# GUJARAT TECHNOLOGICAL UNIVERSITY
## MECHATRONICS ENGINEERING (20)

### SUBJECT NAME: SOFT COMPUTING APPLICATIONS
### SUBJECT CODE: 2172009
### B.E. 7th SEMESTER

**Type of course: Engineering Science (Departmental Elective – II)**

**Prerequisite: N.A.**

**Rationale:** This subject is useful to understand the aspects of artificial intelligence in terms of fuzzy logic and neural network for any mechatronics applications. Concepts of fuzzy logic and neural network explore the area of machine learning to fine tune and improve the accuracy with automatic control structures.

**Teaching and Examination Scheme:**

| Teaching Scheme | | | Credits | Examination Marks | | | | | | Total Marks |
|---|---|---|---|---|---|---|---|---|---|---|
| L | T | P | C | Theory Marks | | | Practical Marks | | | |
| | | | | ESE (E) | PA (M) | | PA (V) | | PA (I) | |
| | | | | | PA | ALA | ESE | OEP | | |
| 3 | 0 | 2 | 5 | 70 | 20 | 10 | 20 | 10 | 20 | 150 |

L- Lectures; T- Tutorial/Teacher Guided Student Activity; P- Practical; C- Credit; ESE- End Semester Examination; PA- Progressive Assessment; OEP-Open Ended problem; AL-Active learning;

**Content:**

| Sr. No. | Content | Total Hrs | % Weightage |
|---|---|---|---|
| 1 | **Introduction to soft computing:** Introduction, Importance of Soft Computing, Main Components of Soft Computing, Fuzzy Logic, Artificial Neural Networks, Support Vector machine, Evolutionary Algorithms, Hybrid Intelligent Systems. | 5 | 5% |
| 2 | **Fuzzy Logic Systems:** Introduction to Fuzzy logic, classical sets *vs* fuzzy sets, Membership functions and its features, Properties and operations on Fuzzy sets, classical relations *vs* Fuzzy relation, Operations of Fuzzy relation, Defuzzification, Fuzzy rule base and approximate reasoning, Fuzzy Inference Systems, Design a fuzzy logic controller: Mamdani & Sugeno Architecture. | 15 | 40% |
| 3 | **Neural Network Systems :** Introduction to Artificial Neural Network, Biological neurons *vs* | 15 | 40% |

| | artificial neural network, Neuron models: McCulloch-Pitts Neuron, Hebb Network, Learning in neural networks: **Supervised Learning Network** – Perceptron, ADALINE, MADALINE, Back propagation network, **Unsupervised Learning Network** – Self organizing Map, Learning Vector Quantization, Adaptive resonance theory. | | |
|---|---|---|---|
| **4** | **Applications of soft computing :** <br> Fuzzy logic and neural network systems in Control System, Automation, Robotics and Machine Vision. | **5** | **15%** |

**Suggested Specification table with Marks (Theory):**

| Distribution of Theory Marks | | | | |
|---|---|---|---|---|
| **Remembrance** <br><br> **R Level** | **Understanding** <br><br> **U Level** | **Application** <br><br> **A Level** | **Analyze** <br><br> **N Level** | **Evaluate** <br><br> **E Level** |
| 40 | 20 | 20 | 10 | 10 |

**Legends: R : Remembrance ; U = Understanding; A = Application and above Levels (Revised Bloom's Taxonomy)**

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

**Reference Books:**

(1)  S. N. Sivanandam, S. N. Deepa, **Principles of Soft computing**, Wiley India Edition.

(2)  Drinkov, **An introduction to Fuzzy Control**, Narosa Publication.

(3)  Ke-Lin Du, Madisetti NS Swamy, **Neural networks in a soft computing framework,** Springer Science & Business Media.

**Course Outcome:**

After learning the course the students should be able to:

1. Develop Fuzzy Inference System for various applications.
2. Integrate and develop Neural Network for various applications.
3. Judge the role played by Mechatronics engineers to automate the process by integrating the knowledge of soft-computing techniques.

**List of Experiments:**

1.  Introduction to MATLAB: Fuzzy Logic Toolbox, Fuzzy Logic Simulink Demos

2.  MATLAB simulation: Fuzzy Logic Controller (FLC) implementation.

3. MATLAB simulation: Simulink Fuzzy Logic Controller (FLC) implementation.

4. MATLAB simulation: Applications of FLC to Control System.

5. Introduction to MATLAB: Neural Network (NN) Toolbox, NN Simulink Demos

6. MATLAB simulation: Artificial Neural Network (ANN) implementation

7. MATLAB simulation: NN Tool Artificial Neural Network (ANN) implementation

8. MATLAB simulation: Various structure of NN algorithms implementation

9. MATLAB simulation: Training Algorithms of ANN.

10. MATLAB simulation: Application of NN to Control System

## Design based Problems (DP)/Open Ended Problem:

Significant part of this course is to study fuzzy logic system and artificial neural network structure. In this students should identify an application area, state the problem, apply fuzzy logic and/or artificial neural networks to solve the problem, present the result, and write a report.

1) Applications of neural network in robot navigation
2) Application of fuzzy logic in control & automation
3) Trajectory prediction using neural networks
4) Fuzzy based robot navigation
5) Noise cancellation using neural networks

## Major Equipments / softwares:

Students may implement open ended problems on some Microprocessors / DSP boards. Computers with MATLAB / Scilab software may serve the purpose

## List of Open Source Software/learning website:

The website of NPTL may be utilized for additional learning.

Open Source Software:  Scilab or C    Other Software(s)   MATLAB® (if license available)

## ACTIVE LEARNING ASSIGNMENTS:

Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.