GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Master of Engineering

Level: PG

Branch: Civil Engineering (Transportation Engineering)

Subject Code: ME02069151

Subject Name: Soft Computing Techniques

w. e. f. Academic Year:	AY 2024-25
Semester:	2
Category of the Course:	Professional Elective Course

Prerequisite:	Nil
Rationale:	Engineering is a creative field dealing with complex, unstructured problems influenced by intuition and experience. Conventional methods can be time-consuming and labor-intensive for real-life issues like travel demand modeling, which involves non-linear problems (e.g., routing), variable relationships (e.g., trip generation), and user perceptions (e.g., mode choice). These challenges are difficult to solve mathematically. Soft computing techniques like Genetic Algorithms, Fuzzy Logic, and Artificial Neural Networks offer effective solutions, providing practical tools to address such complexities.

Program Outcomes:

No	Program Outcomes
01	Engage in critical thinking and research to develop solutions to multifold real-world problems.
02	Communicate effectively with the engineering community at large level on complex design tasks & write and present technical reports.
03	Demonstrate a high level of professionalism in handling multidisciplinary and complex traffic engineering problems.
04	Plan, assess, create, integrate, carry out, and oversee complex transportation infrastructure projects in a sustainable local and global context.
05	Address societal issues pertaining to transportation by offering technologically advanced, reasonably priced solutions while upholding high standards of ethics and professionalism.

Course Outcome:

After Completion of the Course, Student will be able to:

No	Course Outcomes	RBT Level

01	Comprehend fuzzy logic and its applications	R, U
02	Recognize artificial neural networks and its applications	U, A
03	Solve single-objective optimization problems using GAs.	U, N
04	Be conversant with artificial intelligent techniques like GA, Fuzzy logic, Artificial Neural Network and their hybrid systems which are used for solving different transportation problems.	A, N
05	Apply soft computing to solve problems in varieties of relevant domains.	R, A

**Revised Bloom's Taxonomy (RBT)*

Teaching and Examination Scheme:

Teaching Scheme (in Hours)			Total Credits L+T+ (PR/2)	Assessment Pattern and Marks				Total Marks
				Theory		Tutorial / Practical		
L	T	PR	C	ESE (E)	PA / CA (M)	PA/CA (I)	ESE (V)	
3	0	2	4	70	30	20	30	150

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	**Introduction to Soft Computing:** Concept of computing systems, "Soft" computing versus "Hard" computing, Characteristics of Soft computing. Some applications of soft computing techniques	4	2
2.	**Genetic Algorithms:** Goals of optimization, comparison with traditional methods, schemata, Terminology in GA – strings, structure, parameter string, data structures, operators, coding fitness function, algorithm, applications.	12	30
3.	**Fuzzy Logic:** Concepts of uncertainty and imprecision, sets, concepts, properties and operations on classical sets & fuzzy sets, classical & fuzzy relations, membership functions, fuzzy logic, fuzzification, fuzzy rule-based systems, fuzzy propositions, and applications.	12	30

4.	**Artificial Neural Networks: Basics of ANN:** Models of a Neuron, Topology, Multi-Layer Feed Forward Network (MLFFN), Radial Basis Function Network (RBFN), Recurring Neural Network (RNN), learning processes: supervised and unsupervised learning. error-correction learning, Hebbian learning; single layer perceptrons, multilayer perceptrons, least mean square algorithm, back propagation algorithm applications.	12	30
6.	**Hybrid Systems:** Fuzzy Neural systems, Genetic Fuzzy systems, Genetic Neural systems	5	8
	Total	**45**	**100**

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks (in %)					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
10	**10**	**20**	**20**	**20**	**20**

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)

References/Suggested Learning Resources:

(a) Books:

1. F. Martin, McNeill, and Ellen Thro, Fuzzy Logic: A Practical approach, AP Professional, 2000.
2. Timothy J. Ross, Fuzzy Logic with Engineering Applications (3rd Edn.), Willey, 2010.
3. Nikola K. Kasabov, Foundations of Neural Networks, Fuzzy Systems, and Knowldge Engineering, MIT Press, 1998.
4. Ahmed M. Ibrahim, Fuzzy Logic for Embedded Systems Applications, Elesvier Press, 2004.
5. Melanie Mitchell, An Introduction to Genetic Algorithms, MIT Press, 2000.
6. David E. Goldberg, Genetic Algorithms in Search, Optimization and Machine Learning, Pearson Education, 2002.
7. Randy L. Haupt and Sue Ellen Haupt, Practical Genetic Algorithms, John Willey & Sons, 2002.
8. S. Rajasekaran and G.A. Vijayalakshmi Pai, Neural Networks, Fuzzy Logic and Genetic Algorithms : Synthesis, and Applications, Prentice Hall of India, 2007.
9. D. K. Pratihar, Soft Computing, Fundamentals and Applications, Narosa Publication, 2008.
10. Jyh-Shing, Roger Jang, Chuen-Tsai Sun, Eiji Mizutani, Neuro-Fuzzy and soft Computing, PHI Learning, 2009.

11. Simon Haykin, Neural Networks and Learning Machines, (3rd Edn.), PHI Learning, 2011.
12. Timothy J. Ross, Fuzzy Logic with Engineering Applications, McGraw-Hill
13. Simon Haykin, Neural Networks, Prentice Hall
14. J.M. Zurada, .Introduction to artificial neural systems., Jaico Publishers
15. H.J. Zimmermann, Fuzzy set theory and its applications., III Edition, Kluwer Academic Publishers, London.
16. Suran Goonatilake, Sukhdev Khebbal (Eds), Intelligent hybrid systems., John Wiley & Sons, New York, 1995
17. Goldberg, D. E, Genetic algorithm in search, optimization and machine learning, Addison-Wesley, Reading Mass.
18. Kalyanmoy Deb, Optimization for Engineering Design – Algorithms and examples, PHI, New Delhi, ISBN-81-203-0943-x.

(b) Student can refer Open source Code and material available for example

1. http://www.iitk.ac.in/kangal/codes.shtml
2. http://lancet.mit.edu/ga/dist/galibdoc.pdf
3. https://books.google.co.in/books?hl=en&lr=&id=W5SAhUqBVYoC&oi=fnd&pg=PR11&d=SOft+computing+course+&ots=et_2Nvjy_4&sig=jDXLrGIeD3zc4QUxvcEvC5FrFY#v=onepage&q=SOft%20computing%20course&f=false

Suggested Course Experiment List:

List of Experiments: (Work in Computation lab.)

1. Problems based on GA and its applications in transportation.
2. Problems based on Fuzzy logic and its applications in transportation.
3. Problems based on ANN and its applications in transportation.
4. Problems based on hybrid systems and their application in transportation.
5. Solving routing problem of mass transit system using GA
6. Developing trip generation relationship using ANN
7. Developing mode choice model using Fuzzy Logic
8. Obtaining optimal mix design of Bituminous Concrete using GA or Hybrid system

****