

# GUJARAT TECHNOLOGICAL UNIVERSITY

## COMPUTER ENGINEERING (SOFTWARE ENGINEERING) (02)

### SOFT COMPUTING

SUBJECT CODE: 2740203

M.E. 4<sup>TH</sup> SEMESTER

**Type of course:** Master of Engineering

**Prerequisite:** Nil

**Rationale:** The conventional methods of computing relying on analytical or empirical relations become time consuming and labor intensive to solve some complex problem. Soft computing techniques like Genetic Algorithms, Fuzzy logic and Artificial Neural Network can be applied effectively to solve complex problem. This subject gives understanding of various soft computing techniques.

**Teaching and Examination Scheme:**

Teaching Scheme			Credits C	Examination Marks						Total Marks
L	T	P		Theory Marks		Practical Marks				
				ESE (E)	PA (M)	ESE (V)		PA (I)		
					ESE	OEP	PA	RP		
3	2#	0	4	70	30	30	0	10	10	150

**Content:**

Sr. No.	Content	Total Hrs	% Weightage
1	<b>Introduction</b> What is Soft computing? Necessity of Soft computing, Major Areas of Soft Computing, Applications of Soft Computing	03	10
2	<b>Evolutionary Computing</b> Basic Concepts of Genetic Algorithms (GA), Working Principle, Encoding methods, Fitness function, GA Operators- Reproduction; Crossover; Mutation, Convergence of GA, Multi-level Optimization, Real Life Problems.	04	10
3	<b>Fuzzy Systems</b> Fuzzy Set theory, Fuzzy Relation, Fuzzification, Minmax Composition, Defuzzification, Fuzzy Logic, Fuzzy Rule based systems, Fuzzy Decision Making, Fuzzy Control Systems, Fuzzy Classification.	03	10
4	<b>Neural Networks</b> Basic Concept of Neural Network, Overview of Learning rules and activation functions, Single layer Perceptrons and Learning, Back Propagation networks- Architecture of Back propagation (BP) Networks; Backpropagation Learning; Variation of Standard Backpropagation Neural Network, Introduction to Associative Memory, Adaptive Resonance Theory and Self Organizing Map, Recent Applications.	06	15
5	<b>Hybrid Systems</b> Sequential Hybrid Systems, Auxiliary Hybrid Systems, Embedded Hybrid Systems, Neuro-Fuzzy Hybrid Systems, Neuro-Genetic Hybrid Systems, Fuzzy-Genetic Hybrid Systems.	04	10
6	<b>Evolutionary Design of Neural Networks</b>	04	10

	Genetic Algorithm (GA) based Back propagation Networks, GA based weight determination, Fitness function, Reproduction, Convergence, and Recent Applications.		
<b>7</b>	<b>Fuzzy Evolutionary Algorithms</b> Introduction, Fuzzy control of Evolution, Evolutionary Algorithms with Fuzzy components, GA in Fuzzy Logic Controller, Recent Applications.	<b>04</b>	10
<b>8</b>	<b>Neural Network Based Fuzzy Systems</b> Neural Realization of Basic Fuzzy Logic Operators, Neural Network Based Fuzzy Logic Inference, Neural Network Driven Fuzzy Reasoning, Rule based Neural Fuzzy Modeling, Neural Fuzzy Relational Systems, NeuroFuzzy Controllers, Recent Applications.	<b>06</b>	15
<b>9</b>	<b>Fuzzy Logic Based Neural Network Models</b> Fuzzy Neurons, Fuzzy Perceptrons, Fuzzy Neural Networks, Fuzzy Backpropagation (BP) Networks, Fuzzy BP architecture, Learning in Fuzzy BP, Inference by Fuzzy BP, Fuzzy ARTMAP, Fuzzy Associative Memories, Recent Applications.	<b>06</b>	10

### Reference Books:

1. Principles of Soft Computing by S.N. Sivanandam, S.N. Deepa WILEY India Publication
2. Soft Computing with MATLAB Programming by N.P. Padhy & S. P. Simon by OXFORD
3. Neuro-Fuzzy and Soft Computing: A Computational Approach to Learning and Machine Intelligence by Jyh-Shing Roger Jang Pearson
4. Genetic Algorithms: Search and Optimization, E. Goldberg. ADDISON-WESLEY PUBLISHING COMPANY, INC.
5. Fuzzy Logic and Engineering Application, Tomthy Ross, Wiley Publication
6. Neural Networks, Fuzzy Logic and Genetic Algorithms: Synthesis & Applications, S. Rajasekaran, G. A. Vijayalakshami, PHI.
7. Neuro Fuzzy & Soft Computing - J.-S.R.Jang, C.-T.Sun, E.Mizutani, Pearson Education
8. Neuro-Fuzzy Systems, Chin Teng Lin, C. S. George Lee, PHI
9. Spiking Neural Networks - Wulfram Gerstner, Wenner Kristler, Cambridge University Press.

### Course Outcome:

After learning the course the students should be able to:

1. To know basic idea of modern engineering techniques which are useful for solving non-linear and complex functions that may come across dissertation/research work.
2. To solve various optimization problem.
3. To understand different soft computing techniques like Genetic Algorithms, Fuzzy Logic, Neural Networks and their combination.
4. To implement algorithms based on soft computing.
5. To apply soft computing techniques to solve engineering or real life problems.

### List of Tutorials:

1. Write a program to solve logical AND function using perceptron network
2. Write a program for BPN network for XOR function using bipolar inputs and binary targets.
3. Write a program to train NAND gate using neuro fuzzy hybrid technique.
4. Write a program for Kohonen Self-Organizing map.
5. Write a program to minimize  $F(x) = x^2$  using Genetic Algorithm.
6. Write a program to implement the properties of fuzzy sets.
7. Write a program to create an ART1 network to cluster 7 inputs and 3 cluster units.
8. Study of MATLAB and its soft computing tools.
9. Study of SIMULINK and its soft computing tools.
10. How can you devise an alternative formulation of the fuzzy inversion of matrices?

11. Does the algorithm for computing fuzzy inverse apply to binary matrices? If yes, can you use it for diagnostic applications in switching circuits?
12. Develop mode choice model using Fuzzy Logic.
13. Obtain optimal mix design of Bituminous Concrete using GA or Hybrid system.

**Major Equipment:**

Computer system with latest hardware, Programming language C/C++/Java, MATLAB, SIMULINK

**List of Open Source Software/learning website:**

- OpenNN <http://opennn.cimne.com/>
- SNNS <http://www.ra.cs.uni-tuebingen.de/SNNS/>
- Emergent - Neural Simulation Software
- GUAJE – Generating Understandable and Accurate fuzzy model in a JAVA Environment

**Review Presentation (RP):** The concerned faculty member shall provide the list of peer reviewed Journals and Tier-I and Tier-II Conferences relating to the subject (or relating to the area of thesis for seminar) to the students in the beginning of the semester. The same list will be uploaded on GTU website during the first two weeks of the start of the semester. Every student or a group of students shall critically study 2 papers, integrate the details and make presentation in the last two weeks of the semester. The GTU marks entry portal will allow entry of marks only after uploading of the best 3 presentations. A unique id number will be generated only after uploading the presentations. Thereafter the entry of marks will be allowed. The best 3 presentations of each college will be uploaded on GTU website.