GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3172009
Semester – VII
Subject Name: Soft Computing

Type of course: Engineering Science (Professional Elective-II)

Prerequisite: Linear Algebra, Set Theory, Biological Systems

Rationale: This subject is useful to understand the aspects of artificial intelligence in terms of fuzzy logic, neural network, and evolutionary algorithms for any mechatronics applications. These concepts 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
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	2	4	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs
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.	6
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.	12
3	**Neural Network Systems:** Introduction to Artificial Neural Network, Biological neurons *vs* 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.	12
4	**Genetic Algorithms:** Concept of "Genetics" and "Evolution" and its application to probabilistic search techniques, Basic GA framework and different GA architectures, GA operators: Encoding, Crossover, Selection, Mutation, etc. Solving single-objective optimization problems using GAs.	6
5	**Hybrid Systems and applications of soft computing:** Fuzzy logic and neural network systems in Control System, Hybrid Systems - Fuzzy Neural, Neuro-Fuzzy, Genetic Fuzzy, Genetic Neural, Applications in automation, robotics and Machine vision.	6

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Suggested Specification table with Marks (Theory): (For BE only)

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
15	**15**	**15**	**15**	**20**	**20**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create 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. Principles of Soft computing, S. N. Sivanandam and S. N. Deepa, Wiley India Edition.
2. An introduction to Fuzzy Control, Drinkov,Narosa Publication.
3. Neural Networks, Fuzzy Logic and Genetic Algorithms: Synthesis, and Applications, S. Rajasekaran, and G. A. Vijayalakshmi Pai, Prentice Hall of India.
4. Intelligent hybrid systems., Suran Goonatilake, and Sukhdev Khebbal (Eds), John Wiley & Sons.
5. Neural networks in a soft computing framework, Ke-Lin Du, Madisetti NS, and Swamy, Springer Science & Business Media.

Course Outcomes:

After successful completion of the course the students shall be able to:

Sr. No.	CO statement	Marks % weightage
CO-1	Develop Fuzzy Inference System for various applications.	25
CO-2	Integrate and develop Neural Network for various applications.	25
CO-3	Develop GA based applications.	25
CO-4	Judge the role played by Mechatronics engineers to automate the process by integrating the knowledge of soft-computing techniques	25

List of Experiments:

1. Introduction to MATLAB / Python Tool for Soft Computing Applications.
2. Introduction: Fuzzy Logic Toolbox, Fuzzy Logic Simulink Demos.
3. MATLAB simulation: Fuzzy Logic Controller (FLC) implementation.
4. MATLAB simulation: Simulink Fuzzy Logic Controller (FLC) implementation.
5. MATLAB simulation: Applications of FLC to Control System.
6. Introduction: Neural Network (NN) Toolbox, NN Simulink Demos
7. MATLAB simulation: Artificial Neural Network (ANN) implementation.
8. MATLAB simulation: NN Tool Artificial Neural Network (ANN) implementation.
9. MATLAB simulation: Various structure of NN algorithms implementation
10. Introduction: Genetic Algorithm (GA), Simulation Demos.
11. Simulation Assignment: Application of Fuzzy / NN /GA to Control System.

Major Equipments/Softwares:

1. All these experimental study with Software Tool: MATLAB.
2. MATLAB contains Control Systems Toolbox, Digital Signal Processing Toolbox, Fuzzy Toolbox, and Neural Toolbox.
3. Students may implement open ended problems on some Microprocessors / DSP boards. Computers with MATLAB / Scilab / Python (open source) software may serve the purpose.

List of Open-Source Software/learning website:

- Demo versions of MATLAB and other control theory related soft wares are available free of cost for limited periods**.**
- NPTEL Swayam Courses may be utilized for additional learning.
- Python based Application Development.