetic Algorithms, Synthesis and Applications by S. Rajasekran, PHI |
| **5** | Neuro-Fuzzy and Soft Computing By J. Jang, Pearson Education |



| **Supplementary learning Material:** | |
|---|---|
| **1** | Lecture Note |
| **2** | https://nptel.ac.in/courses/108104157 |
| **3** | https://nptel.ac.in/courses/106105173 |
| **4** | https://nptel.ac.in/courses/127105006 |
| **5** | https://person.dibris.unige.it/masulli-francesco/lectures/ML-CI/lectures/MATLAB%20fuzzy%20toolbox.pdf |

**Pedagogy:**

- Direct classroom teaching
- Audio Visual presentations/demonstrations
- Assignments/Quiz
- Continuous assessment
- Interactive methods
- Industrial/ Field visits

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

| Distribution of Theory Marks in % | | | | | | **R**: Remembering; **U**: Understanding; **A**: Applying; **N**: Analyzing; **E**: Evaluating; **C**: Creating |
|---|---|---|---|---|---|---|
| **R** | **U** | **A** | **N** | **E** | **C** | |
| 20% | 40% | 30% | 10% | --- | --- | |

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** | Students will be able to differentiate a Fuzzy set, its properties and the operations on Fuzzy sets from their classical set theory counterparts. | **15** |
| **CO-2** | Students will be able to introduce fuzziness in classical relations and perform various operations on fuzzy relations. | **15** |
| **CO-3** | Students will be able to fuzzify a crisp set and defuzzify a fuzzy set. | **15** |
| **CO-4** | Students will be able to develop a Fuzzy rule based inference system. | **25** |
| **CO-5** | Students will be able to apply the knowledge of fuzzy set theory and logic to various applications such as classification, clustering and development of a fuzzy controller. | **30** |

| **Curriculum Revision:** | |
|---|---|
| Version: | 1.0 |
| Drafted on (Month-Year): | June-2020 |
| Last Reviewed on (Month-Year): | - |
| Next Review on (Month-Year): | June-2025 |