INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal - 500 043, Hyderabad, Telangana

COURSE CONTENT

SOFT COMPUTING								
V Semester: CSE (DS)								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
ACDD12	Elective	**L**	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
		3	0	0	3	40	60	100
Contact Classes: 48	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes: 48**		
Prerequisites: There are no prerequisites to take this course.								

I. COURSE OVERVIEW:

This course provides a comprehensive introduction to Soft Computing, a collection of computational techniques that aim to model and handle uncertainty, imprecision, and approximation in complex systems. It emphasizes the study of intelligent systems that simulate human reasoning and learning using methods such as fuzzy logic, neural networks, evolutionary algorithms, rough sets, and probabilistic reasoning.

The course also delves into fuzzy logic systems including fuzzy rules, inference models, and decision-making techniques. It covers hybrid models like Adaptive Neuro-Fuzzy Inference Systems (ANFIS) that combine the strengths of neural and fuzzy systems. In the final modules, students apply soft computing approaches to solve real-world problems in diverse areas such as pattern recognition, computer vision, information retrieval, mobile ad-hoc networks, and software engineering. This course equips students with the theoretical understanding and practical skills to design and implement intelligent systems capable of adapting to uncertain and dynamic environments.

II. COURSE OBJECTIVES:

The students will try to learn:

I	The fundamentals and characteristics of soft computing techniques, including fuzzy logic, neural networks, and evolutionary computing.
II	The neural and fuzzy systems, their learning algorithms, architectures, and hybrid models like ANFIS for real-world problem solving.
III	The application of soft computing approaches in areas such as pattern recognition, image processing, mobile networks, and software engineering.

III. COURSE OUTCOMES:

CO1	Understand the fundamental concepts of intelligent systems, soft computing, and their components, including fuzzy logic, neural networks, and evolutionary computing.
CO2	Analyse and apply the principles of artificial neural networks, including learning rules, pattern classification, and multi-layer feed-forward networks for solving complex problems.
CO3	Demonstrate proficiency in fuzzy logic operations, fuzzy inference systems (Mamdani, Sugeno, Tsukamoto), and decision-making under uncertainty.
CO4	Explain the architecture and hybrid learning mechanisms of Adaptive Neuro-Fuzzy Inference Systems (ANFIS) and evaluate their applications in regression and prediction tasks.
CO5	Apply soft computing techniques, including fuzzy logic and evolutionary computing, in diverse

applications such as image processing, computer vision, mobile ad-hoc networks, and software engineering.

CO6   Integrate and utilize fuzzy logic, neural networks, and hybrid models in real-world scenarios, fostering innovative solutions in areas like pattern recognition, decision-making, and system optimization.

IV. COURSE CONTENT:

MODULE – I: INTRODUCTION TO SOFT COMPUTING (10)
Characteristic behavior of intelligent systems, knowledge-based systems, knowledge representation and processing, soft computing characteristics; Constitutes of soft computing: Fuzzy logic and computing, neural computing, evolutionary computing, rough sets, probabilistic reasoning and machine learning.

MODULE – II: NEURAL NETWORKS (10)
Fundamental concepts and models of artificial neural systems: Biological neurons and their artificial models, models of artificial neural networks, neural processing, learning and adaptation, neural network learning rules and comparison; Linearly and non-linearly separable pattern classification; Perception convergence theorem;

Multi-layer feed forward network: Delta learning rule for Multi perceptron layer, generalized delta learning rule, feed forward recall and error back propagation training, learning factors, character recognition application; Associative memory: Hopfield network, bidirectional associative memory, radial basis function networks.

MODULE – III: FUZZY LOGIC AND FUZZY SYSTEMS (10)
Evolution of fuzzy logic, fuzzy sets, fuzzy logic operations, fuzzy relations, fuzzy arithmetic and fuzzy measures, fuzzy rules and reasoning.

Fuzzy inference systems Mamdani fuzzy model, sugeno fuzzy model, tsukamoto fuzzy model, fuzzy modeling and decision making, neuro-fuzzy modeling, input space partitioning and fuzzy modeling.

MODULE – IV: HYBRID SYSTEMS (08)
ANFIS (Adaptive neuro-fuzzy inference systems): Introduction, ANFIS Architecture, and hybrid learning algorithm; Advantages and limitations of ANFIS; Application of ANFIS/CANFIS for regression.

MODULE – V: APPLICATIONS OF SOFT COMPUTING TECHNIQUES (10)
Applications of fuzzy in pattern recognition: Printed character recognition, inverse kinematics problems, automobile fuel efficiency prediction, soft computing for color recipe prediction, applications of evolutionary computing in image processing and computer vision, soft computing in mobile ad-hoc networks, soft computing in information retrieval and semantic web, soft computing in software engineering.

V. TEXTBOOKS:

1. J.S.R.Jang, C.T. Sun, E.Mizutani, "Neuro-Fuzzy and Soft Computing", PHI, Pearson Education, 1st Edition, 2004.
2. Timothy J. Ross, "Fuzzy Logic with Engineering Applications," Wiley India, 3rd Edition, 2004.
3. S. N. Sivanandam, S. N. Deepa, "Principles of Soft Computing," Wiley India, 2nd Edition, 2005.
4. Laurene Fausett, "Fundamentals of Neural Networks: Architectures, Algorithms and Applications", Pearson Education, Inc, 1st Edition, 2008.

VI. REFERENCE BOOKS:

1. Hagan T. Martin, H. B. Demuth,Mark Beale, "Neural Network Design," Thomson Learning. 1st Edition, 2004.
2. Satish Kumar, "Neural Networks – A Classroom Approach," Tata McGraw-Hill, 2nd Edition, 2005.
3. Kishan Mehrotra, Chilukuri. K. Mohan, Sanjay Ranka, "Elements of Artificial Neural Networks," Penram International Publishing India, 2nd Edition, 2004.
4. H. J. Zimmermann, "Fuzzy Set Theory and its Applications," Allied Publishers Ltd, 1st Edition, 2004.
5. John Hertz, Anders Krogh, Richard Palmer" Introduction to The Theory of Neural Computation", Addison –Wesley Publishing Company, 1st Edition, 1991.

VII. WEB REFERENCES

1. http://www.sctie.iitkgp.ernet.in/
2. http://www.rkala.in/softcomputingvideos.php
3. http://www.sharbani.org/home2/soft-computing-
4. http://www.myreaders.info/html/soft_computing.html

VIII. MATERIALS ONLINE

1. Course template
2. Tutorial question bank
3. Tech talk topics
4. Open-ended experiments
5. Definitions and terminology
6. Assignments
7. Model question paper – I
8. Model question paper – II
9. Lecture notes
10. PowerPoint presentation
11. E-Learning Readiness Videos (ELRV)